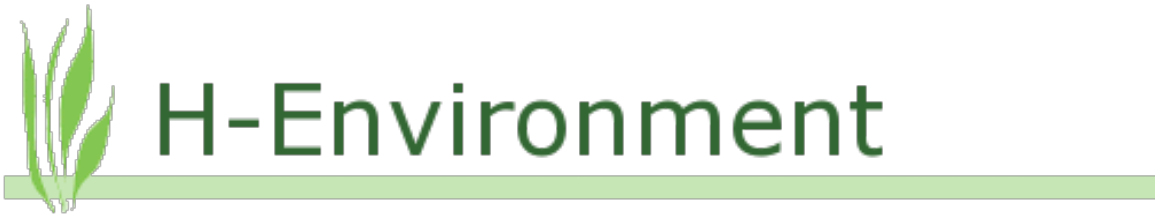

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Nancy Langston, *Toxic Bodies: Hormone Disruptors and the Legacy of DES* (New Haven: Yale University Press, 2010). ISBN: 9780300136074. Cloth. 256 pp.

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Introduction by Jacob Darwin Hamblin, Oregon State University

Our bodies may be toxic waste sites. Today we take it for granted that there are unwanted substances in our bodies, coming from things we've eaten, from drugs our doctors prescribed, from smog, or perhaps from our drinking water. Yet we hope that poison is a matter of dose—that there is a threshold of safety, and that whatever we are carrying is below that threshold. We willingly ingest food preservatives, hormones, and antibiotics, trusting that the experts know what they are doing. After all, if scientists knew these substances to be harmful, governments would ban them. True, there are reasons to be skeptical: we do not always trust governments to make the right decisions, we rarely count on corporations to be ethical entities, and we wonder if scientists have the knowledge, the will, or the power to make a difference. But it is another thing entirely to imagine tossing out the whole notion of thresholds. If the dose doesn't make the poison, what does?

This question stands at the heart of **Nancy Langston**'s book, *Toxic Bodies*. Langston tells us of the synthetic estrogen diethylstilbestrol (DES), a hormone disruptor that doctors prescribed to pregnant women for decades in the mid-twentieth century. Although scientists knew of its potential risks, they were apparently impotent in the face of industry to persuade the U.S. government to impose federal regulations until long after there were names for the victims: DES daughters and DES sons. By the end of the twentieth century, scientists linked the disruption of hormones by synthetic chemicals such as DES to an array of problems: reproductive health in wildlife, birth defects in humans, increases in prostate cancer, infertility, and sexual maturity at young ages. Because hormones regulate communication between cells and organs, disrupting them can have dire consequences in the development of animals and humans.

In telling the story of DES, Langston takes issue with the prevailing idea of threshold doses of exposure. She links DES's history to that of dichloro-diphenyl-trichloroethane (DDT) and to the chemical compounds found in many plastics today. These stories have commonalities, not simply in terms of corporate irresponsibility or scientific uncertainty, but in illustrating how the threshold view of environmental contamination continues to constrain our actions. Langston argues for a new ecology of health emphasizing that "the body is enmeshed in a web of relationships, not isolated within a castle whose threshold can only be breached by a sustained attack from the outside" (p. 147).

I asked **Mark Hamilton Lytle** to comment on *Toxic Bodies* because of my own—and, I imagine, many others'—temptation to draw parallels between the histories of DES and DDT. Lytle's exploration into Rachel Carson's life in *The Gentle Subversive* highlights the dilemmas of setting up adversarial relationships with big industries. The title for *Silent Spring*, for example, was almost *The War Against Nature*, and had started out as *Man Against the Earth*. Even though Carson chose something more

poetic than polemical for her title, Carson's book amounted to a critique of corporate irresponsibility and government complicity. Lytle writes that Carson "taught my generation to appreciate ecology or, what in the early 1960s biologist Paul Sears called, 'the subversive science.'"[1]

Like Lytle, **Frederick Rowe Davis** has researched key figures in the history of conservation and environmental protection, but he also is an expert on the developing science of toxicology during the period discussed in Langston's book. Davis's first book was on the savior of sea turtles, Archie Carr. His latest project is on the relationship between pesticide use and the development of toxicology. It has won substantial financial support from the National Institutes of Health, and will soon appear as *Pesticides and Toxicology: A Century of Risk and Benefit*. While his first book was on the origins of conservation biology, the work on toxicology expands upon his 2001 Yale dissertation on risk assessment from 1936-1997.[2]

Thomas R. Dunlap has written numerous works in environmental history, often with a keen eye toward the history of science. In his 1981 study of DDT, he emphasized the ways in which citizens action groups, such as the Environmental Defense Fund, sought redress in courts and hearings rather than simply relying on publicity or education. Over the years Dunlap has demonstrated wide-ranging expertise in environmental ideas, exemplified by his books *Nature and the English Diaspora* and *Faith in Nature*. More recently he has returned to DDT with an edited collection of "classic texts" for the Weyerhaeuser series at University of Washington Press.[3]

Stephen Bocking is especially interested the development of scientific ideas, fully contextualized in social values and politics. In his 1997 book *Ecologists and Environmental Politics*, he criticized historical outlooks that presented scientists (in Bocking's study, ecologists in particular) as either exemplifying or opposing dominant social values. Instead he proposed studying the diverse contexts in which they worked, fully embracing "the complexity of environmental politics and the historical contingency of the relationship between ecology and social values." These

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[1] Mark Hamilton Lytle, *The Gentle Subversive: Rachel Carson, Silent Spring, and the Rise of the Environmental Movement* (New York: Oxford, 2007), p. 237.

[2] Frederick Rowe Davis, *The Man Who Saved Sea Turtles: Archie Carr and the Origins of Conservation Biology* (New York: Oxford, 2007). Frederick Rowe Davis, *Pesticides and Toxicology: Episodes in the Evolution of Environmental Risk Assessment (1937-1997)* (Ph.D. Dissertation, Yale University, 2001).

[3] Thomas R. Dunlap, *DDT: Scientists, Citizens, and Public Policy* (Princeton: Princeton University Press, 1981); Thomas R. Dunlap, *Nature and the English Diaspora: Environment and History in the United States, Canada, Australia, and New Zealand* (Cambridge: Cambridge University Press, 1999); Thomas R. Dunlap, *Faith in Nature: Environmentalism as a Religious Quest* (Seattle: University of Washington Press, 2004); Thomas R. Dunlap, *DDT, Silent Spring, and the Rise of Environmentalism* (Seattle: University of Washington Press, 2008).

contingencies, and the myriad problems of scientific authority, he discussed in a later book, *Nature's Experts*.[4]

Before turning to the first set of comments, I would like to thank all the roundtable participants for their participation and for their patience. In addition, I would like to remind readers that as an open-access forum, *H-Environment Roundtable Reviews* is available to scholars and non-scholars alike, around the world, free of charge. Please circulate.

[4] Stephen Bocking, *Ecologists and Environmental Politics: A History of Contemporary Ecology* (New Have: Yale, 1997). Quote on p. 203. See also Stephen Bocking, *Nature's Experts: Science, Politics, and the Environment* (Piscataway, N. J.: Rutgers University Press, 2004).

Comments by Mark Hamilton Lytle, Bard College

Some people credit Rachel Carson with mastering three distinctive styles of science writing: natural history (*Under the Sea Wind*), scientific natural history (*The Sea Around Us*), and dystopian scientific natural history (*Silent Spring*). The latter gave birth to a cycle of books that range from muckraking, to scientific detection, and to apocalyptic tales that communicate a sense of imminent environmental disaster, betrayal, and moral outrage. In the very best sense *Toxic Bodies* carries on this last genre. The plot of the story is depressingly familiar to anyone who pays attention to the recurring toxic assaults on the biosphere. A scientist or researcher comes up with a new substance for which a manufacturer, pharmaceutical company, or agribusiness finds a use and often adapts to other financially rewarding applications as well. Evidence exists that the substance has some unintended or undesirable public health effects. Out of fear of losing the golden goose, the producer suppresses, falsifies, or complicates the evidence. In an atmosphere of uncertainty, regulators, who have generally long before become partners with the industry, determine that the benefits from continued marketing outweigh the potential dangers. If reformers press politicians to ban or restrict use, skillful lobbying saves the day. Only if or when researchers find a "smoking gun," concrete proof that links a toxic substance to a specific health issue, do politicians and regulators have the courage to act. By then it is too late for the tens of thousands, sometimes millions, who have served as unwitting guinea pigs in the scientific quest to impose human control on nature. That is the story that Rachel Carson told in *Silent Spring* (1962), that inspired Barry Commoner in *The Closing Circle* (1971), that Richard Kluger told about tobacco in *Ashes to Ashes* (1997), that Gerald Markowitz and David Rosner reveal about PVCs in *Deceit and Denial: The Deadly Politics of Industrial Pollution* (2002), that Tom McCarthy winningly tells about tetraethyl lead in *Auto Mania: Cars Consumers, and the Environment* (2007), and now Nancy Langston about DES. "When will we ever learn?"

The references to Carson are, in Langston's case, neither accidental nor gratuitous. Langston shares with Carson training that is both literary and scientific. She studied English at Dartmouth and Oxford and Zoology and Environmental Studies at the University of Washington. Beyond her scientific training she writes as a historian who knows how to tell a story in which DES (Diethylstilbestrol) takes the lead and sub-plots feature DDT (Dichloro-Diphenyl-Trichloroethane) and PCBs (Polychlorinated biphenyls). Despite having written a biography of Carson, I still can't get beyond the acronym DDT, so I do appreciate someone who understands the biochemistry involved since all three of these chemicals act, outside their intended purposes, as significant endocrine disrupters. As such they have had a major and potentially tragic impact on human and animal reproductive capacities. Like Carson, Langston has the literary sensibility to make even the occasionally daunting science relatively accessible to humanities students and scholars.

Again, in Carson's spirit, *Toxic Bodies,* like *Silent Spring*, begins with an admonitory tale, though unlike Carson's fable Langston's story is all too painfully real and human. Langston once upon a time invited a graduate student to speak to her environmental studies seminar. Maria had grown up in Wisconsin along the Fox River near Green Bay where paper mill discharges included heavy doses of PCBs, as yet not suspected as a carcinogen. During the summers, kids cooled off in the river. Friday nights, Maria's family regularly enjoyed a fish fry at a tavern where the catch came from local waters. Over the years the PCBs accumulated in her body tissue, potentially disturbing her thyroid function, altering brain development, and weakening her immune system. That was not, however, the issue Maria presented to Langston's class. Instead she asked them whether she should breast feed her new infant daughter. Doing so would reduce the PCBs concentrated in her body, but transfer them to her daughter with unknown risks. As Langston puts it, perhaps a bit melodramatically, and perhaps not, "Knowing that her own body was a toxic waste site, how could she breast feed her own child?" (p.viii).

Historians often delve into the past when they face a question they cannot properly answer. And so it was for Langston. She began to wonder about the vast quantities and varieties of synthetic chemicals in plastics, pharmaceuticals, and pesticides that have "permeated bodies and ecosystems throughout the United States, often with profound health and ecological effects, yet the government has largely failed to regulate them." (p. viii). Herein lies the tension that Langston explores. On the one hand, in the 1940s substantial evidence linked synthetic endocrine disrupters, in this case DES, to cancer and other heath risks. Environmentalists argued that a "precautionary principle" should apply, "if an action might cause severe or irreversible harm to complex systems, the burden of proof should be on the industry to show that it is safe, rather than on affected communities to show that it is harmful." (p. ix). On the other side were the industrial spokesmen and lobbyists who complain that regulation without proof of harm limited progress, discouraged innovation, and saddled industry and consumers with unnecessary costs.
The DES story makes a particularly compelling case with which to explore these conflicting points of view. For one, it intersects with Langston's personal history. Members of her family experienced a wide array of unusual cancers and reproductive disorders, all linked to the side effects of endocrine disrupters. And as she wrote the book, rapid fibroid growth required her to have a hysterectomy that revealed she had "no normal uterine tissue" in her "grossly malformed" uterus. The story of DES became her story as well. Another curious aspect of DES is that unlike DDT, it controls no diseases nor does it eliminate threats to the food supply. Scientists first recognized it as a synthetic form of estrogen in 1938. Evidence linking it to cancer and irregularities in sexual development led the FDA to ban it in 1940. In this instance FDA commissioner Walter Campbell invoked what he called "a conservative principle," anticipating the "precautionary principle" by some sixty years.

One year later the FDA reversed that decision allowing doctors to prescribe DES as a treatment for menopausal women. Langston explains why it did so. Her answer

involves more than the politics of public health, though they played a major role. In what is one of her book's most intriguing sub-plots she explores how the understanding (or misunderstanding) of the role hormones play in determining sex and gender and what it means to be female influenced FDA decision making. A *Reader's Digest* article in 1941 informed its 9 million subscribers that a "sensational" drug now existed to relieve the menopausal condition of women over 40. It could offer "inexpensive relief for a dreaded crisis of discomfort and depression." (p. 28). No longer did women have to suffer in silence. The only barrier between them and an end to suffering was the current FDA ban on DES.

The agency understood the risks that DES posed in animal studies. It shared as well the popular engendered notion that women existed primarily as mothers and sexual partners. With DES, medical treatment was now available when those roles changed. The decision to approve it hinged on risk assessment. With cancer or in the case of DDT and malaria, potentially fatal conditions warranted a higher tolerance of risk. By contrast, menopause was a temporary condition, not a threat to life. Yet most physicians viewed menopause as a medical crisis associated with irrationality and depression during which women lost what made them essentially female. As doctors exaggerated the medical consequences, the benefits of hormone therapy seemed to offset the risks DES posed. Within a few years the FDA staff began to ignore the risks completely, assuring women "the results of the investigations demonstrated that the drug could be used with safety if it was used under the direct supervision of a physician." (p. 47).

From then on the barn door was wide open. The FDA shifted away from the "precautionary principle" to enter into a partnership with the drug companies. The burden of proof of harm shifted to those affected. Thus, in 1947 the FDA approved DES for pregnant women with diabetes. Drug companies, competing with a new treatment for menopause, decided to remarket DES. They advertised that all pregnant women should use it to reduce the instances of miscarriage, though no evidence existed that the drug actually had that benefit. From the late 1940s until the early 1970s doctors prescribed DES for millions of pregnancies, most of them involving little or no likelihood of miscarriage. Also by 1947 pharmaceutical companies realized that DES implants promoted rapid growth in chickens and cattle. In that way the drug entered the nation's food supply. Only after the discovery that male agricultural workers exposed to the drug faced sterility, impotence, and breast growth did the FDA in 1959 ban implants in chickens though their use in the beef industry continued unabated. It was not until 1971 that the FDA learned of the occurrence of unusual cases of vaginal cancer in a group of young Boston women whose mothers took DES. Only then did it ban its use. The damage was done, though given the indirect way the drug affected those exposed, the full extent of its harmful consequences are yet unknown.

Langston is persuasive in connecting the FDA's failure to follow the precautionary principle to a set of conditions, some specific to DES and others more a consequence of a generation's commitment to "better living through chemistry." One factor

involved the uncertainties over contemporary definitions of toxicology. Most scientists held to the belief "the dose makes the poison." As a Yale website states, "All chemical substances will exhibit toxic effect given a large enough dose. If the dose is low enough, even a highly toxic substance will cease to have harmful effect." The problem, as Langston explains, is that DES and other endocrine disrupters violate that principle. They are not dose dependent. In fact, they have biological effects at dose levels far below those of other toxins. Further, the effects do not correlate to an individual's size but more to age. Exposed fetuses and infants face far higher risk than adults. Finally, the effects often occur long after the initial exposure, so that affected fetuses may not face cancer or reproductive problems until puberty.

Other uncertainties complicated matters further. Regulators do not treat evidence of harmful effects in animals as proof of risk to humans. Heavy drug company lobbying reinforced that disconnect. Confusion existed about the difference in impact of synthetics and their natural counterparts. Estrogens abound in nature. So why should synthetic versions have a harmful impact when natural ones did not? Additionally, the benefits of using synthetic chemicals are realized collectively and obviously. Feeding DES to cattle increased the supply and lowered the cost of meat. Harm, in contrast, is often experienced privately, belatedly, and indirectly. Affected individuals are often unaware that they are members of an aggrieved class rather than creatures of personal misfortune. Only when researchers recognize a pattern do they connect the dots.

We owe a debt to Nancy Langston for employing her formidable talents as historian, scientist, and concerned citizen to draw our attention to recurring patterns of medical and ecological abuse. People who read this book, and most should, live in the midst of unexamined assumptions and biases Langston cross-examines. How then could one take exception to a book that exposes our anthropocentric assumptions as well as the profound flaws of our regulatory apparatus? I do so only in the spirit of constructive debate since I find so much I agree with. All the same, I have some reservations about the broad use of the word "toxic." The reference to Maria's body as a "toxic site" is in some ways more inflammatory than edifying. Most people associate "toxic" properly with "poison" and while DES, DDT, and PCBs are clearly harmful they are not poisonous in the way most people understand the term. In that regard lead would be a better example of corporate and regulatory malfeasance. The corporate triumvirate of Standard Oil, General Motors, and DuPont who introduced tetraethyl lead into the nation's gasoline, suppressed evidence of its dangers and resisted the shift to unleaded gas even though they new non-toxic alternatives existed. Yet, as with DES, consumers shared some responsibility. They clamored for the increased power and better mileage that Ethyl treated gas offered, even though most understood lead posed health risks. DDT offers an instance where the benefits were so manifold that those who used it had negative incentives to look for risks. Even Rachel Carson recognized DDT's usefulness. Most of her critics failed to note that she never called for its total elimination, but only for more limited and cautious application. Spot spraying was ok; broad aerial campaigns were not.

Readers of *Toxic Bodies* may have a similar misapprehension. Whether we are considering DES or DDT, proper use comes down to judgments over risk. Both Langston and Carson used their literary talents to tell us tales of those who expose us to risk, in part, to maximize profit and of our regulatory guardians who often sided with the foxes eager to enter the hen house. Inevitably moral indignation overwhelms objective judgment. Who cannot feel deep sympathy for Maria and the dilemma she faced? What could those responsible have been thinking, we want to know? Well, often the doctor is thinking about a desperate or unhappy patient for whom DES is about all he has to offer. A farmer worries over the destruction of his crop. Regulators hear the public, no matter how uninformed, clamoring for action. We must also remind ourselves how new drugs come to market. Certainly, Big Pharma plays the "progress involves risk" card to its own advantage. But is that argument, over used and abused as it is, all together wrong? Do not all substances natural and synthetics involve risks to some people? Often, those risks become evident only over time with mass application. Think for example of Vioxx and the other Cox-2 inhibitors. Yes, there was risk, probably unacceptable risk in some cases, but there was also relief for tens of millions. Those who take the muckraking approach might keep in mind a perspective offered by Henry Petroski in his book *To Engineer is Human: The Role of Failure in Successful Design* (1992). Petroski explains how much we value as progress comes out of our experience with disaster. Think what it would have meant if the multiple crashes of the Comet jets in the 1950s had led to a ban on commercial jet aircraft. No Boeing 707 and no cheap international flights. Environmentalists might applaud; most travelers would not.

We owe Nancy Langston a debt for her ability to use history in the service of science and science in the service of history. Even so we need to remember we live in an uncertain world where stuff happens often when people act with the best of intentions. Barry Commoner called it the "technological flaw" and John Kenneth Galbraith reminded us, "It is a commonplace of modern technology that problems have solutions before there is knowledge of how they are to be solved." Or put more simply, as Langston warns us, we come up with solutions such as DES before we know what the problem is.

Comments by Frederick Rowe Davis, Florida State University

In *Toxic Bodies: Hormone Disruptors and the Legacy of DES*, Nancy Langston decisively challenges numerous assumptions regarding human and environmental health. Specifically, she traces the long history of diethylstilbestrol (DES), a hormone replacement drug introduced during the 1920s and 30s and deployed widely for use as a pregnancy drug and as a growth hormone in cattle. Langston's extensive research into the history of DES addresses a series of critical questions: What is the relationship between dose and response in determining risk? What is the role of scientific uncertainty in environmental policy? Does quantitative risk assessment protect public health? Why have industry and regulatory agencies failed to restrict endocrine disruptors in the products we consume? Indeed, Langston argues that endocrine disruptors conflate many of the basic premises of toxicology and quantitative risk assessment. For example, no statement is more fundamental to the science of toxicology than, "The dose makes the poison." Yet, endocrine disruptors may produce greater effects at lower doses depending on the timing of the exposure. Similarly, endocrine disruptors like DES challenge existing models for thresholds, age, and timing.

Langston introduces the precautionary principle through the Harvey Wiley, the Progressive Era consumer advocate. Like other progressive-era reformers, Langston notes, Wiley was no enemy to industry. Yet he believed in the precautionary principle, which placed the burden of proof of safety on industry rather than upon consumers. Of course, producers argued that additives were safe until science proved otherwise. Pesticide residues provided one of the first test cases for Wiley's notion of precaution. Wiley, along with consumer advocates and many medical scientists, argued that chronic effects (i.e., long-term, often subtle threats to health and wellness) derived from laboratory animal studies provided the best measure of safety. Farmers, economic entomologists, the Public Health Service, and some medical scientists claimed that clinical acute poisoning, which is to say exposures resulting in immediate illness, should be the safety standard of the food industry. Wiley and proponents of precaution lost this battle in 1927 when the Bureau of Chemistry established a series of liberal tolerances based on the assumption that below levels of acute toxicity, a substance was safe. Even though the Federal Food, Drug, and Cosmetic Act of 1938 gave proponents of precaution hope, Langston argues, consumers and regulators still doubted the power of FDA to fight political and legal challenges.

It was against this backdrop that a novel drug – diethylstilbestrol (DES) - to treat the symptoms of menopause in "women over forty" appeared in the American market. Langston frames the introduction of DES as an important test case of the government's new authority to regulate new drugs. Moreover, the introduction of DES reveals how stakeholders could manipulate scientific uncertainty. Uncertainty surrounding the toxicity of estrogens and their potential as carcinogens based on data from animal experiments caused FDA to refuse to approve DES in 1940. But in

a prominent court case a federal judge ruled against the American Medical Association, and he dismissed evidence from animal studies supporting AMA's argument that estrogens were known carcinogens. Taking its cue from that case, FDA leaders took a different tack with DES, designating that it would be available by prescription only, thereby establishing a new class of drugs. Nevertheless, the approval of DES reflected deeper cultural biases on the part of the FDA and the medical profession, both of which viewed menopausal women as unable to make decisions without the guidance of doctors. Thus, Langston shows how FDA regulators adopted a position of certainty, after they had approved DES, despite considerable uncertainty regarding possible toxicity.

From hormonal women, Langston turns to "bigger, stronger babies," and the post-war effort to market DES to pregnant women. Again, after initial reluctance to approve the use of DES for pregnant women, FDA responded to political pressure and stood aside as pharmaceutical companies encouraged physicians to prescribe DES and report back the effects. Langston explores many possible reasons why FDA approved DES for use in pregnancy, including the state of medical research at the time, gender biases, and changing conceptual models of fetal development including assumptions regarding placental impermeability. Ultimately, Langston asserts that FDA's somewhat reckless approval of DES for pregnancy underscores the importance of precaution in an environment of uncertainty.

After World War II, DES promised to boost meat and poultry production in order to serve burgeoning demand. Once again, the FDA initially recommended precaution, but industry pressure coupled with consumer demand weakened the agency's resolve. After all, if women treated with large doses of DES showed little evidence of ill effects, why would the much smaller exposures associated with chickens and cattle treated with DES pose any cause for concern? As a result of differing research protocols, Canadian researchers found estrogenic effects of DES residues. American regulators, who did not test for estrogenic effects, did not find evidence of them and thus argued that they did not exist. Only after reports of feminization in exposed men and sterility in animals did FDA initiate tests on treated chicken, which showed high levels of DES residues. Consumers pressured FDA to restrict DES use in poultry, but ironically the agency approved stilbestrol for use in cattle. If this seems strange, Langston notes that FDA distinguished between direct injection (poultry) and ingestion through feed (cattle). Following the provisions of the Miller Amendment (1954), which sought to restrict the presence of known carcinogens in food, FDA set tolerances for residues in foods. Langston cites a growing group of researchers, who doubted that the presence of any quantities of carcinogens could be safe based on studies of pesticides, nuclear radiation, and new drugs.

DES even undermined that most cherished of toxicological aphorisms: "The dose makes the poison." Indeed, Langston details the research of William E. Smith, who worried that low-level exposures to DES in beef from treated cattle could lead to subtle chronic effects like those reported in experimental studies of mice. The 1958 Delaney Clause to the Miller Amendment prohibited the addition to food of any

amount of any substance known to cause cancer. Ironically, Langston suggests that this formal statement of the precautionary principle applied in the strictest sense only to carcinogens while a more relaxed threshold model covered other contaminants.

Neither Rachel Carson's indictment of chemical insecticides in *Silent Spring,* nor Francis Kelsey's thalidomide research leading to the prevention of its approval in America, inspired similar scrutiny and condemnation of DES. Langston reveals that Congress increased pressure on the USDA after its DES Hearings late in 1971. In early 1972, agents claimed that no cows had been found with detectable residues, secretly withholding results from ten cattle with high DES residues. With painful irony, Langston notes that even as DES was being banned for use in cattle, its use to control growth in tall girls was expanding. Each of the cases involving DES involved the calculation of risk and benefit, but far from dispassionate assessments, such calculations were beset by cultural assumptions regarding gender. Risk assessments for other chemicals such as the widespread bisphenol A are beset by similar problems, but DES provides a useful model for evaluating low-dose human exposures. Moreover, DES necessitates reconsideration of gene-environment interaction particularly in the case of pregnant women.

If I were discussing *Toxic Bodies* with a group of students, and I look forward to the opportunity, I would raise some questions that may extend beyond the author's objectives. Is this a story of corporate deceit and regulatory capture? Are there other mechanisms to explain the history of DES? Repeatedly, Langston reveals how governmental agencies and corporations manipulated studies and results to foster uncertainty thereby delaying regulatory action. Finally, Langston goes to great lengths to frame her analysis of exposures in terms of gender (certainly women's bodies bore the brunt of the toxicity of DES). Given that several of the most prominent protagonists were women, I wonder if gender might also have been useful as an analytical tool in analyzing their role in revealing the risks of DES?

By way of conclusion, Langston returns to precaution and the failure of industry and government to apply precaution consistently in the various cases that involved DES. She argues that science alone cannot solve chemical problems. Too often calls for "more research" serve to delay regulatory action while corporations continue to generate profits. But Langston draws a broader conclusion from her remarkable study; namely, it is the responsibility of historians to provide counter-narratives to the stories. More than a superb analysis of how science and policy failed to protect health from a dangerous chemical, *Toxic Bodies* provides a model for how historians can contribute a rigorous and enlightening perspective to debates regarding environmental health policy and regulation.

Comments by Thomas R. Dunlap, Texas A&M University

Toxic Bodies in its Literature

> I contend, furthermore, that we have allowed these chemicals to be used with little or no advance investigation of their effect on soil, water, wildlife, and man himself. Future generations are unlikely to condone our lack of prudent concern for the integrity of the natural world that supports all life.
>
> Rachel Carson, *Silent Spring*, 13.

This might serve as the epigraph for the environmental history of modern chemicals, for a shared theme and scholarly conventions give this literature a common narrative line. Each study begins with the introduction of a modern miracle, enthusiastically adopted and widely used, and goes on to the growing evidence of disquieting side effects, disputes over that evidence, and the eventual, usually grudging, consensus that a problem exists. Each comes to a conclusion as a law or regulation ends or severely restricts the miracle chemical's use. Different actors appear but in the same roles: manufacturers and users defend their product; experts (each side choosing from different specialties) defend or attack the scientific legitimacy and accuracy of the research; regulatory agencies make policies within a web of law, politics, and science; activists condemn the chemical and (usually) the regulators. In chapter one a complacent public hails the new material; by chapter six an outraged citizenry demands effective against a menace to health or the environment. The same themes recur: the debates over definitions of safety, health, and damage, the limits of the evidence and the conclusions to be drawn from it, the difficulties of weighing the profits to a small group against the less certain future damage to a much larger one. The difference between the authority science should possess and what it does makes a ritual appearance, along with discussions of the relationships among regulators, regulated, and public. Every study exhaustively analyzes the pressures on regulators, shown as making decisions on inadequate evidence, guided by inappropriate paradigms, and subject to political pressures. Authors commonly conclude the fault lay less with individuals than the regulatory structure and the political frame within which they labored.

Langston's variation on this story has more than the usual complications, and she goes beyond the usual conclusions, for DES had a long and complex history. It began as medicine in the innocent, or pre-DDT days, first to treat symptoms of menopause, then to prevent miscarriages, and when cast out of the medicine chest, found a new life fattening livestock. Langston uses those events to discuss such larger questions as the environmental impact of endocrine disruptors (of which DES was only one example) and the dichotomies we make between nature and culture, the natural and the artificial, our bodies and the "environment," even what we mean by male and

female. That opens into our understanding of how humans were related to the world. Since her research and analysis match her ambition, the book repays close study and a wide view of its topics.

The first two chapters provide essential background, one on technical and scientific matters, the other on social and cultural. The first takes up an issue facing everyone working in this area: what weight and value to give to scientific studies and scientists? Historians necessarily do research in areas where they have no training or experience, but science presents particular difficulties. It has great authority in the culture and the academy and a perspective most historians, studying it in school, found unattractive at best. Antipathies, it should be said, went both ways and well beyond history. Within the field the clash of cultures led to separate departments of the history of science that had for many years suspicious or adversarial relations with departments of "history." Outside history as well as within it too often led to granting science all authority, thus leaving it as an unexamined black box in the middle of an argument, or trying to reduce it to just another form of knowledge. The first abdicates the scholar's responsibility to understand and analyze, the second ignores the salient difference between science and other forms of knowledge, both in method and measurable impact. Langston avoids these and offers as well clear expositions of scientific concepts. She describes clearly what hormones are and their functions and roles in the body, grants scientists' legitimate claims to authority while asserting historians' own, and closely critiques science and scientists' views. That same clarity appears in her discussions of ideas of nature and culture, the relation of our bodies to the environment, what made for male and female in a body, and the meaning of terms like "poison," "scientific certainty," and the like. Scientific training is not necessary for an historian working in this area, but, I suspect, Langston's own experience in science contributed to her excellent portrait of its ethos and culture that are one of the book's strengths, and gave her the confidence to explain complicated scientific topics.

This section raises basic questions about our relation to the world, questions that inform the entire narrative. We see ourselves as autonomous individuals, separate from the world, but we exist, or also exist, as parts of dynamic, interacting systems. That comes out clearly in the second chapter, in the context of regulation. Deciding what to allow and what to forbid depended on regulators' views of bodies, poisoning, and medical effects. Here, as in other instances (such as DDT), regulatory categories and procedures based on experience with earlier materials proved a poor guide. Langston's story follows the conventional line, but she is perhaps more careful than most in showing how the noble dream of removing regulatory decisions from politics by handing them over to science failed. It allowed decisions reached on other grounds to be presented as objective and "scientific" and enabled a strategy of obstruction based impossible demands for "scientific certainty." She does justice to the techno-optimism of the period and the limits of both science and regulatory regimes, but someone willing to line up the literature on the flood of new materials came into use after World War II could profitably explore the larger dimensions of this story.

The next three chapters trace DES's successive uses. Two cover its medical days, the other its time down on the farm. Together they show some important aspects of the growing exposure to chemicals and new kinds of chemicals that came with the post-war wave of technology. Previously, chemical exposure had been a matter for industrial medicine, for the only visible (or at least acknowledged) accidental exposures seemed the result of working in a few industries or living in the towns around the manufacturing plants. By 1950, though, everyone had DDT in their body fat, and within a few years every bite of Americans' diet had traces of a chemical cocktail. DES was deliberately given as medicine, but the techno-optimism common in the period led everyone to concentrate on the miracles and not worry about side-effects. Looking back from 2011 each of these chapters makes for a horror story, but Langston shows how and why people not only accepted DES but saw it as the fulfillment of the advertisements' promise of better things for better living through chemistry. She follows a familiar narrative path, discussing changing arguments as new information came to light, the concepts of safety championed by different interests, the politics of regulation, the public's shifting views, and the limits and uses of legislative and administrative action. She highlights, though, an important truth often left implicit. Biologically potent chemicals rarely did only one thing in the body. DDT, for instance, affected the central nervous system when given in large doses, but in smaller ones affected such things as the metabolism of steroids. That potency accounts for the migration of the question of DES to migrate from medicine, where it involved women, doctors, and the FDA, to agricultural husbandry, where it became a matter of public health, the profits of livestock growers, and the USDA.

DES also put gender at the center in a way other new chemicals did not. To go back to DDT: women raised the alarm about the decline in songbirds, but a cohort of largely male ornithologists provided scientific backing for their fears. The presence of DDT residues in the body roused only vague uneasiness; the revelation of residues in breast milk fanned public outrage and made the chemical a symbol of technology run amok. DES was tied, quite directly, to gender, and gender and culture had their own mix. Doctors prescribed it for women's reproductive health and it affected the reproductive tract, and while decisions about exposure, effects, and side-effects appeared in the literature and the law as objective assessments based in science, cultural beliefs always colored them, and nowhere more than when male doctors, working within the frame of mid-century stereotypes, treated female patients deeply anxious not just about their bodies but their prospects of having children. (Imagine the DES story if pharmaceutical companies had been able then to advertise their wares.) DES began to be used in animal feed (to increase weight gain just before slaughter) just as the public learned about the thalidomide disaster and read *Silent Spring*--not an auspicious moment--but manufacturers were reluctant to write off a powerful drug or farmers a potential source of profit. At this point its use seemed only another example of the classic problems that led Harvey Wiley to crusade for the Pure Food Act, but DES turned out to be nothing like nitrates in sausages. The discovery that the daughters of women who had taken the chemical to

prevent miscarriage contracted vaginal cancer at a frightening rate put paid to the story. This section of the book alone is worth the price of admission.

In the rest of the book Langston put the DES story in a larger frame. A chapter on "Assessing New Risks" moved to the problems and dangers posed by the general class of compounds that, like DES, disrupted endocrine functions, a group of materials that became common about the time DES was banned. She noted that bisphenol A, a common ingredient in manufactured goods after 1980, used in making those ubiquitous plastic bottles but also computer and car parts, baby bottles, and water filters, had "fascinating" (an ominous adjective in this context) parallels to DES. The problem shifted from exposure in food to exposure in the environment, and to a set of materials that presented new problems of regulation. They did not alter genes but the way the genes were expressed, something conventional measures of risk and so of safety did not account for. Politics complicated the story, for the Reagan administration embraced a new safety standard, "quantitative risk assessment." Manufacturers' reactions to research on endocrine disruptors broke no new ground, but their reliance on "scientific uncertainty" and their campaign to have their own experts on evaluation committees allowed Langston to extend her analysis of political tactics.

With "Sexual Development and a New Ecology of Health," deeper questions came to the fore. What did we mean by "health," a word that lay at the base of our discussions of safety? Answering that required saying how humans were related to the world. This had been implicit in chapter one and explicit in Langston's analysis of scientific views of the uterine environment, but here it applied to everyone. Humans were, she pointed out, "in effect, complex ecosystems made up of a dynamic interweaving of material and cultural feedbacks that are themselves subjects and sources of environmental degradation." (136) From that standpoint we could see other interesting things, to wit, that "sexual differences [are] not constructed by genes or the steroid hormones in the fetal environment or the mother's immune system or synthetic chemicals in the fetal or maternal environmental or the postnatal culture alone. All these elements are dynamic, and all interrelate…" (143). With DES and bisphenol A we came to materials that "transform the body's ecological repair mechanisms [and] alter the epigenetic processes the link environment and gene," words reminiscent of Rachel Carson's warning about "substances of incredible potential for harm," that might "shatter or alter the very material of heredity on which the shape of the future depends." (*Silent Spring*, 8) That we were part of the world in various ways did not qualify as news. Hippocrates and Galen knew our bodies and the world interrelated and interpenetrated, and Langston notes such modern scholarly challenges to our simple views as the work of Donna Haraway and, some years before that, René Dubos. (Add the classic tale of typhus, Hans Zinsser's *Rats, Lice, and History*, still worth reading) Gender identity and formation, though, had special salience, for we saw it as central to our own identity.

The retrospective and analysis of the last chapter, "Precaution and the Lessons of History" moved back toward policy, though not in the sense of prescribing action. Rather, Langston pointed out that science would not solve our problems because they were not matters of science. They were matters of values, some of them values incorporated into science, others we brought to the process of making policy. Everyone accepted this, but they were worth considering, not least in the light of Langston's carefully researched and presented argument. One other issue we might consider. As historians we necessarily cultivate a certain distance from our subjects. Few cling to what Peter Novick called "that noble dream" of objectivity, but analysis and argument depend on disinterestedness. Without it we cannot step back from the evidence to view it in perspective, and unless our work bears its mark, it will be judged—and dismissed—as partisan argument. It is one thing, though, to manage an even-handed presentation while sympathizing with injustice past or even injustice present, another to confront, as Langston did, a research topic so close, to wonder if what we were studying was what was making us sick. Langston met the personal situation in a restrained but candid fashion, and added force to her narrative, but the general one remains. With DDT, PCBs, DES and the rest of the chemical alphabet history moved from being relevant to being intimate. *Toxic Bodies* is a good place to ponder how we can write history of our own lives and possibly, our own fate.

Comments by Stephen Bocking, Trent University

Mid-century America was a marvelous place to be. DDT promised final victory over pests. Control of internal ecologies was also at hand: DES (diethylstilbestrol) promised to regulate women's unruly physiologies, make babies happier, and livestock fatter.

That this seemed to be progress was due to several factors. Scientists, doctors, and other experts promoted novel chemicals. The pharmaceutical and agricultural industries saw new markets, and fresh profits from old. Industry-friendly regulatory agencies readily shifted the boundary between health and illness, redefining women as a medical challenge. Scientific and cultural attitudes were also important: about toxic substances and how they work, about women and their need for expert oversight, about efficiency as the ultimate value. The result has been an uncontrolled experiment, in which ourselves, our environment, and our food have been saturated with synthetic chemicals. It is an essential story, and in *Toxic Bodies* Nancy Langston tells it well.

Environmental historians accustomed to the big stories of transformed forests, rivers, and cities have only recently acknowledged that the most sweeping transformations are sometimes the most intimate. Industry and science meddling in the chemistry of life have imposed a burden of toxicity, disrupting not just health, but ideas about what is natural and normal. As Langston explains, few synthetic chemicals are more potentially disruptive than those that act on hormone systems. DES is the archetype, but they also include PCBs, DDT and organic compounds found in plastics, pharmaceuticals, and pesticides.

For Langston, the essential question posed by this history of better living through chemistry is why so little was done to protect public health and the environment. Even in the 1930s there was ample cause for concern about DES, including evidence of cancer and abnormal sexual development in lab animals. But there was also uncertainty about what animal trials meant for humans. For some, this uncertainty justified a precautionary approach. But American federal agencies consistently chose instead to wait for proof of harm before acting, even as millions were prescribed DES, and it became a staple in feedlots across the nation. By the 1960s health anxieties had morphed into environmental concerns, as the byproducts of DES flowed into ecosystems. But with growing scientific and public concern about chemically-injected "modern meat," the USDA, the FDA and the farming industry eventually found it difficult to keep control of the narrative. DES is no longer used, but its cousins remain: steroids in livestock, pesticide residues on food, Bisphenol A in plastic. Steroids are administered to 90 percent of American beef cattle, and bovine-growth hormones are used in most dairy cows. Their potency as carcinogens and their impacts on sexual development are still emerging.

Throughout this history debates about risk have often turned on interpretations of uncertain evidence. Should regulators take a cautious approach, or wait for clear evidence of harm? Is there a threshold of safe exposure? How should the results of animal trials or epidemiological study be interpreted? In recent decades quantitative risk assessment has exhibited its contradictory identity: ostensibly objective science that could ensure a rational approach to uncertainty, it in fact epitomizes the tortuous negotiation of interests, expert perspectives, and arbitrary definitions of "normal" sexual identity and "natural" chemicals. But even in the midst of efforts to interpret and control the body and biology, nature – and chemicals – have imposed their own imperatives.

In this as in many health and environmental issues, science has played diverse roles. Most obviously, it enabled manipulation of nature while delivering knowledge of the effects. A new politics of science-based regulation also emerged: advocates employed expertise in asserting their positions, and regulators shared expert knowledge and assumptions with those they regulated. Confidence in expertise reinforced the authority of regulatory agencies. So did conventional ideas about toxicology: experience with an earlier generation of poisons, and the dogma that genes control development, left scientists poorly equipped to understand the subtle but pervasive effects of endocrine disruptors. Ideas about expertise were also tied to gender roles: only male doctors, not female patients, could be trusted to evaluate medical information. These and other factors help explain the difficulties encountered in moving from knowledge to action. Langston examines this complex ecology of knowledge, explaining, for example, why the FDA approved DES for use in pregnancy even in the absence of proof that it was safe or effective, how standards claimed to be based on "sound science" were in fact the product of negotiation, and how ideas about gender and culture were as important as science in evaluating risks.

Langston's historical perspective complements other, more detailed analyses of these issues. These include works on the manipulation of science by economic and political interests, such as *Bending Science: How Special Interests Corrupt Public Health Research* by Thomas McGarity and Wendy Wagner (Harvard University Press, 2008), and David Michaels's *Doubt is Their Product: How Industry's Assault on Science Threatens Your Health* (Oxford University Press, 2008). Sheila Jasanoff's *Designs on Nature: Science and Democracy in Europe and the United States* (Princeton University Press, 2007), which traces the transnational co-production of expert and regulatory authority, is also relevant, as are historical studies of the geography and ecology of health and the body, including Linda Nash's *Inescapable Ecologies: A History of Environment, Disease, and Knowledge* (University of California Press, 2007) and Gregg Mitman's *Breathing Space: How Allergies Shape Our Lives and Landscapes* (Yale University Press, 2007).

Chemicals ignore borders, but Langston doesn't. She occasionally mentions events elsewhere, but generally only to illuminate the American experience. Her narrative thus has at times an odd quality – like a recording of a conversation in which only

one voice is heard. A comparative perspective, and greater attention to international events, debates, and negotiations would have added much to the story. But whatever its shortcomings in terms of breadth, Langston's national focus is consistent with her intention to write not just as an historian, but as an advocate. She pushes back against misrepresentations of precaution as a novel and reckless notion, and urges awareness of and respect for the ecologies of health in which all bodies are embedded. These are lessons, she argues, of special relevance to American federal agencies.

Langston also writes as one whose health may have been affected by synthetic chemicals, and as a citizen troubled by the thought that they saturate our environment. Her account reminds one of the work of Sandra Steingraber (*Raising Elijah: Protecting Our Children in an Age of Environmental Crisis*, Da Capo Press, 2011), or Devra Davis (*The Secret History of the War on Cancer*, Basic Books, 2007): accounts based on science, but framed by personal and family experience with anxiety, anger, and grief. Such accounts are essential.

However, Langston's research and advocacy also illustrate how environmental historians remain challenged by science. The challenge is rooted in a paradox: while science is often viewed as a source of authoritative evidence of past and present conditions, it is also a cultural phenomenon whose authority itself requires explanation and critique. This paradox, and the contradictory interpretative strategies it implies, are on full display in *Toxic Bodies*. In her earlier chapters Langston explains how expert advice has been a contingent stew of knowledge, politics, interests and values. But as she approaches the present day she loses much of this critical edge, shifting from writing history to assembling a literature review. Her purpose shifts as well: from exhibiting the complexities and ambiguities involved in constructing and contesting science, to ensuring the correct lessons are drawn from the appropriate evidence. The latter approach is commonly seen when environmental historians turn their attention to science, apparently guided by the assumption that mastering the technical content is enough, even if this neglects examining what scientists thought they were doing, why they were doing it, and why others considered their advice worth listening to. While Langston provides a persuasive demonstration of how scientific expertise has been implicated in failures to solve environmental and health challenges, this historical argument sits uneasily alongside her other ambition, of enlisting science in advocacy.

Author's Response by Nancy Langston, University of Wisconsin--Madison

I thank all four reviewers for their thoughtful, constructive pieces. What greater honor could an environmental historian receive than to be compared to Rachel Carson?

As several of the reviewers recognized, my goal in writing *Toxic Bodies* was not to write a history of the science of endocrine disruption. Sheldon Krimsky has already written a stellar book that explores how scientific understandings of hormone disruptors emerged in the late 20th century.[5] Rather than repeat his work, *Toxic Bodies* asks: how did regulators understand these changing scientific understandings when they crafted their regulatory responses to new synthetic chemicals? My focus is not on the history of the contested science itself; it is on the ways regulators have *used* contested science. In particular, I want to understand how regulators negotiated the uncertainty inherent in scientific understandings of toxic chemicals and their hormonal effects. How did political, economic, and societal constructs shape regulatory responses to emerging scientific evidence? Did cultural constructions of gender and sexual development influence the regulation of hormone disrupting chemicals? How did these responses change over the twentieth century, and why did they change? Is there anything we can learn from earlier regulatory efforts that might help us craft more effective environmental policy today?

As Thomas Dunlap points out in his review, *Toxic Bodies* tells a story with familiar outlines. This is certainly not the first depressing study of synthetic chemicals ever written. As Dunlap writes, "Each study begins with the introduction of a modern miracle, enthusiastically adopted and widely used, and goes on to the growing evidence of disquieting side effects, disputes over that evidence, and the eventual, usually grudging, consensus that a problem exists." Dunlap is too polite to ask the obvious question: Why bother telling yet another version of this familiar tale? Do we really need to learn, once again, that regulators failed to protect public and environmental health? I hope readers agree with me that a history of endocrine disruptors offers something new to the story. Dunlap is kind enough to suggest some of the new twists I introduce to the familiar plotline: specifically, a close look at cultural constructions of gender and how they shaped regulation, and careful attention to the changing meanings of health held by regulators.

Another twist in my story is my finding that many American regulators did try to wrestle with scientific uncertainty, using their understandings of risk to define a

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[5] Sheldon Krimsky, *Hormonal Chaos: The Scientific and Social Origins of the Environmental Endocrine Hypothesis* (Baltimore: Johns Hopkins University Press, 2000).

precautionary principle as early as 1940. The regulators in my book are not government agents blindly being pushed about by industry, nor are they uninterested in the scientific debates of their era. Rather, many of them are thoughtful people trying to craft a pragmatic response to potential risks and scientific uncertainty in a treacherous political environment. Yet even the regulators most committed to public health failed to make much impact on environmental policy, for the structural reasons that Dunlap discusses in his review.

Dunlap, Lytle, Bocking, and Davis all note that I had personal experiences that brought me into intimate contact with my research topic. Unlike many scholars, I wrote about these (discreetly, in the preface and conclusion). Does this personal experience destroy scholarly objectivity? Dunlap writes: "It is one thing, though, to manage an even-handed presentation while sympathizing with injustice past or even injustice present, another to confront, as Langston did, a research topic so close, to wonder if what we were studying was what was making us sick. Langston met the personal situation in a restrained but candid fashion, and added force to her narrative, but the general one remains. ...*Toxic Bodies* is a good place to ponder how we can write history of our own lives and possibly, our own fate." This is an excellent question, and one I wrestled with throughout the writing of *Toxic Bodies*. In fact, I put the research aside for a year when I realized that I needed distance and time to ask the sorts of questions I wanted to ask. The initial flush of anger I felt was not a productive frame of mind for analyzing the political, economic, and social constructs that influenced the decisions regulators made.

Taking some time off from the research also helped me recognize the most important element about my own situation: that there was nothing the least bit unusual or striking about it. When I spoke with my doctor about a suspected diagnosis of DES-induced tumors, I mentioned that all of the women in my immediate family had experienced similar reproductive health issues: cancer, endometriosis, miscarriages, infertility, you name it. She shrugged and told me that was nothing unusual. And this led to my most productive (and unsettling) line of questioning: How did this become the new normal? My personal story is interesting only in that it's so typical. No one can say for certain what might, or might not, have been the cause of my family's particular run of health issues. And that's precisely the point: we're all exposed and novel chemicals have become part of our innermost ecosystems. If we doubt that an exposed person can write an honest analysis of chemicals, then we deny the possibility of any analysis whatsoever.

I should admit to another set of personal and less typical experiences that influence my research in important ways. I like regulators. I grew up among them, in the Maryland suburbs during Johnson's Great Society, when scientists and policymakers believed in the possibility of progress. The fact that I have written three books about government regulators struggling to make sense of complex science is surely related to the fact that both my parents were federal scientists and regulators. My mother was director of research for the Consumer Product Safety Commission; my father was an agricultural extension agent; and my friends' parents were also federal

researchers and regulators. So perhaps it's not surprising that I assume that regulators are usually decent, intelligent people stumbling toward what they hope is a better world. The fact that I appreciate the efforts of regulators probably shapes my reading of the evidence much more than the fact that (like everyone else) I was exposed to low-dose exposures of toxic chemicals.

Those low-dose chemicals are at the core of Mark Lytle's concern about the toxicity in *Toxic Bodies*. Lytle suggests that the term toxic might not be appropriate for endocrine disruptors. He writes: "Most people associate “toxic” properly with “poison” and while DES, DDT, and PCBs are clearly harmful they are not poisonous in the way most people understand the term." This is an interesting perspective, one shared by some politicians in the 1930s when they debated agricultural chemicals. If something doesn't poison you immediately, can it really still be toxic to you? As I argue in *Toxic Bodies*, "Many of the reasons that agencies have had trouble regulating these new synthetic chemicals have to do with the risk frameworks that toxicologists developed before World War II to understand natural, but still toxic, pesticides such as arsenic. These frameworks were based on a set of assumptions about thresholds, impermeable bodies, and purity that worked reasonably well in addressing the effects of acute poisoning from natural toxins. But they have proven to be inadequate tools for dealing with the new threats posed by the synthetic chemicals of the postwar boom, particularly endocrine disruptors,“ (17). Confusion over acute toxicity--which is what laypeople understand as poisoning--and chronic toxicity persists today. But even if a substance does not cause acute poisoning, it still can have toxic effects, and that is why I chose to use the technical definition of toxicity: capable of causing injury.

Lytle raises a fascinating question about risk. Without taking risks, how would society learn from experience? He writes: "Think what it would have meant if the multiple crashes of the Comet jets in the 1950s had led to a ban on commercial jet aircraft. No Boeing 707 and no cheap international flights. Environmentalists might applaud; most travelers would not." My argument in *Toxic Bodies* is certainly not that we should ban all synthetic substances that might pose risks, but that we should learn from our historical experiences after we decide to expose certain populations to chemical risks. Unfortunately, we have set up a structural set of conditions that make it difficult to learn from past experiments. As I argue in *Toxic Bodies*, "Each time regulators reached the limits of their knowledge about the effects of a chemical exposure, they decided to move ahead and allow people to be exposed. Each time they vowed to use that new exposure as an experiment that would be monitored, so that policy makers could learn from the experiment.... Yet time and again, the federal agencies failed to learn from their own histories--sometimes because they lacked the funding and political power to insist on monitoring, and sometimes because they refused to pay attention to results," (158).

In his thoughtful review, Frederick Davis notes that even though I frame my "analysis of exposures in terms of gender", I fail to use gender as an analytical tool in analyzing the role of the scientists and regulators who tried to restrict exposure to

synthetic chemicals. Several of the scientists and regulators who were concerned about chemical exposures were indeed women--Rachel Carson, of course, and Frances Kelsey as well. How might Carson and Kelsey's experiences as women have influenced their particular concerns about chemicals? Was it simply chance that several of the scientists most concerned about toxicity happened to be women, in an era where women scientists were fairly rare? It's also important to note that several of the researchers who vigorously promoted DES were women as well. Dr. Olive Smith, for example, published several of the critical papers that persuaded much of the medical community to prescribe DES during pregnancy. Was this just chance? How might the cultural connotations of the importance of pregnancy for women have shaped Dr. Smith's eagerness to see the benefits of the new technology, and her reluctance to see the risks? These would be interesting questions to pursue.

Historians of science continue to worry that environmental historians accept current science unquestioningly. In his review of *Toxic Bodies*, Stephen Bocking suggests that while *Toxic Bodies* contextualizes past scientific debates, it sometimes simply reviews the current scientific literature. My goal in these sections, however, is not just to review the debates within the current literature, but instead to set the stage for an exploration of how current regulators navigate these debates when it comes time to set policy. All environmental historians must figure out how to avoid using a simple, uncontested understanding of current science to judge scientific actors from the past. *Toxic Bodies* avoids this with a simple expediency: the questions I ask of regulators are not "how did they understand hormones compared to how we understand them today" but rather, "how did they use the contested scientific understandings available to them *at the time* to create and justify their regulatory decisions?" Similarly, when I turn to the present, I locate key points of uncertainty and contestation in current scientific discussions over hormone disruptors, and again I ask: how do regulators today negotiate scientific uncertainties, political constraints, and economic pressures? Have their strategies changed over the past eight decades?

This brings us to the final central question implicit in all the reviews: Is *Toxic Bodies* a book of advocacy? If so, does that make it less of a history? I am careful in *Toxic Bodies* never to advocate a partisan political position, nor do I advocate for banning a particular chemical or class of chemicals. But yes, of course I am an advocate -- not for or against chemicals, but for clearer historical reasoning in decision-making. I agree wholeheartedly with the arguments made by Richard Neustadt and Ernest May in their classic *Thinking in Time: The Uses of History for Decisionmakers*.[6] Policy decisions often contain implicit interpretations of history. Professional historians should help ensure these interpretations are based on historical evidence, not on mythmaking. Policy makers do need to be more explicit about framing historical

[6] Robert E. Neustadt and Ernest R. May, *Thinking in Time: The Uses of History for Decision Makers* (New York: Free Press, 1986).

arguments and testing them with historical evidence, rather than relying on anecdotes about the past.

In *Toxic Bodies* I give the example of precaution, which I show has been at the core of American drug policy since 1938. Yet, as I show, "industry advocates now portray precaution as a novel and reckless idea, rather than a long-held principle at the heart of public health. Industry, in other words, has rewritten history in the public eye, portraying precaution as a new, dangerous, radical idea and indisputable proof of harm as the historical precedent," (154). As historians, I believe we have a responsibility to point out these distortions. Historian Peter Perdue writes, "Governing elites resist looking too closely into historical roots of current crises; they suppress evidence and manipulate historical narratives to legitimate themselves. The fact that financial crises, or environmental crises, have reoccurred repeatedly even in recent memory doesn't guarantee that anyone will really want to address the fundamental causes. Historians have to recognize, and tell their readers, that impulses to denial, willful blindness, and ideological distortion are just as powerful as rational analysis in causing social change."[7]

It's no secret that I like useful history. I want to understand why environmental problems have occurred so we can learn from those mistakes and avoid repeating them. This does not mean that I've abandoned history for partisan advocacy; instead, it means that I see value in asking historical questions that can help us understand our current environmental dilemmas. Research in environmental history, like all humanities research, doesn't need to be useful to be worthwhile. Historians who prefer to do history for its own sake, disconnected from concerns over environmental degradation and human justice, should feel free to do so. But environmental history has potential for helping with decision-making, and such research is no less historical for also being useful.

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[7] Peter Perdue, in ''AHR Conversation: Environmental Historians and Environmental Crisis.'' *American Historical Review* 113 (2008): 1431–1465. DOI: 10.1086/ahr.113.5.1431.

About the Contributors

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Frederick Rowe Davis is Associate Professor of History at Florida State University, where he teaches history of science and medicine and also environmental history. His research examines the history of environmental sciences (including environmental health) with links to environmental history. His first book, *The Man who Saved Sea Turtles: Archie Carr and the Origins of Conservation Biology* (Oxford , 2007) explored the rise of conservation biology as an independent discipline. His second book, *Pesticides and Toxicology: A Century of Risk and Benefit*, will reveal how the discipline of toxicology emerged in response to the development of chemical insecticides.

Thomas R. Dunlap is Professor of History at Texas A&M University. He is the author and editor of several books, including *DDT: Scientists, Citizens, and Public Policy* (Princeton, 1981). His latest book, *In the Field, Among the Feathered: A History of Birders and their Guides* (Oxford, 2011), will be the subject of a future roundtable.

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