

Rachel Carson. *Silent Spring*. Boston: Houghton Mifflin, 2002. xix + 378 pages \$15.99, paper, ISBN 978-0-618-24906-0.

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Introduction by Frederick R. Davis (Purdue University)

Now is a thrilling time for the history of pesticides research.[1] This statement may ring strange to many ears, but recently there has been an incredible outpouring of scholarship regarding many aspects of pesticides and their unintended consequences. Most, if not all, of these works acknowledge the profound significance of Rachel Carson's *Silent Spring* (1962) in the emergence of public and political concern over the widespread use of these toxic chemicals, particularly risks to humans, wildlife, and ecosystems.

For this reason, we were very pleased when Mitch Aso, H-Envirohealth Book Review editor, suggested that *Silent Spring* serve as the first of a planned series of roundtable reviews of classic works in the history of environmental health. Few books so effectively link plant, wildlife, and human health as Rachel Carson's.

Just as significantly, several scholars volunteered to write reviews for this roundtable: Dawn Biehler, Amy Hay, and Frederick "Fritz" Davis. Each review offers a distinct perspective, which we hope others will find useful whether researching or teaching this important work. We even hope to encourage some of you to revisit the book

to enjoy its prose and profound message once again, fifty-five years after publication.

Carson's life has been the subject of several biographies, but some of its details related to *Silent Spring* bear repeating.[2] She was born in 1907 and completed an undergraduate degree in biology at Pennsylvania College for Women. In 1932, she finished her master's degree in zoology at Johns Hopkins. Because of family duties and sexism in the sciences, Carson left her doctoral studies at Johns Hopkins and took a job at the US Bureau of Fisheries as a writer. In 1951, she published *The Sea Around Us*, a classic in its own right, which launched her career as a full-time writer. Carson had been researching and writing *Silent Spring* for close to two decades when in 1960, as the book was close to completion, she discovered she had cancer. In May 1962, *Silent Spring* initially appeared in abridged form across three issues of *The New Yorker*. Thus, chemical companies started attacking the book even before it was published on September 27, 1962. Those in the industry often sought to disparage her work through ad hominem attacks, a practice that, as Hay notes, continues to this day. *Silent Spring* garnered widespread scientific support and broad public attention that led to a famous appearance on CBS in 1963 in which Carson came across as rational and calm next to her critics. Her book has

sold millions of copies worldwide. Its impact on the US environmental movement is even larger as it contributed to the formation of the Environmental Protection Agency in 1970 and the banning of DDT in 1972.

To begin, Dawn Biehler places *Silent Spring* in the context of health activism by introducing her review with Upton Sinclair's ironic statement of frustration concerning his 1906 novel, *The Jungle*: "I aimed for the public's heart but by accident hit it in the stomach." In this statement, Sinclair registered his disappointment that despite his best efforts to alert Americans to the abysmal conditions and dangers that faced workers in the Chicago stockyards, most readers were far more disturbed by the passages regarding the production of meat in the filthy conditions of the packing houses and the real possibility of contamination. Biehler offers a recent analogy in the impact of a report showing little evidence that organic produce is healthier than produce from conventional farms while ignoring the significant risks to workers exposed to pesticides.

Biehler recommends that we look at the past to understand the emergence of organic agribusiness, which has left very little space for smaller, family-owned and -operated farms, including in California where 2 percent of producers provide 50 percent of the produce. Finally, she notes Carson's capacious ecological picture that linked ecological health to human health while critiquing the simple-minded use of science and technology in a fashion analogous to a "cave man's club." Nevertheless, the chemical industry has exploited consumer's concern with personal and family health at the expense of others.

Like Biehler, Amy Hay also focuses on the value of *Silent Spring* in the classroom, noting, "Students like *Silent Spring*." So true! Hay situates Rachel Carson and her work in a broader context of faith, gender, and politics. She asks, "How did this moving, frightening, persuasive work fail to achieve decreased pesticide use?" This question

resonates with themes explored in Fritz Davis's review. According to Hay, activist Carol Van Strum expressed a similar view in *A Bitter Fog* (2014), even quoting *Silent Spring*. Van Strum leveled her critique at domestic uses of powerful herbicides, but she reached conclusions in line with Carson's.

To get at the question of continued, even augmented, pesticide use, Hay introduces recent scholarship, including Michelle Mart's *Pesticides: A Love Story* and Davis's *Banned*, as well as Naomi Oreskes and Erik M. Conway's *Merchants of Doubt* (2011) and Nancy Langston's *Toxic Bodies*. Each of these books consider dimensions of scientific authority and scientific uncertainty. Hay also raises the trenchant example of *Decades of Dioxin*, by Warren B. Crummett (2003), which "muddied the waters" and contributed to confusion surrounding the use and risks associated with another class of chemicals, namely, dioxins.

Hay acknowledges the contributions of Carson's biographers in documenting persecution based on her gender. Moreover, she discusses the recent post mortem resurrection of Carson's excoiation in the form of the so-called controversy that has suggested that the DDT ban was responsible for the deaths of millions of people from lethal diseases such as malaria. Hay recalls how this "controversy" was used as a pretext to derail a congressional resolution honoring the one hundredth anniversary of Carson's birth. Like Biehler, Hay resituates Carson, and *Silent Spring*, to address concerns of the present and future.

Like Hay, Davis queries the expansion of pesticide uses in the decades following the DDT ban. For Davis, a close reading of *Silent Spring* underscores the irony of this state of affairs. He shows how Carson carefully and clearly documented risks associated with numerous insecticides other than DDT, including dieldrin, aldrin, chlordane, heptachlor, and endrin, all from the same class of chemicals as DDT and each more toxic in its own right. Yet, along with professional toxicologists, Carson deemed another class of insecticides to be

far more toxic to wildlife and humans alike: the organophosphates. Despite the clarity and precision of Carson's critique and her call to restrict and reduce a broad range of pesticides uses, farmers adopted the highly toxic organophosphates in the decades following the ban on DDT and other chlorinated hydrocarbons to the detriment of farmworkers and wildlife alike. Regulators focused narrowly on persistence in the environment as the risk standard. Thus, organophosphates dominated agriculture in the United States until the Environmental Protection Agency reviewed many of the insecticides in this class and cancelled their registrations in 2001, nearly forty years after the publication of *Silent Spring* and thirty years after the DDT ban. Finally, Davis suggests that we might look to Rachel Carson and *Silent Spring* as we contemplate the health and environmental risks associated with neonicotinoids, including declines in some species of birds and bees. Introduced during the 1990s, neonics have rapidly emerged as the mostly widely used insecticides in the US.

Each of the authors makes a strong case for the continued relevance and value of *Silent Spring* in teaching, in policy debates, and in the study of pesticides, past, present, and future. We hope that readers will find the reviews of this round table useful and thought-provoking and useful as they and their students reread *Silent Spring*.

Notes

[1]. For additional details and context, see Frederick Rowe Davis, *Banned: A History of Pesticides and the Science of Toxicology* (New Haven, CT: Yale University Press, 2014). See also Adam Tompkins, *Ghostworkers and Greens: The Cooperative Campaigns of Farmworkers and Environmentalists for Pesticide Reform* (Ithaca, NY: Cornell University Press, 2016); Michelle Mart, *Pesticides: A Love Story: America's Enduring Embrace of Dangerous Chemicals* (Lawrence: University of Kansas Press, 2015); Linda Nash, *Inescapable*

Ecologies: A History of Environment, Disease, and Knowledge (Berkeley, CA: University of California Press, 2006); Edmund Russell, *War And Nature: Fighting Humans and Insects from World War II to Silent Spring* (Cambridge: Cambridge University Press, 2001), and Russell, *Evolutionary History Uniting History and Biology to Understand Life on Earth* (Cambridge: Cambridge University Press, 2011); Thomas R. Dunlap, *DDT: Scientists, Citizens, and Public Policy* (Princeton, NJ: Princeton University Press, 1981), Dunlap, ed., *DDT, Silent Spring, and the Rise of Environmentalism* (Seattle: University of Washington Press, 2008); Nancy Langston, *Toxic Bodies: Hormone Disruptors and the Legacy of DES* (New Haven, CT: Yale University Press, 2010), Langston, *Sustaining Lake Superior: An Extraordinary Lake in a Changing World* (New Haven, CT: Yale University Press, 2017); John Wargo, *Our Children's Toxic Legacy* (New Haven, CT: Yale University Press, 1996); Charles F. Wurster, *DDT Wars: Rescuing Our National Bird, Preventing Cancer, and Creating the Environmental Defense Fund* (New York: Oxford University Press, 2015); Dawn Biehler, *Pests in the City: Flies, Bedbugs, Cockroaches, and Rats* (Seattle: University of Washington Press, 2015); David Kinkela, *DDT & the American Century: Global Health, Environmental Politics, and the Pesticide that Changed the World* (Chapel Hill: University of North Carolina Press, 2012); and Edwin A. Martini, *Agent Orange: History, Science, and the Politics of Uncertainty* (Amherst: University of Massachusetts Press, 2012). Finally, there are important studies forthcoming: see, for example, David D. Vail, *Chemical Lands: Pesticides, Aerial Spraying, and Health in North America's Grasslands since 1945* (Tuscaloosa: University of Alabama Press, 2018), forthcoming.

[2]. Biographies include: Linda Lear, *Rachel Carson: Witness for Nature* (New York: Owl Books, 1998); Mark Lytle, *The Gentle Subversive: Rachel Carson, Silent Spring, and the Rise of the Environmental Movement* (Oxford and New York: Oxford University Press, 2007); William Souder,

On a Farther Shore: The Life and Legacy of Rachel Carson (New York: Crown Publishers, 2012); Dunlap, *DDT*; Maril Hazlett, *The Story of Silent Spring and the Ecological Turn* (PhD diss.: University of Kansas, 2003), and Hazlett, "'Woman vs. Man vs. Bugs': Gender and Popular Ecology in Early Reactions to *Silent Spring*," *Environmental History* 9, no. 4 (2004): 701-729; Paul Brooks, *The House of Life: Rachel Carson at Work* (New York: Houghton Mifflin Company, 1972); and Frank Graham, *Since Silent Spring* (New York: Houghton Mifflin Company, 1970).

Contribution by Dawn Biehler

(University of Maryland, Baltimore County)

In the fall of 2012, I observed the fiftieth anniversary of *Silent Spring*'s publication by focusing my Health Geography seminar on Rachel Carson's most famous book, its history, and its legacy. This was a learning experience as much for me as for my students, and one of the biggest lessons was about the wide gulf that continues to separate the mass of American consumers from the conditions of production, particularly of food production. I was frequently reminded of the lament attributed to Upton Sinclair about his 1906 book *The Jungle*: "I aimed for the public's heart, and by accident I hit it in the stomach."^[1] I'm sure my students grew weary of me repeating this quotation. Socialist Sinclair hoped to inspire Americans to demand protection for laborers with his story of a fictional Lithuanian immigrant family who were drawn to Chicago's stockyards by rumors of well-paid jobs but ultimately exploited by capitalists. But President Roosevelt and the broad public showed little concern about the overarching social tragedy and injustice playing out in the stockyards, and were more repulsed by brief passages in *The Jungle* describing filthy conditions in which America's meat was produced. Within just a few months of its publication, Congress passed two landmark pieces of legislation establishing protections for the food supply; meanwhile, progress to-

ward fair treatment of laborers remained glacially slow.

Of course, *Silent Spring* does not parallel *The Jungle* in its content, concerns, or policy outcomes. Notably, the plight of workers was not a motivating concern for the book, though critics accused Carson of communist sympathies; she actually wrote little about the farmworkers who endured heavy exposure to pesticides as part of their jobs. What was remarkable to me as I talked with students was the degree to which popular discourse about food and health directed attention away from *Silent Spring*'s big ecological picture and toward contamination of individual bodies. By "big ecological picture," I mean the way Carson shows the inextricable interconnections between ecologies and human bodies, and the way she lambastes the kind of hubristic science that attempts to isolate so-called pests from the environment. Similarly, Sinclair's big picture is that of capitalist exploitation; the story of the Rudkus family encompasses every kind of abuse that unchecked industrialists heaped upon workers, from hazardous housing to sexual harassment of women.

And furthermore—bringing us back into Sinclair's territory—I remain struck by the degree to which responses to *Silent Spring* seemed to further divide social causes from environmental causes. We continue to grapple with this problem today, and Carson's choices in the book may be somewhat to blame. In other words, the fact that farmworkers were not part of Carson's big picture has had lasting effects; as Linda Nash has shown, farmworkers were definitely suffering at the time Carson was writing.

Just as the semester was beginning, researchers at the Center for Health Policy at Stanford University released a study that demonstrated this problem once again, making green consumerism one of the central themes in my course. The researchers conducted a meta-analysis of studies comparing health outcomes of eating or-

ganically grown versus conventionally grown food. The study “did not find strong evidence that organic foods are more nutritious or carry fewer health risks than conventional alternatives.”[2] Major media outlets picked up the story, and from National Public Radio to the *New York Daily News*, journalists suggested that we could “save our cash” since pricier organic products seemed to carry no health benefits for consumers. Few of these outlets mentioned that the health of farmworkers and their communities might be another reason for consumers to choose organic produce, regardless of consumers’ own health outcomes, though some did mention other possible environmental quality benefits. As geographers such as Jill Harrison and Ryan Galt have shown, farmer and farmworker exposure to pesticides in the United States and abroad remain grave environmental injustices. Other researchers and advocates soon pointed out serious flaws in the study’s methods and conclusions, condemned the uncritical media coverage, and foregrounded potential benefits of organic agriculture for environmental quality and the health of wildlife and farmworkers. But the first wave of coverage had already heightened confusion in public understanding of organic agriculture, and again diverted attention away from wider problems in food and agriculture and back to individual consumers’ bodies.

Meanwhile, in my class, some students were captivated by the debate touched off by the Stanford study, and it was my constant goal to broaden the terms of the debate, often using historical documents from sources such as United Farm Workers, as well as Tom Dunlap’s wonderful collection of primary materials. Still, some students proposed to examine organic food and green consumerism for their portion of the class project, an educational exhibit about *Silent Spring*’s legacy that we would display in the library rotunda at the end of the semester. Initially, they planned to dedicate their exhibit to evaluating whether any health benefits of organic food products were worth the premium price. I tried to coax them in a

different direction, asking teacherly questions about how exactly buying organic expressed Carson’s legacy, and how they might challenge their audience to think beyond a conventional framing of costs and benefits.

All this made me think about how we got from *Silent Spring* to today’s popular consumerist conception of environmentalism. To better understand American traditions of consumerism, environmentalism, politics, and health, we might start looking backward in history first rather than forward after 1962. The connection between green consumerism and organic agriculture long predates *Silent Spring*, as historian Andrew Case shows in his study of Jerome Rodale’s publishing enterprise. Rodale’s own interest in organic agriculture seemed to develop from a concern for nutrition and his own health troubles. In 1942, twenty years before *Silent Spring*, he helped popularize organic farming with his new magazine *Organic Gardening and Farming*, and the press he established became known for mail-based marketing of natural-lifestyle publications and products.

Since *Silent Spring*, organic agriculture has grown from what might be described as a niche or even a fringe movement, to a multibillion-dollar industry dominated by corporate farms that supply national retail chains from Whole Foods to Walmart. This may look like a successful legacy for Carson and pesticide-free agriculture—even when challenges arise like the 2012 Stanford study—but as Amy Hay points out elsewhere in this roundtable, pesticide use continues to rise elsewhere. Furthermore, others argue that organic farming is not the panacea that we might imagine for social and environmental ills. In *Agrarian Dreams*, geographer Julie Guthman shows where a consumerist concern for organic products has gotten us since the 1960s, and takes us beyond the debates over the Stanford study and even questions about the “real” reasons to buy organic. Many critics have lamented the rise of “big organ-

ic” to the detriment of small, family-run organic farms, but Guthman sees the successful family-owned and -operated organic farm as a practically impossible ideal given the realities of land costs, labor dynamics, and organic standards in California, where the top 2 percent of producers control some 50 percent of the organic market. Guthman argues that the scale of agriculture is not the problem so much as agri-business’s “legacy of social and ecological exploitation,”[3] and that programs such as organic certification that help reduce pesticide use must address issues such as working conditions and intensity of land use as well.

Carson’s big ecological picture was capacious for its time, connecting human bodies with the fate of birds, fish, and waterways, advancing critiques of science and technology in popular environmentalism. But it has been too easy for industry to exploit affluent consumers’ concern only for the “ecology of the world within our bodies” at the expense of others’ bodies—human and non-human alike.

Notes

[1]. Quoted in Eric Schlosser, “Foreword: *The Jungle* Was a Socialist’s Cry For Labor Justice. It Launched a Consumer Movement Instead,” in *The Jungle*, by Upton Sinclair (New York: Penguin Random House, 2006), vii.

[2]. Michelle Brandt, “Little evidence of health benefits from organic foods, study finds,” Stanford Medicine News Center, September 3, 2012, <https://med.stanford.edu/news/all-news/2012/09/little-evidence-of-health-benefits-from-organic-foods-study-finds.html>.

[3]. Julie Guthman, *Agrarian Dreams: The Paradox of Organic Farming in California* (Berkeley, CA: University of California Press, 2014), 61.

Contribution by Amy Hay

(University of Texas Rio Grande Valley)

Students like *Silent Spring*. I write that with no intent of damning the classic with faint praise,

but rather acknowledging its enduring appeal. Their regard gives testament to Carson’s skills as a writer and the power of the message she so eloquently conveys. In commemorating the 55th anniversary of *Silent Spring*’s publication this fall, revisiting the work seems appropriate. The voluminous scholarship on Carson includes work on her Presbyterian faith, the radical—subversive, even—nature of her work, her status as a public intellectual, and her critiques of human (what feminists later claimed as male) hubris in attempting to control nature.[1] From this vantage point of history, the increased use of pesticides, even after DDT was banned, remains a source of great frustration. How did this moving, frightening, persuasive work fail to achieve decreased pesticide use? What may be equally important though would be addressing this question from a slightly different perspective. In this review of *Silent Spring* I would like to explore some of the unintentional, and intentional, factors that limited *Silent Spring*’s ability to more dramatically transform human use of pesticides.

Writing two decades later, one activist inspired by Carson discussed one Carson’s radical propositions in *Silent Spring*. “If the Bill of Rights contains no guarantee that a citizen shall be secure against lethal poisons ... ” was the passage from *Silent Spring* Carol Van Strum quoted in her own warning against herbicides, *A Bitter Fog*. In Van Strum’s estimation, an informed-consent amendment “could give provide a positive focus for the many citizen groups now exhausting themselves in separate battles for the same thing.”[2] While a constitutional amendment might not have been the right mechanism, Van Strum’s understanding of Carson’s proposition rightly identified the problem confronting Americans: the need to restore democratic participation in the chemical regulatory process. Carson and Van Strum both understood the vulnerability scientific expertise had created for ordinary citizens, who were left out of decision-making. Scientific myopia represents one of the other major hurdles

in fully realizing the concerns raised by Carson in *Silent Spring*.

Two works stand out when addressing unintentional obstacles to *Silent Spring*'s influence. The first, *Pesticides, a Love Story: America's Enduring Embrace of Dangerous Chemicals*, by Michelle Mart (2015), addresses the challenge *Silent Spring* made to chemical pesticides and the ways it failed to enact change. Surprisingly, and initially counterintuitively, Carson's moderation and acceptance of pesticides' importance in modern agriculture presented one of the major charges Mart makes against *Silent Spring*. Although she acknowledges *Silent Spring*'s importance, Mart notes that Carson avoided a more cutting critique of the American agricultural industry, busily modernizing in the postwar period. Aided by a Cold War emphasis on security, and the military-industrial complex recognized by President Dwight D. Eisenhower, pesticide manufacturers and their supporters argued that pesticides were needed to save the world, or at least feed it. In doing so, US interests were advanced. This minimized *Silent Spring*'s radical call to action.

Scientific authority often comes from the certainty it appears to offer rather than identifying points of intervention within the natural world. Over the course of the twentieth century scientists created a new discipline in response to the multitude of chemicals being used in everyday life. Fritz Davis examines this process in his book *Banned: A History of Pesticides and the Science of Toxicology* (2014). Toxicology, or the science of assessing chemical risk, emerged over the course of the twentieth century in response to the increased use of pesticides and because of some very visible and lethal episodes of chemical misadventure. As these scientists sought certainty, one challenge became the formulas they created to quantify risk. By focusing on mortality as an endpoint, toxicologists often ended up blind to indirect hazards. Another problem, one not completely of toxicolo-

gists' making, became the emphasis on carcinogenic chemicals. This focus meant that other kinds of chemical agents, such as endocrine disruptors, received less attention. And the uncertainty of the science meant that different actors could derive different meaning from the same set of data. Chemical manufacturers asserted chemical safety in the absence of definitive evidence of harm. Industry chemists and paid consultants added to the uncertainty surrounding chemical toxicity, an uncertainty *Silent Spring* had tried to allay.[3]

The example of one chemical compound, dioxin, demonstrates the confusion sown by chemical company scientists. Warren B. Crummett, a Dow Chemical Company research chemist, published *Decades of Dioxin: Limelight of a Molecule* in 2002. Dioxin represented a much broader category of chemicals recognized to be toxic in varying degrees. 2,3,7,8-tetrachlorodibenzo-p-dioxin, otherwise known as TCDD, represented the most toxic incarnation and was often identified as dioxin. Crummett's chemical biography of this toxic chemical focused on the fear its name aroused. Crummett noted that dioxin also formed as a result of natural processes, like fire, and therefore existed in "trace" quantities. The idea advanced here argued that a naturally occurring chemical represented less risk somehow than one that was totally synthetic. It muddied the water as to the sources of such trace contaminations, making it more difficult for environmental activists to hold corporate polluters accountable. Crummett's book highlighted the difficulty of scientific uncertainty coupled with a more troubling problem: the conscious and persistent opposition of industry. This opposition represents a significant reason underlying the mixed results achieved by *Silent Spring*.

Carson biographer Linda Lear and other Carson scholars have extensively documented the gendered persecution Carson and *Silent Spring* received at the hands of the chemical industry and

its allies. But the extent and depth may not fully be appreciated. Some examples of opposition to the book help remind us of these rancorous adversaries. One example of the ongoing war against *Silent Spring* comes from a clipping of a negative book review pasted in a used copy of *Silent Spring* which described the book as “exaggerated hysterical.”[4] Another tactic industry took in opposing *Silent Spring* attacked the environmental movement it inspired. In a 1981 Dow Chemical newsletter, the company applauded its own grassroots movement of “farmers, foresters, applicators, agri-women and other proponents of free enterprise defend[ing] the agricultural chemical tools that are important to everyone’s standard of living.”[5] The piece acknowledges the power of grassroots activism even as it seeks to emulate it. A persistent theme that has emerged in the decades after *Silent Spring* argues that the book, and Carson, have condemned thousands to death because of the banning of DDT. A controversial 2004 *New York Times Magazine* piece by Tina Rosenberg, “What the World Needs Now is DDT,” excoriated the United States and Western nations for enforcing the ban against DDT, condemning poorer and sicker countries to suffer from lethal diseases like malaria. One measure of the way the world was changed, however, by *Silent Spring* was the pushback against this position within the scientific community. A planned congressional resolution in 2007 to honor the 100th anniversary of Rachel Carson’s birth was derailed by Oklahoma senator Tom Coburn. A statement from his office claimed that Carson had authored the “now-debunked” *Silent Spring*. In a moment averse to scientific knowledge, *Silent Spring*’s appeal to reason appears even more important.[6]

Given the sustained, organized, and well-funded campaign against *Silent Spring*, the most impressive thing about Carson’s book continues to be its ability to change thinking and inspire action. Students, like the rest of us, recognize Carson’s exemplary writing, her grounded and balanced scientific arguments, and her passion for

the natural world. So we say: Happy birthday, *Silent Spring*!

Notes

[1]. See Mark Stoll, “Rachel Carson: The Presbyterian Genesis of a Nature Writer,” in *Eminent Lives in Twentieth-Century Science and Religion*, ed. Nicolaas Rupke, 2nd rev. ed. (New York: Peter Lang, 2009); Mark Hamilton Lytle, *The Gentle Subversive: Rachel Carson, Silent Spring, and the Rise of the Environmental Movement* (New York: Oxford University Press, 2007); David Hecht, “Constructing a Scientist: Expert Authority and Public Images of Rachel Carson,” *Historical Studies in the Natural Sciences* 41, no. 3 (2011); and Joni Seager, *Carson’s Silent Spring: A Reader’s Guide* (New York: Bloomsbury Academic, 2014).

[2]. Carol Van Strum, *A Bitter Fog: Herbicides and Human Rights* (San Francisco, CA: Sierra Club Books, 1983), 236. Van Strum’s extensive cache of documents on chemical toxins is now available online at the Poison Papers.

[3]. One of the best-known historical studies of the practice of sowing uncertainty would be Naomi Oreskes and Erik Conway’s 2010 book, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming* (New York: Bloomsbury Press, 2010).

[4]. Mike Dickison, Twitter post, <https://twitter.com/adzebill/status/894710619412156416?s=09>, accessed August 7, 2017.

[5]. Dow Chemical Company, *The Bottom Line*, January 1981, folder 5961, box 212, Alvin L. Young Collection on Agent Orange, National Agricultural Library, Beltsville, MD.

[6]. Rudy M. Baum, “Rachel Carson,” *Chemical & Engineering News* 85, no. 23 (2007): 5, <http://cen.acs.org/articles/85/i23/Rachel-Carson.html>, accessed August 7, 2017; Tina Rosenberg, “What the World Needs Now is DDT,” *New York Times Magazine*, April 11, 2004, <http://www.nytimes.com/2004/04/11/magazine/what-the-world-needs-now->

is-ddt.html, accessed August 7, 2017; Tim Lambert, “What the World Needs Now is Accurate Reporting About DDT,” blog post, August 10, 2005, *Del-toid*, <http://scienceblogs.com/deltoid/2005/08/10/ddt11/>, accessed August 7, 2017. Another excellent piece refuting Rosenberg’s argument is Sonia Shah, “Don’t Blame Environmentalists for Malaria,” *The Nation*, March 31, 2006, <https://www.thenation.com/article/dont-blame-environmentalists-malaria/>, accessed August 17, 2017.

**Contribution by Frederick R. Davis
(Purdue University)**

It is not necessary to rehearse for the readers of H-Envirohealth the many distinctions of *Silent Spring*, such as its place on the list of the 100 most significant books of the twentieth century or its catalytic role in the American environmental movement. Instead, it might be fun to play a little game of mentalism. Ready? Think of “silent spring” or “Rachel Carson.” Now say the first pesticide that comes into your mind. Apologies for the not-too-subtle subliminal message contained in the title to this review. The simple fact that the first pesticide most of us can name is DDT speaks to the remarkable effectiveness of *Silent Spring* in getting its message across. Or does it? When I started to study the history of chemical insecticides (ahem) twenty years ago, I wanted to answer a deceptively simple question: Which pesticides replaced DDT after it was banned for use in the United States in 1972? Like most birders, I knew from the publications of conservation organizations like the National Audubon Society and the American Bird Conservancy, that millions of birds were dying as a result of pesticides exposures, even in 1997. Another question: Were such pesticides in use when Carson wrote *Silent Spring*? If so, how did they escape her notice and meticulous research? (Spoiler alert: yes, they were, and no, they did not escape Carson’s notice.) The fact that organophosphates replaced DDT and the chlorinated hydrocarbons after the DDT ban constitutes one of the great ironies of pesticide

regulation and the American environmental movement.[1]

In *Silent Spring*, Carson established a hierarchy of insecticides. She first addressed the chlorinated hydrocarbons, starting with DDT, and progressively described (in order of increasing toxicity) other chemicals in the class, including chlor-dane, heptachlor, dieldrin, aldrin, and endrin. Carson wove details about their toxicity to mammals, birds, and fish into her descriptions of the chlorinated hydrocarbons. In just a few pages, Carson introduced concepts such as bioaccumulation, lipofelicity (the bonding of chemicals to fats), passage of chemicals from mother to offspring via breast milk, food residues, and liver toxicity even at the residual levels found in food. Among the chlorinated hydrocarbons, she identified endrin as particularly toxic: five times more toxic than dieldrin and many times more toxic than DDT (pp. 26-27).

Nevertheless, Carson left no doubt where organic phosphates stood in the hierarchy of insecticides: “The second major group of insecticides, the alkyl or organic phosphates, are among *the most poisonous chemicals in the world*” (pp. 27-28, emphasis added). Carson went on to describe ironically the development of the organic phosphates as nerve gases during World War II and the concurrent discovery of insecticidal properties; but it is her powerful description of the major effect of the organic phosphates on organisms, insects and warm-blooded animals alike, that sets her account apart from previous reports.

Aware that her subject demanded precision, Carson described the normal function of the central nervous system in detail, including the critical role of a “chemical transmitter:” acetylcholine, which under normal conditions facilitates passage of nerve impulses and then disappears. Excess acetylcholine or its continued presence can wreak havoc on the central nervous system, leading to tremors, muscular spasms, convulsions, and death. Carson proceeded to describe the criti-

cal role of cholinesterase in ensuring that the body never builds up a dangerous amount of acetylcholine. By inhibiting cholinesterase, organophosphate insecticides disrupted this process. Thus, Carson elucidated the relation between the symptomology of cholinesterase inhibition and the normal function of the nervous system, in a way that made clear the risk organophosphate insecticides such as parathion posed to humans.

But what was the risk to people who were not exposed on a regular basis? Carson answered this question with additional data showing that seven million pounds of parathion was applied in the United States, with the amount used on California farms alone able to “provide a lethal dose for 5 to 10 times the whole world’s population” (p. 30). The common view held that what saved the people of the world was the rate at which the organophosphate chemicals decomposed. They broke down into harmless components more rapidly than the chlorinated hydrocarbons, and their residues did not remain as long. Yet, Carson challenged this view by citing a case in which parathion posed a real threat to workers weeks after spraying: “The grove had been sprayed with parathion some two and a half weeks earlier; the residues that reduced [eleven out of thirty men picking oranges] to retching, half-blind, semi-conscious misery were sixteen to nineteen days old.” Carson noted that similar residues had been found in orange peels six months after the trees had been treated with standard doses.

Not even malathion, the least toxic of the organophosphate insecticides, escaped Carson’s perceptive analysis. Malathion, according to Carson, was almost as familiar to the public as DDT. It was used in gardens, household insecticides, and mosquito spraying. Carson revealed that nearly one million acres of Florida communities had been sprayed with malathion in an attempt to control the Mediterranean fruit fly. She questioned the assumption held by many people that

they could use malathion freely and without harm. According to Carson, it was only an enzyme in the mammalian liver that rendered malathion “safe,” but without the enzyme, an exposed person would receive the full force of the poison (p. 31).

Citing research by the FDA and Kenneth DuBois of the University of Chicago Toxicity Laboratory, Carson explained that potentiation, or the synergy between two organophosphate chemicals, could significantly exacerbate the effects of either or both. Workers could encounter different organophosphates, with one compound destroying the enzyme in the liver responsible for the detoxification of another organophosphate. She also targeted consumers, noting that a salad bowl could present a combination of insecticides. Moreover, Carson cited evidence that potentiation was not limited to the organic phosphates. Parathion and malathion intensified the toxicity of certain muscle relaxants and others (malathion included) dramatically increased the effect of barbiturates.

Carson stressed that the advantages that organophosphates possessed over the chlorinated hydrocarbons, such as rapid decomposition, were significantly offset by the dangers of cholinesterase inhibition and potentiation. Her remarks on the acute toxicity of the various pesticides were only a preamble to her larger case: namely the long-term risks of pesticides (particularly the chlorinated hydrocarbons) to landscapes, wildlife, and humans. In the remainder of *Silent Spring*, the organophosphate insecticides recede to the background. Although Carson thoroughly documented and dramatized the lingering damage to soil, water, flora, and fauna associated with chlorinated hydrocarbons, her research revealed few such problems with the organophosphates. Her one example of the effects of organophosphates on wildlife was typically dramatic. In an attempt to control flocks of blackbirds that fed on cornfields, a group of farmers engaged a spray plane to cover a river bottomland with parathion.

More than 65,000 red-winged blackbirds (*Agelaius phoeniceus*) and European starlings (*Sturnus vulgaris*) died, and Carson wondered how many other animals perished from the acute effects of this universally toxic substance. Had rabbits, raccoons, and opossums succumbed as well? Carson was most concerned, however, about unintended effects on humans, specifically workers and children who were most likely to come into contact with organophosphates.

By now it should be clear that Carson believed that the organophosphates posed an equivalent, if not greater, risk to wildlife and humans than the chlorinated hydrocarbons. When she turned to solutions, Carson advocated biological control. She cited numerous cases in which natural predators and diseases had been introduced to control insect outbreaks. Judicious use of insecticides played a minor role in Carson's vision of pest control, but they needed to be phased out eventually. An awareness of ecological relationships should guide all endeavors to reduce the depredations of insects and other organisms deemed pests. According to Carson: "Only by taking account of such life forces and by cautiously seeking to guide them into channels favorable to ourselves can we hope to achieve a reasonable accommodation between the insect hordes and ourselves" (p. 296). For Carson, no chemical insecticide offered a genuine solution: "As crude a weapon as the cave man's club, the chemical barrage has been hurled against the fabric of life.... These extraordinary capacities of life have been ignored by the practitioners of chemical control who have brought to their task no 'high-minded orientation,' no humility before the vast forces with which they tamper" (p. 297).

It would be foolish to overdraw comparisons between the past and present and yet the similarities speak to recent discussions of risk, benefit, and uncertainty. When Rachel Carson wrote *Silent Spring*, both organochlorines and organophosphates were widely used in agricul-

ture, with uncertainty still clouding both science and policy. In a stroke of genius, Carson assembled a range of scientific and anecdotal sources into an impassioned call for reflection on the part of legislators and the public as well as further investigation by toxicologists and environmental scientists. We all know that the early 1970s were a watershed time, with the establishment of the EPA, passage of the National Environmental Protection Act, the ban on DDT, and the passage of FEPCA, all of which served as critical steps in the management of risk. Despite these and other developments, organophosphate use surged in the decades that followed. Contrary to Carson's clarification call for reduction in the use of all insecticides, the ban on DDT and other organochlorines initiated a risk-risk trade-off in which agribusiness replaced DDT and the persistent organochlorines with highly toxic organophosphates such as parathion that threatened welfare of humans and wildlife despite relatively rapid disintegration in the environment. When Congress enacted the Food Quality Protection Act (FQPA) in 1996, the EPA launched a comprehensive review of the organophosphates and carbamates. In 2001, the EPA cancelled the registrations for many organophosphates, effectively banning their use in the United States, almost forty years after *Silent Spring* and nearly thirty years after the DDT ban. Subsequently, neonicotinoids provided agribusiness with substitutes, albeit ones that may contaminate ecosystems and threaten nontarget organisms including bees and birds. Initial assessments suggest that neonicotinoids pose lower risks to humans and other mammals than the organophosphates and carbamates. As regulators review these chemicals and the risks they pose to ecosystems and wildlife, we should (still) look to the thoughtful analysis of risk and benefit of *Silent Spring*.

Note

[1]. For additional details and context, see Frederick Rowe Davis, *Banned: A History of Pesti-*

cides and the Science of Toxicology (New Haven: Yale University Press, 2014).

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