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Allan Mazur

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Introduction

I recall as a child in the 1940's, shopping for shoes with my mother. To check the fit, all of us — I, my mother and the salesman — peered down into an x-ray fluoroscope while I wiggled my toes inside the new shoes. A fluoroscope was also part of routine trips to the pediatrician; the doctor and my mother would look inside my torso on a glowing screen. In 1944, physicians shrunk my chronically infected tonsils with x-rays — a progressive treatment given to thousands of children that decades later was found to cause thyroid cancer.[1]

DDT was widely used in the summers during the 1950's and 60's. Introduced as a body louse powder during the war, it had successfully controlled malaria, typhus and other insect-borne diseases among the troops. Later, its application in the third world saved millions of lives through the control of malaria, an unprecedented victory over disease which earned its discoverer, Paul Muller, a Nobel Prize for Medicine in 1948. Now civilians bought "bugbombs" to destroy insects in their homes and gardens, while trucks and airplanes sprayed clouds of the inexpensive insecticide over fields and neighborhoods, often using far more than recommended and carelessly engulfing animals and people. Most of us didn't care then.

How did we get from there to here? By the 1980's, many had become so fearful of chemicals and radiation that cynical commentators began to speak of "chemophobia" gripping America, with apocalyptic images of trace poisons insidiously seeping though our environment and into our bodies, carrying an epidemic of cancer.[2]

* I appreciate the advice of Professor Jacob Bendix.

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1 Allan Mazur, The Dynamics of Technical Controversy (1981).

Increased scientific understanding of environmental hazards must have played a role, but, if knowledge alone were sufficient to explain new worries about chronic poisoning, there would be few smokers today. Historians often point to Rachel Carson's bestselling 1962 book, **Silent Spring**, as the fulcrum for these changes and the coalescing event of the modern environmental movement.[3] Carson's warning that the misuse of pesticides, particularly DDT, would destroy the songbirds — hence a "silent spring" — and perhaps kill people too, brought widespread public attention to the hazard of trace poisons.

No doubt the book was an important seed, but it did not sprout from unfertilized ground. America in the 1950's and early 60's experienced important precursors to **Silent Spring.** Most salient was the mass protest movement of the political left against radioactive fallout from atmospheric testing of nuclear weapons.[4] At nearly the same time, but on the political right, was a mass protest against the fluoridation of drinking water. Antifluoridationists were grassroots activists, usually successfully trying to influence community decision making. The fallout protest had a national focus, eventually succeeding in changing Washington's policy. It engaged many elite activists from establishment organizations in Chicago and the major cities on the coasts, thus attaining far more prestige and legitimacy than were ever accorded the antifluoridation protest. Still, the arguments of both movements against trace poisons were basically the same.

The Radiation Hazard

Within a year after Wilhelm Roentgen discovered x-rays in 1895, Thomas Edison set his assistant, Clarence Dally, to work on the fluoroscope. Frequent exposure to the rays made Dally's hair fall out, his hands to become ulcerated and eventually cancerous, and finally killed him. From such experiences, it was thought that radiation had to inflict ulceration or other gross damage to cause malignancy, and so long as, e.g., medical workers avoided dosages large enough to produce burns or other severe changes, they and their patients were safe.[5]

2 Edith Efron, **The Apocalyptics** (1984); Elizabeth Whelan, **Toxic Terror** (1993) and Aaron Wildavsky, **But Is It True?** (1995).

3 *See, e.g.,* Philip Shabecoff, **A Fierce Green Fire** (1993).

4 John Maddox, **The Doomsday Syndrome** (1972).

Thus, early workers tested their machines on their own hands as they began work each day, eventually accumulating massive doses.

Also in 1896, Henri Becquerel showed that a piece of uranium ore exposed a photographic plate just as x-rays did, a phenomenon called "radioactivity" by Marie Curie. She and her husband, Pierre, comparing the radioactivity of uranium ores with that of metallic uranium, calculated that the ores were more radioactive than expected from their uranium content. This indicated other radioactive substances contained in the ores, probably in small quantities. Laboriously refining a ton of uranium ore, the Curies discovered by 1900 two new elements, polonium and radium, the latter two million times more radioactive than uranium and possibly the agent of Marie's death from leukemia.

By the 1920's, the large number of burns, other skin problems and some cancers indicated that safety standards were desirable for radiation workers. A group in Britain led the way by recommending that x-ray and radium workers limit exposure by keeping distance and lead shielding between themselves and the radiation source, and that they not work more than seven hours a day or five days per week, or have less than one month's holiday a year.[6]

In 1928, the International Commission on Radiological Protection (ICRP) was formed to recommend limits on exposure. Like a series of groups in the U.S. with which it operated more or less in tandem, the ICRP eventually became active and credible in setting standards, but at the outset it simply adopted the British recommendations. At the time radiation protection was not considered as important as defining units of measurement. Not until 1934 did the ICRP promulgate a permissible level of radiation exposure, a limit adequate to prevent overt skin damage and therefore, it was thought, more dire consequences. After 1937, it ceased to function, an indication that, as the prewar era was closing, the radiation hazard was considered to be under control.

The strongest voice of warning in this period of relative complacency belonged to Harrison Martland who published a series of studies, beginning in 1925, on what has become one of the most

5 Percy Brown, American Martyrs to Science through the Roentgen Rays (1936).

6 *International Recommendations for X-ray and Radium Protection,* 1 Brit. J. Radiology 358 (1964).

famous cases of occupational epidemiology — the radium dial painters. From 1917–24, roughly 800 young women in New Jersey applied radium-containing paint to watches and clocks so the faces would glow in the dark. They formed fine brush points by rolling the bristles on their tongues. Ingesting radium continually over years of employment, by 1931, eighteen women were dead and others suffered from anemia, necrosis of the jaw and bone cancer. Often these afflications appeared years after they had stopped their work as dial painters.

Much of the radium passed out of their bodies, but some was absorbed and incorporated into bone, which, according to Martland, was lethal in amounts as small as ten micrograms. "Alpha particles," he claimed, "are probably the most potent and destructive agent known to science."[7] Unlike contemporaries who regarded radiation as safe if the exposure was kept low, he emphasized hazards from tiny doses:[8]

> A milligram of radium bromide is not much larger than a small grain of sand. One microgram is only one thousandth as large, is invisible, and cannot be detected by any known chemical method. It is necessary to have only ten micrograms, or one hundred thousandth of a gram, distributed over the entire skeleton to produce a horrible death years after it has been injested.

The practice of radium dial painting was changed when the hazard became known, but the lesson that trace doses are worrisome was not widely applied. The use of x-rays for medical diagnosis and therapy accelerated for conditions as serious as cancer and as minor as infected tonsils (my own) and acne, exposing probably millions of people to dangerous amounts of radiation. In the mindset of the time, these all seemed to be legitimate orthodox medical treatment, not especially suspect — compared to unorthodox uses of radiation that had also proliferated. Even Martland did not focus his warning on his colleagues' methods but rather on such practices as:[9]

> the sale, usually by quacks, of radio-active waters for the cure of everything from ingrowing toe-nail and alopecia areata to the sexual impotence of senescence, high blood pressure, chronic arthritis and arteriosclerosis.

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7 Harrison Martland, *The Occurrence of Malignancy in Radioactive Persons,* 15 Am. J. Cancer: 2435, 2438 (1931).

8 *Id.* at 2439.

9 *Id.* at 2506.

The Manhattan Project brought more attention than ever before to problems of safely handling radioactivity,[10] and the massive irradiation of Japanese populations at Hiroshima and Nagasaki produced a terrible natural experiment on the long-term effects of doses from huge to low levels. By 1950, the ICRP was reorganized, its focus now on atomic energy and hazards to whole populations rather than to a relatively few radiologists. The maximum permissible dose was set in 1950 at half the level adopted in 1934, and, in 1956, it was again lowered by a factor of about 3 as leukemia reached an abnormally high level among the Japanese exposed to nuclear radiation.[11]

American reactions to the atomic bombs ranged from wonderment to dread. I grew up with the science fiction of the 1950's in which mutant monsters, produced inadvertently by nuclear radiation, were beaten at the end of the movie by a brave young scientist and a beautiful girl who was the daughter or assistant of a kind and wise older scientist. Dread came to the fore when the Soviet Union exploded its first hydrogen device in 1953. The Cold War reinforced a sharp left-right polarization in American politics, each side seeking its own symbols and issues with which to carry on the debate.

In 1954, a Japanese fishing boat, the Lucky Dragon, was accidently showered with fallout from an American hydrogen bomb test, precipitating first in Japan, then the U.S. and Europe, a leftist political movement aimed specifically at halting atmospheric testing. More generally, the movement was an expression of opposition to the arms race and nuclear confrontation. Adlai Stevenson, the liberal Democrat campaigning against President Eisenhower, endorsed a moratorium on tests of hydrogen bombs, warning the nation against fallout — "the most dreadful poison in the world."[12] Scientists on each side of the debate disagreed not only over moral and political issues but also over facts. Proponents of atmospheric testing, e.g., Edward Teller, the "father of the H-bomb," exaggerated its benefits and minimized its risks. Opponents did the opposite. Linus Pauling, an outstanding

10 Richard Rhoades, **The Making of the Atomic Bomb** (1986) and J. Stannard, **Radioactivity and Health: A History** (1988).

11 Lauriston Taylor, *History of the International Commission on Radiological Protection (ICRP),* 1 **Health Phys.** 97 (1958).

12 Quoted in Spencer Weart, **Nuclear Fear** 202 (1988).

chemist and an especially influential polemicist, warned of fission products like strontium 90 that are produced by nuclear explosions and descend as radioactive precipitation, contaminating grass eaten by cows and passing in milk to children. He claimed, "There exists a real possibility that the lives of 100,000 people now living are sacrificed by each bomb test or series of bomb tests in which the fission products of 10 megatons equivalent of fission are released into the atmosphere."[13] "There is no safe amount of radiation or of radioactive material," he wrote. "Even small amounts do harm."[14]

The antitesting movement had an enormous effect on perceptions of environmental radiation, as historian Spencer Weart notes:[15]

> Fallout was perfectly suited to induce anxiety..., something that rests upon helplessness and uncertainty, on the feeling that a threat cannot be escaped nor perhaps even comprehended before it is too late.... Nor was it just that radiation was invisible, for so were many other hazards from chemical poisons to viruses, and indeed Geiger counters could detect radiation at lower levels of danger than the levels at which almost any other hazardous agent could be detected. The worst uncertainty came at the next state, when you knew that you had absorbed some radiation but did not know what the effects might be....
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> ...
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> Contamination, poison, impurity, pollution, obscenity — more and more people were applying such words to fallout.... Revulsion against radioactivity, a new attitude resembling a primitive taboo, like fallout itself was settling invisibly into every home.

The movement ended abruptly in 1963 when President Kennedy and General Secretary Khrushchev, frightened by their clash the previous year over Soviet missiles in Cuba, signed an agreement to halt the testing of nuclear weapons in the atmosphere, easing Cold War tensions. Many activists shifted their attention to the war in Vietnam. The concern over low-level radiation went into abeyance to re-emerge in the late 1960's with the rising protest against nuclear power plants.

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13 Linus Pauling, No More War! 108 (1958).

14 *Id.* at 82.

15 *Supra* note 13, at 206 and 214.

Fluoridation

It was noticed in the 1930's that residents of areas where the drinking water naturally contained fluoride had teeth which tended to be discolored but also were relatively free of cavities. Further work showed that if the concentration of flouride was as low as one part per million (ppm), the benefit of cavity prevention was obtained with virtually no discoloration. In 1945, the U.S. Public Health Service (PHS) began experimentally adding fluoride at one ppm to the drinking water of two cities, intending over the next ten years to compare their cavity rates to those of control cities. A group of Wisconsin dentists, enthusiastic over the low rates reported early on, urged that mass fluoridation be promoted immediately. The PHS first resisted, saying it would wait for completion of the ten-year experiment, but soon yielded. By 1951, the American Dental Association and the American Medical Association had added their endorsements, urging American communities to fluoridate.

Almost immediately, politically conservative groups in Wisconsin protested against adding a toxic chemical to their drinking water, arguing that it was used as rat poison and that involuntary flouridation amounted to mass medication — a step toward socialism. The movement spread, gaining strength from the strong conservative sentiment in the country, which championed Senator Joseph McCarthy in the 1950's and Senator Barry Goldwater in the 1960's, and then to other countries. When communities voted in referenda whether or not to fluoridate, usually the measure lost.[16]

From today's perspective, health professionals were reckless to promote mass fluoridation as early as 1951. Fluoride is indeed an acute poison, and human data used to evaluate the risk of adding one ppm to drinking water was more or less limited to crude comparisons of vital statistics among selected communities with varying levels of naturally occurring fluoride in the water.[17] If the proposal to fluoridate the nation's drinking water were made today, supported by the kind of risk

16 Mazur, *supra* note 1.

17 *Hearings of the (House) Select Committee to Investigate the Use of Chemicals in Food Products,* 82nd Cong., 2d Sess. (1952).

By the 1990's it was possible to make a more satisfying case for the safety of fluoridation; Bernard Wagner, The Health Effects of Ingested Fluoride (1993).

data available in 1951, I don't believe it would be approved. Health professionals in 1951 simply were not then as concerned about chronic exposure to trace poisons.

A popular stereotype of the antifluoridationist as a kook, a fanatic right-winger, is captured beautifully by the mad General Jack D. Ripper in Stanley Kubrick's film, *Dr. Strangelove.* While some opponents of fluoridation might be so described, respectable scientists, physicians and others were sensibly cautious about chronic toxic effects. Yet, few "neutral" commentators gave serious consideration to their arguments because they had been successfully painted by proponents as extremists. Psychologists called opposition to fluoridation an "anti-scientific attitude."[18] Social scientists studying the controversy often assumed that informed voters could not rationally oppose fluoridation and viewed referendum defeats as "democracy gone astray."[19] It is ironic to read this facetious discussion in a sociological study:[20]

> [Most]... claims against fluoridation on alleged medical grounds... have their basis in the fact that in concentrated dosage fluorine is a poison. When the proponents... try to argue that one part per million is a highly diluted dose, the critics reply that the fluoride will collect in out-of-the-way corners of the water mains to build up to deadly dosages. The reputed side effects of fluoridation run from destruction of teeth to liver and kidney trouble, miscarriages, the birth of mongoloid children, and psychological disturbances, incuding susceptibility to communism and nymphomania. When the public-health officer points out that nearly a tenth of the drinking water in the U.S. has always had traces of fluoride in it without causing ill effect, the critics then charge that fluoridation damages car batteries, rots garden hoses, and kills grass.

It would not sound nonsensical today for someone to express concern about a "highly diluted dose" of trace poison in their drinking water.

Protests against fluoridation and weapons testing occupied opposite ends of the political spectrum. So, few if any activists joined both. Yet,

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18 Bernard Mausner & Judith Mausner, *A Study of the Anti-scientific Attitude,* 192 Scientific American 35 (1955).

19 Allan Mazur, *Opposition to Technological Innovation,* Minerva, Spring 1975, at 58.

20 Robert Crain, Elihu Katz & Donald Rosenthal, The Politics of Community Conflict: The Fluoridation Decision 4 (1969).

the risk messages propounded were essentially the same. Both objected to the involuntary chronic exposure of large populations to low doses of agents that were known to be very dangerous at higher doses. Both regarded distant and misguided — even wicked — leaders of government and industry as responsible for placing populations at risk. Both accused those parties of ignoring accumulating evidence of chronic toxicity from low-level exposure. Both envisioned poisons from man-made technology as insidiously contaminating the purity of nature. Both emphasized the process of bioconcentration, by which some trace poisons become increasingly concentrated in species higher up the food chain. Both saw chemical pollution as a symptom of social decay. Both worried particularly about cancer. The rhetorics against fluoridation and radiation are often virtually interchangable.[21]

Although these elements had long been present in the beliefs of health food enthusiasts and other small circles, most Americans first learned of them from the flouridation and fallout protests of the 1950's and early 60's, if not by direct participation or sympathy with one of the movements then by their coverage in the mass media.

These elements constitute the ideology of Rachel Carson's **Silent Spring**, warning of DDT and other pesticides, produced by corrupt industry and promoted by misguided government, polluting the purity of nature, concentrating in animals until they are brought to extinction, lodging in our bodies, eventually killing us with cancer. Throughout her book, Carson explicitly compares pesticides with radiation.[22] In her brief but famous opening chapter, *A Fable for Tomorrow,* a happy and prosperous American town becomes afflicted with a strange blight that first kills animals, then humans. Afterward, "In the gutters under the eaves and in the shingles of the roofs, a white granular power still showed a few patches; some weeks before it had fallen like snow upon the roofs and the lawns, the field and streams." This is exactly the imagry of radioactive fallout, now applied to pesticides. Here are other examples from early pages:[23]

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21 Mazur, *supra* note 1.

22 But not with fluoridation, despite ample opportunity in her discussions of the purity of drinking water — perhaps because she "tried to keep at arm's length... food faddists, health quacks and other cultists," among whom she may have counted the antifluoridationists; Frank Graham, Jr., Since Silent Spring 71 (1970).

23 At 6–7.

> In this now universal contamination of the environment, chemicals are the sinister and little-recognized partners of radiation in changing the very nature of the world — the very nature of its life. Strontium 90, released through nuclear explosions into the air, comes to earth in rain or drifts down as fallout, lodges in soil, enters into the grass or corn or wheat grown there, and in time takes up its abode in the bones of a human being, there to remain until his death. Similarly, chemicals sprayed on croplands or forests or gardens lie long in soil, entering into living organisms, passing from one to another in a chain of poisoning and death.
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> ...
>
> [R]adiation is now the unnatural creation of man's tampering with the atom. The chemicals to which life is asked to make its adjustment are... the synthetic creations of man's inventive mind, brewed in his laboratories, and having no counterparts in nature."

If **Silent Spring** was the font from which flowed the modern environmental movement and alarm over trace chemicals, it was well fed by streams of earlier protest.

The Delaney Amendment

One more strand from the 1950's deserves attention in tracing the roots of worries about chemicals. The "Delaney Amendment" in the Food, Drug and Cosmetics Act bans the addition to processed food or cosmetics[24] any chemical shown to cause cancer in man or animals. It was enacted without much notice in 1958 but has grown in importance, becoming a focus of controversy. The reason is the great improvement in methods for detecting traces of a chemical in food. In the 1950's, chemicals could be detected in parts per million. Anything of lower concentration was undetectable and therefore, legally, not present. By the 1990's, analytical methods were a million times more sensitive, sometimes detecting concentrations as low as parts per trillion. To appreciate this, consider that one part per million is equivalent to *one* drop of poison *in 1,000* quarts of water, whereas one part per trillion is eqivalent to *one-thousandth* of a drop of poison *in one million* quarts of water. Nearly any chemical involved in agriculture or food processing may leave a residue to be detected at this level and banned if

24 *See* 21 U.S.C. §§ 348(c)(3)(A) and 376(b)(5)(B), respectively.

it has been shown carcinogenic in massive doses to laboratory animals, as is sometimes the case.

Delaney's prohibition takes no account of possible benefits from chemicals known to cause cancer in rodents; e.g., pesticides or food preservatives can control disease and damage to foods caused by bacteria, fungi and insects. Under the Clinton Administration the Environmental Protection Agency suggested that the Amendment might be skirted, allowing trace residues in processed food when the risk of the additive is insignificant and far offset by its benefit. However in 1993 a court ruled that it must be applied strictly,[25] a position supported by those who worry, like columnist Molly Ivins,[26] that "carcinogens tend to be cumulative — that is, they stay in the body, and each trace gets added to the next until cancer is touched off."

It seems odd that this first and most absolute protection against trace poisons carries the name of a conservative Democratic Pol from working-class Queens. First elected to the House in 1945, James Delaney had no interest in chemicals during the late 1940's until a colleague suggested that pesticide contamination of food was ripe for investigation. The earliest critics of DDT had just begun to express concern over its rapidly increasing and often careless use. Delaney convinced Speaker Sam Rayburn to create the Select Committee to Investigate Chemicals, Presticides, and Insecticides in Food — with himself as chair.[27]

The Committee held hearings during 1950–52, calling experts with diverse views on the use of chemicals in food, agriculture and cosmetics. Considerable attention was given to DDT, and after the PHS endorsed fluoridation in 1951, to that too. Some testimony reads like a tutorial on toxicology, emphasizing the difference between acute and chronic effects; much warns of the potential danger of chronic exposures.[28] The Committee issued reports on different foci of its investigation, the one on fluoridation warning communities that the long-term effects of

25 Philip Abelson, *Pesticides and Food,* 259 Science 1235 (1993). *See also,* Public Citizen v. Young, 831 F.2d 1108 (D.C. Cir. 1987).

26 Molly Ivins, *Deregulation: A Question of Money vs. Health,* Syracuse Post-Standard, July 8, 1995, at A-8.

27 Richard Stalvey, *Mr. Delaney Passes a Law,* 5 Nutrition Today 29 (1970).

28 Hearings, *supra* note 17.

ingestion were unknown.[29] Delaney had become a strong opponent by 1963 if not earlier, calling fluoridation "an unnecessary health risk and unwarranted intrusion on the rights of our citizens."[30]

The amendment did not follow immediately but was introduced a few years later, when interest in chemicals had grown to the point that others in the House were then introducing similar bills. All were the subject of new hearings in which Delaney played little part,[31] but in 1958 his version was the one enacted.

Testifying in both 1952 and 1957 was Dr. Wilhelm Hueper, Chief of the Environmental Cancer Section of the National Cancer Institute. A crusader as well as an occupational toxicologist, his activities at the Institute contentious, he believed that trace industrial chemicals were a major cause of cancer: "The cancer-producing power of one of these chemicals, betanaphthylamine, is so high that a daily exposure to a few micrograms for several months may result in the development of cancer in some exposed workers some 15 to 20 years later."[32] According to skeptic Edith Efron,[33] Hueper was a participant in a rebellion of scientists within the federal scientific bureaucracy in the 1960's, promoting the view that industrial chemicals are the major cause of cancer that could be eliminated through political action and regulation. Hueper's views are important because of his influence on Rachel Carson and, via Carson, on American beliefs about cancer.

Nearing retirement, in 1964 Hueper published with Walter Conway a treatise entitled **Chemical Carcinogenesis and Cancers**, which presents Hueper's long developed philosophy of chemically-induced cancers. The book opens by calling attention to the[34]

> fundamental alterations which modern man has been making in his environment during the last century by the addition of numerous... physical and chemical agents.... A

29 James Delaney, Fluoridation of Public Drinking Water, H.R. Rep. No. 2500, 82nd Cong., 2d Sess. (1952).

30 121 Cong. Rec. 23,729–33 (1975) (*Flouridation and Cancer,* statement of Rep. Delaney).

31 *Food Additives: Hearings before the Subcomm. on Health and Science of the House Comm. on Interstate and Foreign Commerce,* 85th Cong., 1st Sess. (1957).

32 *Id.* at 370.

33 *Supra* note 2, at 83.

34 Wilhelm Hueper & Walter Conway, Chemical Carcinogenesis and Cancers 3–4 (1964).

> new and continuously changing artificial, man-made environment has thereby been created... superimposed upon the natural one. Through these events... man is... increasingly exposed to new harmful inanimate agents against which he neither possesses adequate natural defense mechanisms nor has sufficient time to develop them....
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> Of particular significance... are the often insidious chronic and long-delayed effects resulting from prolonged exposures to small or even minute amounts of some of these agents and not infrequently becoming manifest a few-to-many years after such an exposure has ceased. In fact, some of these man-made pathogens have been shown to exert their deleterious toxic, teratogenic and carcinogenic action through transplacental penetration from the maternal organism upon the fetus, or they may be introduced into the infant with the mother's milk. A disturbingly high number of these newly introduced radiotoxic and chemicotoxic agents which form a part of the modern economy and are pollutants of the human environment, are mutagens and thus may extend their action on members of future generations....
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> [Carcinogens are]... an important part of the pathogens responsible for the development of a new disease panorama during the past fifty years, which reflects both the beneficial as well as harmful effects related to the impact of modern industrialsm upon human health, survival rate and life-span.
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> Cancers, like all other diseases, are not mysterious phenomena of spontaneous creation, but are the results of the action of definite chemical and physical... agents. It, therefore, should be possible to eradicate cancer hazards and cancers by preventive and therapeutic measures....

Hueper and Conway regard the unrestrained and increasing contamination of the human environment with man-made carcinogens as setting the stage for a "catastrophic" cancer epidemic.[35] They name many substances in the modern environment as causing cancer in humans, however their evidentiary standard appears to be weak, and at one point they even suggest that distilled water is a human carcinogen.[36] Their list (Table 5) of "Recognized Occupational and Environmental Cancer Hazards," running twenty pages, names several more chemicals than the 36 regarded in 1980 as "established" human

35 *Id.* at 17.

36 *Id. at*15.

carcinogens by the authoritative International Agency for Research on Cancer of the World Health Organization.[37] (Certainly, far more than 36 chemicals are carcinoginic in humans, but for only 36 was there sufficient data to make a probable assessment.) Dismissing cigarette smoking as the overwhelming reason for the alarming increase in lung cancer during this centry, Hueper and Conway instead implicate chemicals that have entered the human economy.[38] They write:[39]

> exposures of pregnant mothers and infants to environmental carcinogenic chemicals, including radioactive agents, sustained to an increasing degree during recent decades, are at least in part, responsible for the observed rise in cancers and especially of leukemias, in childhood.

It is well known that Carson was influenced by Hueper's views, including his belief that DDT is carcinogenic. She sent him portions of her manuscript to review and interviewed him personally.[40] She consulted other experts too but seems to have had a special affinity for Hueper, writing in 1959 to her friend Dorothy Freeman:[41]

> Did you see that "my" Dr. Hueper received the A.A.A.S. award in Chicago... for distinguished contributions to the study of cancer? Overdue recognition, but I'm so glad it happened. The chemical companies won't be happy. As perhaps I've told you, I'm giving a full chapter [in **Silent Spring**] to the subject of cancer — something I hadn't expected to do.

I do not know if Hueper was the primary source for Carson's ideas about chemical carcinogenesis, but her book frequently acknowledges him as an authority on the subject, and their views are apparently identical. Her biographer Mary McCay[42] suggests that Heuper's beliefs touched Carson deeply because she was diagnosed with cancer in 1957, given a radical mastectomy in 1960, and treated for the disease until her death in 1964 amidst the controversy she had ignited.

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37 Efron, *supra* note 2.

38 *Supra* note 33, at 145.

Modern estimates attribute 80% or more of American lung cancers to smoking and most of the remainder to naturally occurring radon; Centers for Disease Control, Morbidity and Mortality Weekly Report, June 19, 1992, at 417.

39 *Supra* note 33, at 160.

40 Paul Brooks, The House of Live: Rachel Carson at Work 255 (1972).

41 Always, Rachel 295 (Martha Freeman ed. 1995).

42 Mary McCay, Rachel Carson 69 (1993).

It is worthwhile contrasting the Hueper-Carson view of America's chemically-caused cancer epidemic, which became widely accepted by the American public during the 1960's and 70's, with a modern mainstream epidemiological view. It is true that more Americans than ever before are contracting and dying of cancer, but this is primarily because people are living longer today than previously and therefore are more likely to die from one of the major diseases of old age: cancer, heart disease or stroke. Furthermore, there has been a remarkable decrease in deaths from heart disease due to improved prevention and treatment, its age-adjusted mortality rate in 1987 only 55% what it was in 1950. Therefore some elderly people who once would have died from heart disease now survive long enough to contract and die of cancer. Still, the overall increase in age-adjusted incidence of cancer, from 1973 to 1987, was only 14.6%, and part of this reflects improved diagnosis of cancers that once would have gone undetected. The age-adjusted increase in mortality from cancer was smaller — only 5.4% — reflecting some improvement in treatment.[43]

Cancer is a catchall term for a variety of diseases, so it makes sense to look more closely at individual cancer sites. There has been a large age-adjusted increase in lung cancer, entirely attributable to increases in smoking after World War II. There are also worrisome increases in the reported incidence of breast and prostate cancer, in part due to improved detection, in part unexplained.[44] Also, some infrequent cancers show increases. On the other hand, cancers at other sites (stomach, cervix, uterus, Hodgkin's disease) show sharp decreases in incidence and mortality. Overall, there is no general cancer epidemic that can be attributed to industrial chemicals. Occupational exposures to specific carcinogenic agents probably account for no more than 4% of cancers in the U.S.[45]

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43 Brian Henderson, Ronald Ross & Malcolm Pike, *Toward the Primary Prevention of Cancer,* 254 Science 1131 (1991).

44 Eliot Marshall, *Search for a Killer,* 259 Science 618 (1993) and Steven Jacobsen et al., *Incidence of Prostate Cancer Diagnosis in the Eras Before and After Serum Prostate-specific Antigen Testing,* 274 J. A.M.A. 1445 (1995).

45 Richard Doll & Richard Peto, The Causes of Cancer (1981) and Henderson et al., *supra* note 43.

Devra Davis et al., *International Trends in Cancer Mortality in France, West Germany, Italy, Japan, England and Wales, and the USA,* 336 Lancet 474 (1990) present a more dire picture that is controversial; *see, e.g.,* Eliot Marshall, *Experts*

Furthermore, the emphasis in the 1960's on man-made carcinogens ignored natural carcinogens in the environment. Today we recognize that of the many chemicals in the human diet known to be carcinogenic to rodents (and possibly to humans), far more come from natural sources, especially from plant toxins and the products of cooking, than are synthetic.[46] Carson mistakenly believed that natural carcinogens "are few in number,"[47] that if not for synthetics the environment would be nearly free of cancer-causing agents, leading her to assert — incorrectly — in one of her most quoted passages:[48]

> For the first time in the history of the world, every human being is now subjected to contact with dangerous chemicals, from the moment of conception until death. In the less than two decades of their use, the synthetic pesticides have been so thoroughly distributed through the animate and inanimate world that they occur virtually everwhere.

Silent Spring

Rachel Carson's **Silent Spring** is often and justly ranked with **Uncle Tom's Cabin** among the outstanding and most influential polemics in American literature. It has been the primary impetus to changing public attitudes toward chemicals and to new cautionary policies within industry and government toward pesticides and other toxics, and it is the seed of the modern environmental movement. By 1958 when she began serious research on **Silent Spring**, Carson was acclaimed as an author of books on the sea, especially **The Sea Around Us** in 1951, and success brought financial independence. Later charged by her critics with being unscientific and inaccurate, Carson was in fact educated in biology through the masters degree and a highly competent science writer who had worked for years as an editor with the U.S. Fish and Wildlife Service. **Silent Spring** contains few outright errors, given the scientific information of the day.[49]

Clash Over Cancer Data, 250 Science 900 (1990).

46 Lois Gold et al., *Rodent Carcinogens: Setting Priorities,* 258 Science 261 (1992).

47 At 219.

48 At 15.

49 **Silent Spring Revisited** (Gino Marco, Robert Hallingworth & William Durham eds. 1987).

One can now fault the book on important points: It is fairly certain that synthetic chemicals are not a major source of human cancer; no great increase in age-adjusted cancer rates is seen after smoking and improvements in diagnosis are considered.[50] DDT itself can cause cancer in rats and mice, but evidence of carcinogenicity in other species or humans is inadequate.[51] Excessive use did hurt certain bird populations, especially raptors,[52] but obviously Carson was incorrect in expecting robins — the symbol of spring — to become extinct.

Yet, in an important sense this is beside the point. Carson's primary claim — that pesticides were flagrantly overused, polluting the environment to a degree that damaged wildlife and possibly threatened human health — was correct and timely. If she interpreted ambiguous evidence to favor her thesis, emphasizing lethal effects of pesticides while ignoring benefits, and, if she portrayed overly dire outcomes in alarming prose, appealing to readers' emotions as well as their reason, that is what successful polemics are all about. She never claimed to be writing a textbook. She had a message and conveyed it effectively. In hindsight, her warning was needed and produced important corrections.

In 1972, the U.S. banned DDT and was emulated by some third world nations that quickly suffered increases in malaria. Whelan charges that overzealous followers of Carson, especially the newly organized Environmental Defense Fund, forced from use one of the most beneficial chemicals ever invented, one that when applied properly offered little threat to humans or animals.[53] Carson herself never advocated a total ban on organic pesticides, acknowledging the need for pest control. Other federal actions directly spurred by **Silent Spring**, and more consensually applauded, were the passage in 1976 of the Toxic Substances Control Act,[54] requiring that industrial chemicals be tested for toxicity, and the Resource Conservation and Recovery Act,[55] governing disposal of trash and toxics.

50 Henderson et al., *supra* note 43.

51 National Institute of Environmental Health Sciences, Summary, **Seventh Annual Report on Carcinogens** (1994).

52 Marco et al., *supra* note 49.

53 *Supra* note 2.

54 15 U.S.C. § 2601.

55 42 U.S.C.A. § 6901 et seq.; *see* Pub.L. 94-580 § 2, 90 Stat. 2796 (1976).

Carson was not the first to warn about the dangers of pesticides, so why did **Silent Spring** have so large an impact? Certainly her skill as a writer was helpful, as is apparent to anyone who reads her opening chapters, but, further in, the text becomes densely technical and — my students testify — boring. Her reputation and connections surely helped. Her literary agent and her editor at Houghton Mifflin were personal friends who promoted her work enthusiastically. Together, they arranged with the editor of The New Yorker — where excerpts from two of Carson's earlier books had first appeared — to publish parts of **Silent Spring** in three weekly installments, beginning June 16, 1962. The book was released in September.[56]

The readership of The New Yorker would not then have known a chlorinated hydrocarbon from a pileated woodpecker, but their interest in the fallout controversy was high, and pesticides now appeared as a corollary issue. A July 2 editorial in The New York Times praised Carson's series, suggesting she was as deserving of a Nobel Prize as was the inventor of DDT, and, on July 22, in a story headlined *Silent Spring Is Now Noisy Summer,* the Times described the uproar in government, chemical and agricultural circles — all of this two months before the book was released. The chemical industry was fighting furiously to discredit Carson, casting among other aspersions that anyone who questions the widespread use of pesticides can be expected to oppose fluoridation.[57] Profits aside, DDT had been a boon. Industry saw itself on the side of the angels, but its efforts succeeded — primarily in bringing more publicity to the controversy.

Part of the impact of The New Yorker series resulted from its association with the thalidomide tragedy.[58] A tranquilizer used in Europe but not yet approved in the U.S., it was found in 1961 to cause birth defects when taken by pregnant women, babies being born with flipper-like stumps instead of arms and legs. On July 15, the same week that Carson's first article appeared, the thalidomide story became a national sensation with a front-page story in the Washington Post telling how one woman, Dr. Frances Kelsey of the Food and Drug

56 Graham, *supra* note 22; Brooks, *supra* note 40.

57 Graham, *supra* note 22, at 164.

58 Graham, *supra* note 22.

Administration, had single handedly stood firm against great pressure and abuse in denying approval, thus saving America from the tragedy of armless and legless children.[59] The parallels with Rachel Carson's crusade against pesticides were obvious.

The book was released with advance sales of 40,000 copies, its text complemented with beautiful drawings by Lois and Louis Darling. Selected by the Book-of-the-Month Club (with Justice William Douglas contributing an article on the book in the club's newsletter), the book immediately was a bestseller. Numerous reviews mirrored the controversy, some raving and others bitterly hostile. In April 1963, CBS Reports carried an hour-long television program, *The Silent Spring of Rachel Carson,* ostensibly telling both sides but actually favoring Carson. **The Readers' Guide to Periodical Literature** shows an average of seven articles per year on pesticides in the two years prior to **Silent Spring** and an average of over 30 in the three years after.

Skeptics charge that environmental groups, a few writers and government regulators seized the issue, exaggerating evidence of harm and repeatedly quoting a handful of pessimistic scientists (including Hueper) whose views are rejected by scientific consensus.[60] Of particular interest is the claim, popularized in the 1970's, that about 80% of cancers are environmentally induced, a majority by chemicals. According to Whelan,[61] this derives from John Higginson's research during the 1950's, in which he, comparing the incidence of certain types of tumors among blacks in Africa and America, concluded from disparities that roughly two-thirds of all cancer had an environmental cause. By "environmental" Higginson intended cultural as well as chemical elements, including smoking and diet which are especially important — as well as, e.g., alcohol consumption, sunbathing and sexual patterns.

His findings have been used incorrectly to imply that chemicals are the major culprit. But it is too facile to dismiss environmentalists' alarms as cries of wolf. By the 1970's, it was clear that pesticides and the x-ray *had* been used recklessly. Radioactive fallout *was* a hazard. Toxic pollution of the air, land and water *had* reached alarming levels. Wildlife and natural habitat *were* being destroyed.

59 Edward Lawless, **Technology and Social Shock** (1977).

60 *See* references in note 2.

61 *Supra* note 2.

The increasing tempo of concern over trace doses may be seen from Lawless' survey[62] of 45 public alarms and controversies over technology reported in the U.S. press from the end of World War II until 1973. Twenty-seven involved a chronic trace poison, either chemical or radioactive. Of these, only four began in 1945–55 (diethylstibestrol, fluoridation, shoe fluoriscopes and DDT) and five in 1955–65 (tainted cranberries, polio vaccine hazard, thalidomide, medical x-rays and taconite pollution). Eighteen began in the eight-year period 1965–73 (including mercury in tuna, asbestos, nuclear weapons tests and nuclear power).

Therefore it should not be surprising that by the mid-1970's, the hazard of trace poisons had a firm foothold on the nation's agenda of problems. The trouble for policy makers was, and remains, to identify and deal with real problems without wasting resources on false alarms.

62 *Supra* note 59.