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Frederick Rowe Davis, *Banned: A History of Pesticides and the Science of Toxicology* (Yale University Press, 2014). ISBN: 978030020517

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Introduction by Michael Egan, McMaster University

At the 2006 ASEH annual meeting in St. Paul, MN, a well-attended roundtable session explored the interface between environmental history and the history of science. With a few exceptions, these two historical subdisciplines possessed very little overlapping literature. Yes: environmental historians engaged with science, and historians of science discussed the physical environment. But the historiographies were quite distinct. The question the panel and the audience addressed during that session was why the lack of common ground. Ron Doel, Carolyn Merchant, Gregg Mitman, and Ed Russell provided good and thoughtful answers and offered directions for more fruitful interactions between the disciplines.

Almost ten years removed from that session, it seems a curious topic of discussion that environmental history and the history of science required couples counseling. During the intervening years, histories of science and the environment have experienced a marked rapprochement (helped in no small measure by forays into STS). More and more studies treat the interstices between science and environment. The traditional tensions are less evident and historical scholarship is the richer for it. Frederick Rowe Davis's *Banned* is one of a growing number of titles that bridges this former divide. The account Davis provides is equally adept at recounting changes in scientific knowledge as it is in elucidating the environmental consequences of pesticides in nature. I submit that if chemistry is the science of material change, then environmental historians—inherently interested in materialism—should pay especial attention to chemistry, chemicals, and their histories. And how chemical activity has profoundly altered the environment and human understandings of it.

Given my own interests in chemical history on a polluted planet, I jumped at the opportunity to guest-edit a roundtable on Davis's book. While it would be possible to tell a history of pesticides and toxicology simply by evoking the environmental history canon—Rachel Carson, Barry Commoner, and others could loom large—Davis introduces environmental historians to a relatively new cast of characters, who toil at trying to make sense of the new hazards that confronted the post-World War II world. These toxic histories also invite us to think about different landscapes in our work.[1] In so doing, they merge not just environmental contamination and scientific knowledge, but also a panoply of public health, policy, and social justice questions that demand expansive analysis. And that is before environmental historians explore the uncertainties, agnotologies, risks, and expertises that constitute the epistemological accounts of understanding ecological distress induced by chemical contamination. Stories of pollution remain fertile ground.

[1] See, for example, Nancy Langston, *Toxic Bodies: Hormone Disruptors and the Legacy of DES* (New Haven: Yale University Press, 2010); Linda Nash, *Inescapable Ecologies: A History of Environment, Disease, and Knowledge* (Berkeley: University of California Press, 2006); and Christopher R. Sellers, "Thoreau's Body: Towards an Embodied Environmental History," *Environmental History* 4 (1999), 486-514.

Banned rewards inquiries from a variety of different perspectives, and invites different interpretations from scholars of diverse backgrounds. As a result, it seemed appropriate to recruit reviewers who represented some coverage of this breadth. Inasmuch as disciplinary labels and backgrounds fail to adequately represent any scholar's work, I asked **David Hecht** to examine *Banned* from his training in the history of science. Hecht also shares with Davis a research interest in Rachel Carson, which seemed to merit some interaction. Having shared a couple of panels with **Rachel Rothschild** in the recent past—and admiring her felicity at working seamlessly across environmental history, the history of science, and policy history—I was especially interested to get her perspective on Davis's interpretations of toxicology at that intersection. **Max Liboiron's** work offers a novel reading of the communication of risks and environmental action against invisible threats. Finally, **Jody Roberts** has been spearheading numerous science/environment/policy projects at the Chemical Heritage Foundation. His work on the Toxic Substances Control Act (which he notes below) offers an important lens through which to consider *Banned*.

In closing, I should like to thank Christopher Jones for the opportunity to curate this roundtable. And I am especially grateful to the roundtable contributors for their efforts in submitting their reviews. As ever, *H-Environment Roundtable Reviews* is an open-access forum and is available to scholars and non-scholars alike, around the world, free of charge. Please circulate.

Comments by David Hecht, Bowdoin College

What would it look like to write a history of pesticides that does not focus on *Silent Spring*? In his impressive and authoritative study *Banned*, Frederick Rowe Davis does not go quite that far: he recognizes and appreciates Rachel Carson's important role in the history of pesticides and of environmental risk assessment. But he offers us a new way of seeing those histories, one in which the highly public DDT debates of the 1960s are simply a chapter in a decades-long quest to properly understand and regulate toxic chemicals. Moreover, it is far from clear that this story ends happily. DDT was banned for most domestic uses in 1972, but its replacements are arguably more dangerous to human and environmental health. Among the many things that become clear in the pages of *Banned* is that reckoning with pesticides has been a complicated task – technically, environmentally, and politically. It is therefore both rewarding and illuminating to read Davis' take on the subject, which places the publicly visible history of pesticide debates within an intertwined history of the science and regulation of toxic chemicals across the twentieth century.

Fittingly, Carson and *Silent Spring* play critical but decidedly supporting roles in the story that Davis tells: direct discussion is largely limited to one chapter. Conceptually, however, both loom large. "As I originally understood the story," Davis writes in the preface, "*Silent Spring* was a significant catalyst in the environmental movement of the 1960s and 1970s as well as in the banning of DDT" (x). The rest of the book unfolds as a test, and corresponding revision, of that thought. The resulting history of toxicology significantly complicates our understanding of the science, politics, and consequences of chemical pesticides. From this vantage point, the 1962 publication of *Silent Spring* looks less like a singular moment, and more like one of a number of instances – such as the elixir sulfanilamide tragedy in 1937 or the cranberry scare of 1959 – in which technical matters became politically and publicly relevant. That it was perhaps the most visible and culturally resonant of these events should not obscure its fundamental similarity to those other moments.

That story, Davis argues, does not even begin with pesticides. The toxicological tools that were in place by the time Carson began researching *Silent Spring* were developed over many decades, and were often prompted by research into food and drug safety. Elixir sulfanilamide provides an early, compelling example. One of a number of drugs to take advantage of the therapeutic properties of sulfanilamide, it proved toxic. Within three months of its September 1937 entrance onto the market, it had killed 93 people across fifteen states (22). Such results could not escape media and regulatory notice, nor the attention of researchers. The development of the LD_{50} standard (which marks the lethal dose for 50 percent of a given population) was an important consequence of this work, as were methods for determining dose-response curves (28). These years also saw the emergence of a focus on chronic as well as acute toxicity – although this change was slower to occur and in fact was one of the major concepts that Carson would popularize in *Silent Spring*. Overall, Davis

writes, researchers in the 1930s "transformed toxicology from the study of the effect of a single dose on a single animal to the sophisticated statistical analysis of dose response curves necessary to understand the toxic effects of drugs and other chemicals on various animals and humans" (26). Among other things, this powerfully suggests that we can understand *Silent Spring* as a very successful – but not unique – attempt to bring toxicological research to bear on policy debates. Davis details how the Federal Food, Drugs and Cosmetics Act (1938) and the Federal Insecticide, Fungicide, and Rodenticide Act (1947) depended on making policy calculations using the best available data. So too did the peacetime use of DDT, which was extensively studied during and after World War II. "It is safe to say," Davis writes, "that no chemical before had received such extensive study from such a wide range of scientists: economic entomologists, laboratory scientists, wildlife biologists, public health officials, and doctors" (69). Pesticides may have been overused in midcentury America, but this did not happen out of scientific neglect.

It may have emerged out of uncertainty. One of the key points Davis makes is that establishing toxicological profiles for different chemicals was difficult. DDT research, he argues, proved a major impetus for refining methods of determining toxicity – particularly with regard to chronic rather than acute effects. As late as 1951, when a congressional committee began soliciting testimony in what became known as the Delaney Hearings, lawmakers were confronted with uncertainty on a number of counts, such as with effects on human health and with the prospect of insect resistance to pesticides (131). Uncertainly could take multiple forms: conflicting evidence, divergent interpretations of evidence, or recognition of the limits of existing studies. As in previous hearings, "legislators were asking the questions that needed to be asked, but concrete answers remained elusive as the opinions of experts from the USDA, the FDA, industry, and academia diverged widely" (151). Ultimately, Congress agreed to insert an amendment to the Federal Food, Drugs and Cosmetics Act which prohibited approving an additive "if it is found to induce cancer when ingested by man or animal" (150). This was a potentially far-reaching change. But it underscores the connection between science and policy that Davis' story works hard to establish. The Delaney Clause gave federal agencies latitude to act, but also directed them to demonstrate carcinogenic effects using the very same science that was so often uncertain and limited. To properly appreciate the history of pesticide regulation, we need to understand the history of both science and regulation. One of the most compelling aspects of *Banned* is that – for all Davis' meticulous reconstruction of experiments and toxicological debate – he never loses sight of the connection between these two. The complexities of toxicology are a central part of the story of pesticide policy.

So is institutional history. Many organizations, both in and out of government, were involved in developing toxicological profiles of DDT and other pesticides. Of particular interest is the University of Chicago Toxicity Laboratory and its influential principal investigator, E.M.K. Geiling. Funded during World War II by the Office of Scientific Research and Development, Tox Lab scientists "evaluated the toxicity of several thousand potential chemical warfare agents, including nitrogen mustards,

antimalarial drugs, radioisotope markers, and organophosphate poisons" (75). Although it has not become mythologized in the same way as the Manhattan Project (which itself had a laboratory at the University of Chicago), the Tox Lab was an example of "big science" that mirrored the atomic bomb effort in both wartime and postwar significance. It was an essential producer of information, personnel, and research methods; as Davis makes clear, the development of toxicology as a distinct discipline owes much to the Tox Lab. One crucial area of study was joint toxicity. Pesticides do not act in isolation. They combine in ways that are not always obvious: "the effectiveness or toxicity of a chemical mixture could not be assessed from that of the individual components, but rather depended on knowledge of the chemicals' joint toxicity when used in different proportions" (81). The conceptual advance here was important, but so too was the kind of disciplinary rigor and intellectual work it demanded, including novel methods of experiment and statistical analysis. By the time that Carson began to research the matter, there was a robust and developing toxicological enterprise in the United States – a fact with which she would have been familiar given her work with the U.S. Fish and Wildlife Service, and which is amply reflected in her citations in *Silent Spring*.

The stage is now set for the major irony of the story. Davis' use of the history of science has prepared us to understand quite well what happened – and what did not – in the period of activism between 1962 and 1972. DDT belongs to a class of chemicals known as the chlorinated hydrocarbons, a group that is distinguished by comparatively low acute toxicity but also by strong persistence in the environment, as well as in animal (including human) bodies. This raises the specter of chronic effects, and proved to be a large reason why the Environmental Protection Agency heeded Rachel Carson's warning about DDT. To a large extent, however, it was replaced by chemicals known as organophosphates, which break down more quickly but have a significantly higher acute toxicity. Therefore, what shifted was the method and nature by which Americans used poison, not whether they did. Among the interesting (and poignant) effects of this switch is that it defined new victim groups: farm workers rather than consumers were at greater risk for acute toxicity. Wildlife and children were also highly susceptible. Little in *Silent Spring* itself necessitated this choice, as Carson wrote about the dangers of both groups of pesticides. Instead, the policy changes reflected the same mix of science and politics – and the same wrestling with evolving technical understanding – that had characterized the first two thirds of the century.

Carson scholars (myself included) have much to gain from considering pesticide history in this light. For one thing, it provides a path toward understanding where Carson fits into the history of scientific thought and not merely its popularization. For another, it contributes to recent work which emphasizes the unfinished nature of Carson's project. More broadly, *Banned* serves as an excellent model for how to combine the history of science and environmental history. Davis is clearly well versed in both fields, and after reading his excellent, intertwined tale it becomes difficult to imagine how (or why) we might re-separate them. The history of toxicology cannot be understood with appreciating its political and social context,

one which increasingly demanded answers that necessitated new investigative tools. Similarly, environmental history must take into account the ways that available scientific information structured how it was possible to think and to talk about toxic dangers. And the same is true of regulatory history. Weaving these multiple strands together, *Banned* demonstrates that a history of pesticides which de-centers Carson is not only possible, but fascinating and important.

Comments by Rachel Rothschild, New York University

The fields of environmental history and the history of science have largely developed independently in the United States, with different methodologies, topics of interest, and disciplinary norms. Yet in recent years, a growing number of historians have attempted to bridge these two subfields in their scholarship, particularly on topics concerning 20th century chemicals in the environment.[2] In part, this is because it is difficult to understand the history of manmade chemical toxins without addressing both the laboratories and factories that created them or the scientists and technologies that detected their environmental impact. It is also equally challenging to explain the formation of new environmental scientific disciplines without understanding changes in threats to the natural world and the corresponding social and political movements to address them.

Frederick Rowe Davis's *Banned* is a superb attempt to bring these two historical disciplines together through an examination of both the history of pesticides and the corresponding development of the science of toxicology in the U.S. It is thus worth examining what it contributes to each field, as some of the challenges in integrating them are evident in a few places in the book. Covering a century of developments in toxicology from start to finish, the book's stated ambition is to resituate Rachel Carson's *Silent Spring* in the larger history of environmental science and regulation by tracing the pesticide studies which undergirded Carson's singular tome. Through this examination, Davis brings attention to the importance of these efforts not only for the formation of a distinct science of toxicology but also in influencing legislative and public debates over the risks and benefits of DDT, dieldrin, and other potentially harmful chemicals. Indeed, the book's most novel contribution is that it redirects our attention away from Carson and towards the significant changes in the emerging science of toxicology in the years after World War II. Davis demonstrates that a key group of pharmacologists at the University of Chicago's toxicity laboratory came to have a significant influence on how American scientists and government officials perceived the environmental risks of pesticides well before the publication of *Silent Spring*.

The book begins by reviewing several key medical disasters that altered the U.S. government's involvement in protecting public health from new chemical

[2] Notable examples include Joshua Blu Buhs, *The Fire Ant Wars: Nature, Science, and Public Policy in Twentieth-Century America*, 1 edition (Chicago: University Of Chicago Press, 2004). David Kinkela, *DDT and the American Century: Global Health, Environmental Politics, and the Pesticide That Changed the World*, 1 edition (Chapel Hill: The University of North Carolina Press, 2013). Nancy Langston, *Toxic Bodies: Hormone Disruptors and the Legacy of DES* (Yale University Press, 2010). Edmund Russell, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* (Cambridge University Press, 2001). Christopher C. Sellers, *Hazards of the Job: From Industrial Disease to Environmental Health Science* (UNC Press Books, 1999). Brett Walker, *Toxic Archipelago: A History of Industrial Disease in Japan* (Seattle ; London: University of Washington Press, 2010).

therapeutics and launched the careers of many pharmacologists who would later play important roles in defining potential threats from pesticides. Most notable is the case of Elixir Sulfanilamide, which led to serious side effects and sometimes death in patients treated with the untested drug combination. While these episodes have been discussed by other scholars, Davis is the first to examine them in the context of burgeoning toxicological studies at the University of Chicago and the U.S. Food and Drug Administration. In doing so, he shows how the public health crises caused by Elixir Sulfanilamide and other harmful medical treatments helped solidify the major research questions that would come to guide toxicological studies in early 20th century. As just one example, Davis discusses how the concept of "LD_{50}" emerged from studies of these drugs in order to measure acute toxicity and was eventually adopted by researchers in both government and industry (pp. 27-29). Davis argues that such public health disasters not only helped scientists better understand the synergistic effects of chemicals on the human body – an insight that would prove very applicable in debates over pesticides – but also the ways in which members of the same species could exhibit different physiological responses to similar dosing. These findings came to have serious implications when considering the effects of pesticides on vulnerable segments of the population, notably children.

Studies of the drug disasters were spearheaded by the University of Chicago's Eugene Geiling, whose laboratory was subsequently chosen to oversee defense research on antimalarial drugs and chemical warfare during World War II. Based on this work, Geiling's research group became the logical home of government studies on insecticides when they were introduced into the war effort. Davis explores how these investigations began to deepen scientific understanding of a particularly deadly class of insecticides: organophosphates. Several toxicological concepts were developed to assess the potential dangers of these chemicals for public health, especially when subjects were exposed to multiple types at once, known as "potentiation" (pp. 113-114). As a result of this research, Congress held several hearings to consider what kind of action the government should take, if any, to prevent insecticides from harming the environment or exposed persons in the early 1950s. Davis notes that the scientific testimony left little consensus for policymakers to use in formulating regulations, yet nonetheless led to the "Delaney Clause" which granted the Food and Drug Administration authority to restrict any chemicals in foodstuffs found to be carcinogenic (pp. 150-151). These were followed by further hearings after Rachel Carson's publication of *Silent Spring*, which brought Carson and the University of Chicago toxicologists together with other prominent researchers to debate the relative dangers of DDT and the organophosphates.

In reexamining the scientific testimony on pesticides from university, government, and industry experts, Davis's narrative departs from several recent historical works in the history of science that expose the ways in which certain economic interests have tried to cast doubt on environmental science. Instead, Davis focuses on the U.S. government's questionable decision to ban DDT in 1972 after these hearings and the Presidential Scientific Advisory Committee's review of the issue. As a result of the U.S. ban on DDT, Davis shows that agribusiness turned towards pesticides with

fewer risks to wildlife through bioaccumulation but greater toxic dangers for humans who experienced acute exposures. Several of the toxicologists Davis profiles in these hearings, notably Kenneth DuBois, presciently feared that removal of DDT would result in the greater use of organophosphates that have long been shown to be highly neurotoxic. In the final chapter and epilogue, Davis vividly describes the consequences of the increasing use of organophosphates for the environment and public health since the DDT ban, and issues an appeal for more thoughtful risk assessments when dealing with the introduction of new insecticides in future decades.

Overall, *Banned* reveals the key scientific and political debates that shaped pesticide use and its environmental impacts, and the book is particularly significant for bringing attention to the important research that laid the groundwork for Carson's *Silent Spring*. Yet one of the aspects of *Banned* I struggled with the most was the ostensible historical connections between Carson and the community of toxicologists profiled in the book. Without a doubt, Carson drew on the scientific work done by those such as Geiling and Dubois; a cursory look at her notes to *Silent Spring* includes citations to the latter as well as many other prominent toxicologists of the time. But in his chapter on rereading Carson's *Silent Spring*, Davis doesn't connect the toxicological studies he discusses with Carson's work beyond pointing out that she based her book on this research and gave concurrent testimony with many of these scientists during Congressional hearings on pesticides in the 1960s. I suppose I wanted to see Davis deal more directly with the issue of how the emerging science of toxicology influenced *Silent Spring* and its reception. He fittingly credits Carson with galvanizing the public in a way that the scientists he profiles did not, but does he really believe that "the consolidation of toxicology as a discipline among government and academic researchers had little impact on popular conceptions of changes in the natural world" (p. 157)? It seems doubtful we could have had *Silent Spring* without the work of scientists like Geiling and Dubois; while Carson may have given an accessible, powerful voice to their research, it is difficult to imagine how her book could have had the influence it did without the findings of these toxicologists. Thus, I am interested to learn more about what Davis thinks the significance of the emerging science of toxicology was for *Silent Spring* in particular as well as broader conceptions of the environmental risks from chemicals within the public sphere.

The book is written with an impressive attention to scientific detail as well as the ways in which toxicology crystalized as a discipline, but I would have also liked to better understand the people behind these discoveries: their motivations, personal interest in toxic chemicals, and views of their role as scientific experts at a time when the U.S. government was increasingly incorporating technical views into legislation. Primarily reliant on scientific journals and Congressional materials, *Banned* would have benefitted from sources that could provide greater insight into the backgrounds of the scientists it discusses. How did they view their obligations to the American public or the federal government in raising awareness about the dangers of pesticides? An examination of this issue could reveal why it was that

Carson – rather than the scientists most involved in this research – became the face of the environmental movement.

Pesticides have left an extensive environmental footprint on the U.S., ranging from their long noted effects on wildlife to their more recently acknowledged implications for cognitive development in humans. Davis points to several such damaging consequences from the introduction of these chemicals into ecosystems over the past century. However, there were several places in the book where I thought Davis could have done more to directly address how pesticide spraying has impacted the environment. For instance, the reader is presented with several tables that chart the rise of insecticide use in the U.S. from 1919 to 2002. Yet how these changes affected the natural world beyond science and politics is given brief mention, such as where Davis notes that one particularly hazardous pesticide, Diazinon, has caused the second largest number of bird deaths of any pesticide (p. 210). This is perhaps one of the central challenges of writing at the crossroads of the history of science and environmental history – it is a delicate and demanding balance to move between histories of science, politics, and nature. Davis does this admirably, if giving greater attention to the evolution of the science of toxicology than the environmental changes caused by pesticides.

Ultimately, *Banned* is an important contribution to our understanding of how environmental science took shape in the U.S. and the struggle to enact meaningful legislation to address the harmful effects of pesticides. I can easily envision incorporating this book into my course on the history of pollution, and it will be essential reading for both historians of science and environmental historians who work on topics at the intersection of environmental science and government policy.

Comments by Max Liboiron, Memorial University of Newfoundland

Frederick Rowe Davis's *Banned: A History of Pesticides and the Science of Toxicology* (2014) is a close reading of key 20th century experiments, legislative hearings, events, and texts to investigate how scientific facts and legislative decisions about pesticides were made. While the book follows how toxicology became the gold standard discipline in the regulation of harmful chemicals, it pays equal attention to the roles of personalities, budgets, legislation, and labs in how chemical harm was defined. Davis isolates key moments—in experiments, health crises, and testimonies—where open concerns were settled, and different techniques and meanings of harm were solidified and naturalized through legislation. This research is important for scholars dealing with present-day topics in pesticides and other industrial toxicants. A history of how toxicity came to be understood at a particular time in reference to a specific chemical can help us denaturalize theories of chemical harm and standards of evidence so we might better grapple with the threats posted by industrial chemicals today.

The methodology of the book is striking. Davis conducts line-by-line, close readings of primary materials like experiments and testimonies. The extreme detail is useful for readers with stakes in the various case study, and close readings of experiments will be familiar to researchers in science and technology studies, but the detail can also be exhaustive. However, there is a summary at the start and end of each chapter that facilitates moving through the book and allows readers to choose which chapters and sections are the most important. Moreover, while the text is focused tightly on its case study of pesticides, particularly DDT and organophosphates, and does not theorize or extrapolate into other types of toxicity or harm, readers familiar with the history, science, and legislation of other toxicants will see points of convergence. Because of its concentration on details and its focus on particular chemicals, the text is best suited for readers who are already familiar with toxicology, pesticides, or industrial toxicants and are looking for nuance or new cases, rather than readers who are coming to the issues for the first time. However, given some knowledge of the topic, the reader can easily and productively see how the text is engaging in wider discussions about risk, harm, and links between science and action.

Banned opens in the early 20th century before toxicology was an acknowledged professional discipline. It looks at the professionalization of industrial and occupational disease that created methods for quantifying toxic materials like lead; a health crises from ingesting "Ginger Jake" that failed to capture public or political attention; and finally the key event in the birth of toxicology and legislative action: the US-wide epidemic of Elixir Sulfanilamide poisonings that lead to the launch of modern methods of toxicology such as determining quantitative lethal doses and animal experimentation which in turn supported the revision of an ineffective 1906 Pure Food and Drug Act. The text traces a sort of coalescing, rather than a linear

progression of, knowledge about toxicity, even though the text flows in chronological order.

The following chapter also highlights how different studies, standards, and points of view on DDT coalesce, but never fully reach consensus in the 1940s and 50s. Scientists scrutinized DDT during and after WWII to a degree than no other chemical had ever received. Economic entomologists, laboratory scientists, wildlife biologists, public health officials, and doctors contributed to the scientific discussions and refined laboratory methods such as the use of the LD50 (lethal dose for half a sample) as the benchmark standard of acute toxicity. While concerns about the chronic effects of the pesticide were voiced, the pesticide became ubiquitous in military and agricultural spaces.

The rest of the text follows a similar pattern, whether considering the invention of new classes of pesticides to the eventual banning of DDT in 1971. Each chapter shows how the insistent but dynamic materiality of industrial pesticides makes scientific and political consensus difficult. The text documents a search for evidence of harm. Each case highlights problems that lively industrial chemicals used in pesticides present for certainty, containment, and risk.

What is most surprising, and also potentially the most useful to a range of researchers, is that debates about toxicity in the 1930s, 50s, and 70s are similar to those happening today. In his conclusion, Davis warns that, "[i]t would be foolish to overdraw comparisons between the past and present, yet the similarities speak to our discussion of risk, benefit, and uncertainty" (222). It is more than just ongoing debates about risk, benefit, and uncertainty that resonate with the present today. Competing theories of toxicity—where harm is, how it works, and how to make it manifest enough for action— clearly map onto those in contemporary debates about endocrine disruptors or persistent organic pollutants. The search for evidence of harm is still plagued by questions of acute versus chronic exposures, mortality versus morbidity as endpoints, ranges between "wild" versus laboratory studies, using tissues as endpoints versus using an entire organism to document harm, the ability to extrapolate animals studies to humans, and even the comparison of different species in laboratory studies. Toxicology's methodologies are still up for debate, fifty or more years after their institutionalization and the politics of evidence are nearly the same.

For example, the testimony of a Connecticut physical named Morton S. Biskind in the 1952 *Delancey* hearings raises the same issues about finding evidence of harm that are contested in bisphenol A (BPA) and brominated flame retardant (BFRs) debates today:

> "He argued that exposure to DDT was virtually universal and that it was impossible to separate the effects of direct exposure and those that occurred following ingestion of contaminated food. Even specimens of mother's milk from patients with a history of exposure

> showed DDT. Cow's milk offered no alternative, Biskind argued, since USDA reports indicated that samples contained 0.5 to 25 ppm of DDT" (125).

Davis' history, and particularly its comparison to current debates, show that theories of what toxicity is and how it works does not entail a linear progression of learning one thing after another and fixing each in place to be built upon, but a back and forth of forgetting, remembering, contest, and disagreement.

Banned also demonstrates how facts are made within wicked problems. Wicked problems (Rittel & Weber 1973) are difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize.[3] They are problems within problems, so solving one aspect of the issue may cause a negative ripple effect in an adjoining area. These problems are simultaneously technical, scientific, social, political, and economic. *Banned* attempts to capture this complexity, and traces what stuck and became a fact (and then a law, in some cases), while other claims remained unmoored and were never acted upon. When Davis shows how government regulatory agencies where thoroughly "captured" by industry imperatives and highlights the excruciating slowness of legislation as government agencies dealt—or failed to deal—with harmful chemicals already in the public realm, he is showing how toxicity is not just a scientific problem.

Wicked problems are a defining feature of 21st century crises, whether they are primarily thought of as environmental, economic, or social problems. The scale, severity, and complexity of problems is increasing, from human and ecological health threatened by ubiquitous pesticides to global economic depressions, debt, and the bankruptcy of entire nations. *Banned* is a microcosm of the assembled actors and conditions that make up these crises, and offers a framework to think through large controversies and movements by doing close readings of key events or artifacts. A history of toxicology might seem to be a technical story at first blush, but is always already a story about power and economics. This is the way such stories should be told, so we can remember to bring social and political actions to bear on "technical" problems. As such, I will end with the *Silent Spring* quotation Davis uses to open the book:

> "When the public protests, confronted with some obvious evidence of damaging results of pesticide applications, it is fed little tranquilizing pills of half truth. We urgently need an end to these false assurances, to the sugar coating of unpalatable facts. It is the public that is being asked to assume the risks that the insect controllers calculate. The public must decide whether it wishes to continue on the present road, and it can do so only when in full possession of the facts."

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[3] H. W. Rittel & M. M. Webber, "Dilemmas in a general theory of planning," *Policy Sciences*, 4:2 (1973), 155-169.

Comments by Jody Roberts, Chemical Heritage Foundation

In his new book, *Banned*, Frederick Rowe Davis walks us through the changing landscape of testing pesticides in the twentieth century. The laborious trek through thickets of technical data and congressional hearings provides the reader with a hands-on perspective of process and product. The march is perfect for those in search of the minutiae that stand as artifact or fossil of these changes. But reading the details in this way often comes at the expense of being able to ask the bigger epistemic questions - let alone engaging with them. The result is a fascinating and detailed account of pesticide regulation in the United States in the twentieth century, but little in the way of understanding the how and why of the changes documented in the book.

I finished reading a good part of the book during a trip that took me to the Eastern Shore of Maryland. For those not familiar with the area, or not aware that such a place exists outside of the Maryland that is more synonymous with Baltimore, Washington, D.C., and Ocean City, it is the part of the state that is squeezed - maybe "hugged" - between the Atlantic Ocean and the Chesapeake Bay. Beyond the obvious Atlantic Coast beach towns, the interior of the peninsula is the home to two convergences of the modern and the antiquated: colonial towns now trading antiques and heritage; and vast farmland now mostly producing trademarked seeds of soy and corn. The Eastern Shore is home to a plethora of signs letting you know where George Washington once slept; and a chain of signs letting you know which company's breed of crop is growing on the adjacent plot. The crops are most definitely relics of the modern - and so is their process of production. Indeed, the Eastern Shore has some of the highest levels of atrazine (until recently, the number one pesticide by volume in the country) sprayed on their crops than any other place in the country - equal only in intensity to the corn-belt. That's the nature of the world we live: relics of the past commingle with artifacts of the modern still producing an unknown - and largely unknowable - future.

Davis does a lovely job of showing us what happened on the micro-level of regulating pesticides. I am especially appreciative of his level of attention towards three areas in particular. First, through his examination of the changing nature of health-related research, he documents the change from concerns about acute toxicity (poisoning) towards chronic exposure. This is all the more important because while the researchers conducting work in these areas are solidly found working in the latter category, our public and therefore political discussions still largely reside in the former ("where are the bodies in the streets?!") Second, Davis demonstrates the difficulty that regulators have moving between the human and the non-human. The issue is more complicated that just the technical details of transferability from model to human. Scientists don't use the same language for discussing the exposures and outcomes between the groups either. The tentative connection between animals as proxy for humans in testing is one large reason the European Union is driving scientists to develop and use computational models as

better tools for assessment. Third, Davis draws attention to the difficulties of enforcement. It's one thing to enact a law; it's an entirely different thing to enforce it. The complicated nature of these regulations makes oversight a persistent problem - especially when it's unclear who ought to be doing the enforcing (USDA? FDA?) and where the enforcement ought to take place (on the farm? in the factory? at the store?).

But I need someone to explain to me what's going on - and here is where I run into trouble with the sorts of narratives that *Banned* exemplifies. The characters are flat. Good guys and bad guys are predetermined. A terrible wrong needs to be righted. We can start with the title: banned. Is that the end goal? Because it functions as the central and defining force of the book, it lines up characters (too) neatly on either side - working for or against. Corporate actors (predictably) line up on one side facing off against rogue, renegade scientists determined to have the truth uncovered, heard, and acted upon. Even when the actors do something that seems a bit to the contrary - for instance, when companies begin exploring toxicology in the lab to better understand what the potential harms might be of a new pesticide - their actions are treated with skepticism and a "who'd a thunk it?" attitude. Likewise, heroes are always on the path to truth - fighting the good fight, dogged by industry and other bad actors, but determined to see their work through to the end. The real world is far messier than that.

In 2009, I started a short-lived project examining the history of the Toxic Substances Control Act of 1976 - the primary mode of chemical management in the United States since it covers everything left out of the many legislative statutes and regulations covered by Davis in this volume. The project consisted of just over a dozen interviews with those most intimately involved with the inception, crafting, and implementation of TSCA. At that time, TSCA was under consideration for reform for the first time in its 35 year history (reform didn't happen, but we seem to be on the cusp of that changing right now - perhaps even before these pages will be published). I wanted to chart a narrative that stood outside of the rhetoric that dominated the debates in Washington, D.C., about what proper chemical management would look like. That is, rather than seeing the issue from the perspectives of the American Chemistry Council on the one side and those such as the Environmental Defense Fund or the Safer Chemicals Healthy Families Coalition on the other, I wondered if it might be possible to tell an insider's story from the perspective of those who had written the original statute and those charged with implementing what was largely deemed a flawed law upon passage. And so I spent some thirty hours all told talking with the person who crafted the idea of TSCA (J. Clarence "Terry" Davies) and the person charged with turning that idea into a law (Charles Lettow). There was the person called upon to set up an Office of Toxic Substances at the still-nascent EPA in anticipation of Congressional Action (Glenn Schweitzer), and the person chosen to lead the implementation of this new law once it finally passed (Steve Jellinek, who subsequently decided to merge oversight of TSCA with the Federal Insecticide, Fungicide, and Rodenticide Act, or FIFRA) and his top lieutenants. We spoke to the person who oversaw the submission of the rule to

ban asbestos in 1989 (Chuck Elkins) and the person who inherited the office in the wake of that rule's failure (Mark Greenwood). We spoke with Greenwood's boss, Linda Fisher, who rejoined the EPA in that period of the early 1990s and helped to develop a fast-track system for moving safer alternatives through the new chemicals system more quickly - before departing for Monsanto, a subsequent return to EPA, and then on to DuPont as their chief sustainability officer. We spoke with James Aidala the sociologist plucked from Harvard by Jellinek before finishing his PhD because he had written a paper on the difficulties of overseeing FIFRA at EPA and seemed to understand the intricacies of implementing these complex laws with their inherent scientific and political challenges who left for a position in the Congressional Research Service and the as staff in congressional offices during the Reagan years, but returned to help use the Food Quality Protect Act, or FQPA, to modernize FIFRA and TSCA at the same time by shifting their focus away from old concerns and towards new ones - and trying to bring new resources in to do so. And we spoke with Charlie Auer, who started his life as a bench chemist at EPA in the 1970s, helped to develop the Qualitative (and later Quantitative) Structure Activity Relationship (QSAR) program to creatively overcome data gaps, and found himself the director of the Office of Toxics when the controversial decision was made to regulate nanomaterials as "existing" and not "new."

I recount this narrative because it helped to highlight - for me - the important ways in which individuals make decisions based on what they know in that moment. And through their stories we gain some bit of access to the more difficult question of why things changed by probing the what and the when and the how of the situation. From the perspective of a federal regulator, the management regime of pesticides was *good enough* to be a model for how we might tackle the larger (still unknown at the time) universe of chemicals in commercial production. The story also gives us a glimpse at the dynamic interplay between science, policy, politics, and society. No one was mobilized asking for regulation of chemicals at the time (there were efforts to get more data for work place exposures) when TSCA came into being. And when people (mostly scientists) were mobilizing for action in the early 1990s from the perceived risk stemming from the emerging concern of endocrine disruption, the science as well as the regulation proved to be largely inadequate. For example, we still don't have a standardized, definitive test for endocrine activity or to measure the effects of chemicals in combination - the two tasks given to scientists by the EPA when the FQPA was passed in the 1990s. Some of this is political - if you don't fund it you can't do the research - but some of it is also technical; no model exists for creating such a test. Finally, sometimes good guys and bad guys change teams. Or maybe there aren't any teams at all (except in extreme cases, which are already well documented in books like *Deceit and Denial*).[4] Today's EPA office director is tomorrow's corporate sustainability officer is next week's president of a global non-profit. Sometimes following people - actors, not just their organizations – can take

[4] Gerald Markowitz & David Rosner, *Deceit and Denial: The Deadly Politics of Industrial Pollution* (Berkeley: University of California Press, 2002).

us into a more complicated but nuanced and needed narratives to better understand how the messiness of our world evolved.

Don't get me wrong: I need Davis' appreciation for the details; but I also need the mess. We all do. The power in these narratives is that they give us a sense of appreciating how the present world has been constructed. That's important information for those interested in trying to imagine, create, or build a different kind of future. If you're interested in a more sustainable form of agriculture, you need to know how our current regime of pesticide production, management, and use came about. But we also need to imagine scenarios that disrupt our taken for granted assumptions about who is for and against what. We need our histories to provide us the sort of detail and story that allows us to see differently than we did before so that we can likewise see different paths forward.

Response by Frederick Rowe Davis, Florida State University

It is a gratifying experience to read careful and thoughtful reviews of a study that occupied such a large proportion of my thoughts and time over the past fifteen years. It is a credit to each of the reviewers that they isolate arguments that I tried to make. Each of the reviewers recognized that *Banned* represents my attempt to draw together environmental history, the history of science (and medicine), and the history of environmental policy. Everyone appreciated the details to the development of science and policy with respect to pesticides.

Rachel Rothschild would have liked a clearer connection between Rachel Carson's *Silent Spring* and the development of toxicology by the various scientists I examine. To answer her question about the impact of such research on popular notions of risk, I should clarify by adding, "Before *Silent Spring*" or "In the absence of *Silent Spring*,…" Carson interpreted the toxicologists' findings for the layperson. Interpreted is too weak since Carson had the ability to animate dry research reports with a sense of drama. Moreover, Carson linked the work of the toxicologists to the findings of wildlife biologists to the work of human health experts. Moreover, Carson echoed toxicologists like Arnold Lehman and Kenneth DuBois when she placed pesticides into classes and ranked them. In Carson's hierarchy, organophosphates posed greater risks, on the whole, than chlorinated hydrocarbons. In my future work on *Silent Spring*, I will strive to make these connections clearer.

Rothschild also wonders about the motivations of the scientists in *Banned*. Did they have any sense of a larger purpose in their efforts? Throughout my research, I was struck by the caution on the part of the scientists in extrapolating or generalizing beyond the specific findings of a particular study. The reason for such caution is not obvious. Certain scientists were focused on their academic or corporate careers while others feared public censure. There is no doubt that Wilhelm Hueper was hounded by DuPont representatives throughout his career at NIEHS.[5] Others feared being branded as cranks. Robert Rudd, a wildlife biologist at the University of California – Davis wrote a book about Pesticides and Wildlife that could have scooped *Silent Spring* (or at least reached bookstores before it), but publication was delayed until 1964 (two years after *Silent Spring* and long after the smoke had begun to clear). There is evidence that the decisions that led to the delay of Rudd's book happened at the highest levels of the UC – Davis administration.[6]

Max Liboiron characterizes the regulation of pesticides as the challenge of addressing "wicked problems." What a perfect metaphor! I wish I had known of it when I wrote *Banned* and I am tempted to incorporate the notion into future work. One could say that insect control as a whole (let alone eradication) is a wicked

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[5] See Robert Proctor, *Cancer Wars: How Politics Shapes What We Know and Don't Know About Cancer* (New York: BasicBooks, 1995).

[6] Robert L. Rudd, *Pesticides and the Living Landscape* (Madison: University of Wisconsin Press, 1964).

problem.[7] At the face of it, the problem is simple (as economic entomologists often believed): develop a chemical that is toxic to insects. But beware wicked problems! Not all insects succumb to insecticides; others can develop resistance. The most effective insecticide pose risks to other species, starting with beneficial insects like honeybees and ladybugs not to mention wildlife. One of my mentors, John Wargo, argued that we tend to regulate known risks. Novel insecticides often pose risks that have yet to be revealed. Wicked problems indeed!

David Hecht found a history of pesticides and toxicology that decentered Rachel Carson and *Silent Spring* to be potentially useful to Carson scholars. I should acknowledge, as both Hecht and Rothschild noted, my original purpose in writing *Banned* was to explore (and explain) Carson's sources to *Silent Spring*. Yet, that story took me to the deeper history of toxicology and pesticides of the Twentieth Century. In end, *Silent Spring* claimed part of just one chapter! During the many of years of research, writing, and revision, I worried that someone else would consider pesticides not as individual chemicals (e.g., DDT, Dieldrin, Parathion, Malathion, Permethrin) but as classes of chemicals (eg., Chlorinated Hydrocarbons, Organophosphates, Synthetic Pyrethroids). I began research shortly after Congress passed the Food Quality Protection Act of 1996, which stipulated a review of pesticides beginning with the organophosphates. I do hope that *Banned* will offer other scholars a springboard to other topics on pesticides, toxicology, environmental risk and regulation, and of course Carson and *Silent Spring*. And I plan to join Carson scholars by writing a fine-grained study of Carson's sources to *Silent Spring*.

One of my favorite questions in seminars is, "Is this a story of villains and victims?" Like everyone else, Jody Roberts appreciates the voluminous detail but ultimately he found that the central characters of the story: the scientists, regulators, politicians, and corporate representatives came out flat with predictable roles as heroes and antiheroes. If anything, I tried to emphasize that such characterizations are problematic. Much of *Banned* reveals the broader context for the writings of the individual who serves as the heroine in the story of the DDT ban: Rachel Carson. In fact, I struggled to walk the line between the desire to show Carson's genius in interpreting the dry detail of scientific papers and revealing the wizard behind the curtain.

A few of the actors in *Banned* behaved heroically including Carson and Frances Oldham Kelsey, the FDA regulator who blocked Thalidomide from sale in the U.S. (she died August 7 at the age of 101). But the most prominent heroes and antiheroes in *Banned*, as I conceived it, were the many pesticides that were released to the market as the "magic bullet" in the perpetual battle against insects that threaten public health and the food supply. Certainly, this was the case for lead arsenate, if we are interpret the millions of pounds used in U.S. agriculture during the early

[7] See, for example, Edmund P. Russell III, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* (Cambridge: Cambridge University Press, 2001).

decades of the Twentieth Century. I also tried to show how DDT was received by farmers in the aftermath of World War II (no one made this point better than my father who witnessed the benefits firsthand and distilled for me the experiences of millions of American farmers). The notable successes of DDT during World War II in averting public health threats including malaria and typhus need no recounting here.[8] In the time since *Silent Spring* and DDT ban, environmentalists and historians have reframed DDT as the villain, and surely its long-term effects on birds of prey deserve our attention and their spectacular recovery since the DDT Ban is also highly significant.

Yet, the story that many of us tell in our classes is far too tidy. It goes something like this: Greedy corporations released DDT to American farmers without premarket testing. DDT poisoned birds and other wildlife and posed possible risks for humans as well. *Silent Spring* drew national attention to the problem. The EPA banned DDT and the environment recovered. Like Roberts, I appreciate the messy details that complicate stories that are too neat. What I tried to convey in *Banned* is that DDT was one of hundreds of chemicals, and according to one EPA regulator, the lowest hanging fruit for the simple reason that DDT was <u>not</u> a proprietary chemical: dozens of corporations produced and sold hundreds of different products containing DDT. By banning DDT, EPA shrewdly spread the burden across numerous companies, some of which had already replaced their DDT-containing products with other chemicals including organophosphates. It should come as no surprise that most of the organophosphates were proprietary, meaning one to three companies produced each one. Specific companies reaped the profits from proprietary chemical insecticides. In addition, the passage of FEPCA stipulated indemnification, which meant that the EPA would need to reimburse companies and end users for unused stocks of banned chemicals. Subsequently, EPA faced $20 million in indemnity fees following its ban on Aldrin.

Meanwhile, the real villains in my story were the organophosphate insecticides. Despite their origin in the same German labs that produced nerve agents for potential use during World War II, the organophosphates were widely adopted by farmers along with DDT following the war. Parathion and other organophosphates are among the most toxic chemicals every produced. The DDT Ban deserves celebration, particularly in light of the recovery of various wildlife species. Yet, should we not also be mindful of the chemicals that replaced DDT? If it is difficult to see some of the most toxic chemicals known to mankind as heroic, farmers noted that organophosphates succeeded (read: killed target insects) after DDT and other chlorinated hydrocarbons failed. Use of organophosphates in American agriculture exploded, surging to more than 100 million pounds of active ingredient per year after the chlorinated hydrocarbons like DDT, Aldrin, Dieldrin, and finally Toxaphene were banned. Yet, as Hecht noted, organophosphates were far more toxic in general

[8] David Kinkela, *DDT and the American Century: Global Health, Environmental Politics, and the Pesticide that Changed the World* (Chapel Hill: University of North Carolina Press, 2011).

than most chlorinated hydrocarbons with unintended consequences for wildlife and farmworkers.

My choice of the title *Banned* was meant as ironic or perhaps it reflected a degree of frustration as historian and environmentalist since most of the chemicals used in agriculture and public across the twentieth century have followed a similar trajectory: success following release, diminished returns coupled with concerns about unintended consequences for humans, wildlife, and ecosystems, and finally a ban. It is only a matter a time for the Neonicitinoids highlighted in the epilogue (the European Union has been aggressive in its regulation of Neonics in contrast to EPA). Given the growing concerns regarding honeybees and grassland birds, a ban on Neonics cannot come too soon!

Allow me to conclude by expressing my gratitude to David, Rachel, Jody, and Max for their thoughtful and considerate reviews. Each of them offered enlightening perspectives on the history of pesticides, toxicology, and environmental policy. I also appreciate the efforts of Michael Egan in finding such excellent reviewers and bringing this roundtable to fruition.

About the Contributors

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David Hecht is Assistant Professor of History at Bowdoin College and the author of *Storytelling and Science: Rewriting Oppenheimer in the Nuclear Age* (University of Massachusetts Press, 2015.) He studies public attitudes toward science in modern United States history, and is currently working on a book about the way that Rachel Carson and other bestselling authors have shaped contemporary views of environmentalism.

Max Liboiron is Assistant Professor of Sociology at Memorial University of Newfoundland. Her research focuses on how harmful yet invisible threats such as disasters, endocrine distributors, and marine plastics become visible in science and activism, and how these methods of representation relate to action. Liboiron is founder and director of Civic Laboratory for Environmental Action Research (CLEAR), which creates action-oriented citizen science technologies for environmental monitoring of pollution and waste; and managing editor of the Discard Studies Blog, a public forum for a variety of audiences interested in waste and pollution.

Jody Roberts is Director of the Center for Contemporary History and Policy at the Chemical Heritage Foundation in Philadelphia. In addition to his duties at CHF, Roberts is a research faculty member in the Center for Science, Technology, and Society at Drexel University and lectures in the Department of History and Sociology of Science at the University of Pennsylvania. Among his recent work, he has helped develop "Sensing Change," an art exhibition that explores the role of artists in reconnecting communities to the experience of their local environment as an alternative gateway to conversations about climate change, and a collaborative venture with the University of Pennsylvania's Perelman School of Medicine, "REACH Ambler," which explores the role of history in helping communities to make sense of place and plan for the future. He is also working on a history of green chemistry.

Rachel Rothschild is an Assistant Professor and faculty fellow at New York University's Gallatin School of Individualized Study. Her research focuses on the history of environmental science and technology, particularly its intersection with international policy and global affairs. She is currently completing a book on the history of acid rain pollution, environmental science and diplomacy. You can learn more about her work at rachelrothschild.com.