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INTRODUCTION

Silent Spring at 50: Earth, Water, and Air

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This special issue of *Ambix* marks the fiftieth anniversary of the publication of Rachel Carson's *Silent Spring*.[1] Her book was an outstanding consciousness-raising story, quite unlike Lewis Herber's *Our Synthetic Environment*, which had appeared earlier in 1962.[2] Carson's lucid and reasonable arguments, at least as they appeared to many readers, resonated with the wider, better educated public. *Silent Spring*'s power derived its narrow focus from the widespread devastation of wildlife. The villains were pesticides. This was the type of science writing that the public could immediately appreciate, mainly because it was not difficult to observe the results through daily experience, not just dead birds and fish kills, but also unfamiliar tastes from and stains imparted to water, fruit, and vegetables. The fear of chemical technology, which very few understood, or cared to understand, was suddenly overwhelming. The safety of all synthetic pesticides, particularly as potential carcinogens, was called into question. *Silent Spring* became the Bible of environmental campaigners, and brought ecology to the forefront. John George, a former colleague of Carson at the US Fish and Wildlife Service, considered, with others, that Carson was "the greatest biologist since Darwin."[3]

Silent Spring was attacked by chemical industry managers, scientists and lobbyists almost as soon as they became aware of it. Some of the more neutral experts, in addition to offering praise, suggested caution; others questioned Carson's very premise. John M. Barnes, of the Medical Research Council, Toxicology Research Unit (UK), considered parts to be scientifically vague, even unsound, observing in his review: "The fact is, the author has made no attempt to present a balanced picture of the use of pesticides, but she leaves the reader with the impression that she wishes to launch a crusade against the use of these materials. How much better would it have

[1] *Silent Spring* appeared in the autumn of 1962, following serialisation in *The New Yorker* during June. Rachel Carson, *Silent Spring* (New York: Houghton Mifflin, 1962; London: Hamish Hamilton, 1963).

[2] Lewis Herber (Murray Bookchin), *Our Synthetic Environment* (New York: Knopf, 1962). For a comparison of Herber's and Carson's agendas, see Yaakov Garb, "Rachel Carson's *Silent Spring*," *Dissent* (Fall, 1995): 539–46.

[3] Quoted in Shirley A. Briggs, "Rachel Carson: Her Vision and Her Legacy," in *Silent Spring Revisited*, ed. Gino J. Marco, Robert Hollingsworth and William Durham (Washington D.C.: American Chemical Society, 1987), 3–11, on 8.

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been for everyone, including the fish, if this book had been more objective."[4] One of the most scornful reviews was penned by biochemist William J. Darby at Vanderbilt University. In his "Silence, Miss Carson," Darby noted that Carson had failed to distinguish between occupational hazards involved in the industrial manufacture and handling of agricultural chemicals, on the one hand, and pesticide residues in agricultural crops destined for human consumption, on the other.[5] Certainly, general concerns over the environment, as exposed by Carson's book, had already been fuelled by issues such as nuclear radiation, and the toll taken in Europe by thalidomide (it was banned in the USA); these concerns would soon be intensified in America with the damage caused by Agent Orange, uranium mining, and major social issues, particularly civil rights (not to mention the activities of Ralph Nadar). There was a sharp backlash against chemical corporations. The conjunction of environmentalism, Vietnam, a stagnating economy and an increasingly disillusioned electorate would leave an indelible impression on many Americans. In Europe today, one can draw parallels with indignation over GM crops, designed to reduce and ideally eventually eliminate dependence on pesticides and fertilisers.

By the mid-1970s, differences between health risks in the workplace and environmental exposure had blurred, as several chlorinated organic chemicals in everyday human surroundings were shown to be carcinogens through animal testing, and were detected at trace levels, including in water, as a result of improvements in analytical instrumentation.

Problems of pesticide toxicity were already known by around 1960. This was nothing new. Questions of threats to human health came to the forefront. Previously, they were mainly confined to water and air, documented hazards of the workplace, and issues related to industrial hygiene. Pesticides, unlike other synthetic organic chemicals, were spread across the land, and by their very nature were toxins. They also resisted breakdown. The 1962 US *Report of the Committee on Environmental Health Problems to the Surgeon General* observed "With some 500 million pounds of highly toxic chemicals being broadcast over the land, it is inevitable that some of it will reach our watercourses. They may be applied directly to the water, they may drift into the water during the treatment of adjacent areas, or they may be washed in from treated areas of the entire watershed. Many of these materials have a long residual toxicity in the soil."[6]

[4] J. M. Barnes [review of *Silent Spring*], *Span* 6, no. 1 (1963). Copy of reprint held with the Schoental Archive, Edelstein Center, The Hebrew University of Jerusalem. According to Barnes, "With one exception, no pesticide in general use has been shown to have carcinogenic properties. The exception — aramite — was finally shown to be a carcinogen after further tests had been done at the insistence of the experts of the US Food and Drug Administration. This acaracide has a relatively limited use and no member of the public received food containing more than one part per million, even while it was only under suspicion. . . Clearly one cannot give the claim that pesticides are responsible for a rise in the incidence of children's cancer one moment's serious consideration. Is the increase in liver disease due to the people's exposure to pesticides? The exposure of the public, is, at the most, to a few micrograms daily. Yet no single pesticide in common use can produce serious liver damage in animals at doses bordering on lethal doses."

[5] William J. Darby, "Viewpoint: Silence, Miss Carson," *Chemical and Engineering News* 1 (October 1962), 62–63.

[6] *Report of the Committee on Environmental Health Problems to the Surgeon General*, Public Health Service publication no. 908 (Washington D.C.: US Department of Health, Education and Welfare, 1962), 224.

While Carson drew attention to problems created by pesticides, she did not discuss how they were to be identified and measured, although the death of wildlife was sufficient cause for concern. The main known culprit was dichlorodiphenyltrichloroethane (DDT). Carson did, however, refer to contamination of ground water at the Rocky Mountain Arsenal in Colorado, and the chemical reactions taking place below the ground leading to the formation of 2,4-dichlorophenoxyacetic acid (2,4-D). Significantly, perhaps, Barnes, in his review, mentioned that the reaction between the insecticide methoxychlor and carbon tetrachloride afforded "a potential poison."

An early response to the public's concerns in the USA was the creation, in 1963, at the behest of President Kennedy, of a special pesticide study panel of the Science Advisory Committee. From this, there emerged interest in the toxicities of all synthetic chemicals, particularly potential carcinogenic and mutagenic impacts.

The public's consciousness was further aroused in 1964, following the US Army's defoliation by aerial spraying of Vietnamese forests with Agent Orange. The agent was a mixture of the herbicides 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and 2,4-D, applied on a large scale since 1962. Here, the toxic culprit was shown to be an isomer of dioxin, an impurity in the manufacture of 2,4,5-T.[7] The question now became: how many other impurities, or even products, found in the home, the workplace, on the land, or in water, were deleterious to human health? And, more urgently, how could potentially toxic residues and contaminants be measured? This certainly stimulated the need to enhance analytical methods for measuring and identifying contaminants in the environment.

Coincidentally, instrumental methods for the measurement of trace chlorinated hydrocarbon pesticides became available not long before *Silent Spring* was published. Most significant were the remarkable Lovelock and Coulson supersensitive gas chromatography detectors. However, as to their role, or otherwise, in Carson's story, it is important to put the historical record right: these detectors played no part whatsoever. As Peter Morris pointed out in *Chemistry in Britain*:

> All the references to DDT analysis used the "classical" Schecter–Haller colorimetric method or the spectrophotometric variant of the same method. [This is not surprising as] Carson wrote most of *Silent Spring* in the late 1950s and the ECD [Lovelock electron capture detector] was not used for DDT residue analysis until 1960. Carson's concern about DDT and other pesticides had stemmed from biological experiments using diluted solutions in water rather than chemical analysis. The ECD came into its own in late 1963, a year after the publication of *Silent Spring*, when it was used by chemists at Shell to solve the mystery of a major fish-kill in the lower reaches of the Mississippi. This was traced to the release into the river of intermediates in the production of a pesticide, endrin.[8]

[7] E. N. Brandt, *Growth Company: Dow Chemical's First Century* (East Lansing, Mich.: Michigan State University Press, 1997), 363–64.

[8] Peter J. T. Morris, "Detecting DDT," *Chemistry in Britain* (April 2001), 26. For the Lovelock detector, see P. J. T. Morris, "'Parts per Trillion is a Fairy Tale': The Development of the Electron Capture Detector and its Impact on the Monitoring of DDT," in *From Classical to Modern Chemistry: The Instrumental Revolution*, ed. Peter J. T. Morris (London: Science Museum and Royal Society of Chemistry, 2002), 259–84, on 273.

In 2002, Lovelock remarked: "Strangely, there's no mention of this device [the Lovelock electron capture detector] in Rachel Carson's book," and acknowledged that her claims were supported by mainly traditional "wet" chemical analyses.[9] Nevertheless, there is no question that it was the existence of the Lovelock and Coulson detectors that would drive regulators' demands for rapid, accurate instrumental measurement of low levels of pesticides and chlorinated hydrocarbons in general in various media.

This issue of *Ambix* draws on scholarship dealing with environmental and ecological concerns that have received increasing attention since the fortieth anniversary of the publication of *Silent Spring* was marked in an earlier special issue. In 2002, the emphasis was on the 1860–1960 period. Here, there is a considerable emphasis in the first two papers on events and developments both around and after 1960.[10]

The influence of *Silent Spring* on the already developing ecological and environmental movements in the UK is explored by Hannah Gay through wider debates over chemical and other methods of pest control; not always smooth dealings between associations and government bodies; availability of funding for new academic programmes in ecology and environmental science; contributions towards agricultural pest control in Britain and Commonwealth countries, and unanticipated problems that were created; and the engagement of young ecologists, entomologists and chemists at Imperial College London during the 1960s and 1970s. Notwithstanding the tremendous benefits of agrochemicals, Gay reminds us that there is still a long way to go before worldwide malnutrition is alleviated and poisoning by pesticides avoided.

As mentioned in the foregoing, Carson drew attention to problems created by pesticides, but did not discuss how they were to be identified and quantified, although concerns over crop and food residues, as well as contaminated waters, had stimulated interest in new instrumental and other methods of analysis well before 1962. Anthony S. Travis describes innovations in instrumentation, particularly from around 1960, that arose from both academic and industrial research, and soon brought rapid, reliable measurement to below parts per million for chlorinated hydrocarbons. This was a major contribution to both the instrumental revolution and the development of environmental regulations.

The third and fourth papers are reminders that well before *Silent Spring* chemists were making major contributions to challenges brought on by the impact of modern technology on the environment. Peter Reed describes how the regulatory and legislative model for pollution control in Britain finds its origins in the Alkali Inspectorate, formed in 1863 to control by technical means the airborne industrial pollution produced by the soda industry. The several problems included the first manifestations of "acid rain." Reed shows how Robert Angus Smith and his successor, Alfred Fletcher, became, as government inspectors, leading lights in this endeavour, and draws attention to unregulated industries, and how they were brought within the remit of

9 D. A. Christie and E. M. Tansey, eds., *Environmental Toxicology: The Legacy of* Silent Spring. *The Transcript of a Witness Seminar Held by the Wellcome Trust Centre for the History of Medicine at University College, London, on 12 March 2002*, Witness Seminars, vol. 19 (2004), quoting Lovelock on 5.

10 Anthony S. Travis, guest ed., *Ambix* 49, no. 1 (2002).

inspectors, with subsequent changes to the regulatory controls. This set the legislative framework for much of the twentieth century. Rony Armon explores the 1930s studies of James W. Cook, chief chemist with Ernest L. Kennaway at the London Cancer Hospital, on carcinogenic chemicals of industrial origin. This offered a profitable field for investigation after polyaromatic hydrocarbons from tars were identified as carcinogenic agents. Although Kennaway and Cook are generally hailed as pioneers of chemical carcinogenesis research, Armon notes that cancer experts doubted the relevance of their model in explaining cancer's chemical or biological basis. Nevertheless, a review of Cook's synthetic chemistry campaign reveals that, although he made few inroads into the understanding of cancer, the novel compounds that he and his colleagues synthesised opened up new branches of chemical and biochemical investigation.

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