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Chapter 40

CHANGES IN PUBLIC ATTITUDE TOWARD SCIENCE DURING MY LIFETIME

We must remember that in nature there are neither rewards nor punishments – there are consequences.
Robert Green Ingersoll

There can never be a conflict between true science and true religion, because they both describe reality.
Anonymous

We will not be driven into an age of unreason if we dig deep into our history and remember we are not descended from fearful men. Edward R. Murrow

I must not fear. Fear is the mind-killer. Fear is the little-death that brings total obliteration.
Fran Herbert in his novel *Dune*, 1965

I was born in 1923 when science evoked more than mere respect – many school children wanted to become a scientist. My high school class trip was to the 1939-1940 World's Fair in New York City, whose unifying theme was "The World of Tomorrow." In those days, most students did not distinguish between science and technology, so all of us were properly awed. The world we saw on display was so different from the depression era world we were living in that it seemed more like a dream. However, I had just turned 17 and was not a doubter. The subliminal message was that "MORE" was possible and it would be "BETTER."

In my teens, I had a beginner's chemistry set that I used in my basement, and later on I had the "master" chemistry set – the best and most expensive then available. I was also given a 20-volume set of the *Encyclopedia Britannica*. Some parts of the volumes were far beyond my understanding, but I understood enough to know that I wanted to learn more. I realized that someone had to gather all the information in the *Encyclopedia Britannica*, but I never fully realized the energy needed for the systematic and orderly gathering of data to test a particular hypothesis. Learning about what other people did was interesting, but, in retrospect, I really had very little exposure to research. My big opportunity to observe research came when I visited my Aunt Margaret, one of my mother's sisters, and her husband Walter in Salt Lake City, Utah. Uncle Walter had a PhD in biochemistry and had been a professor at Kansas State University. He took a professional position measuring air quality around a huge, open, copper mine when the biochemistry building burned down at Kansas State. He was one of the early ecotoxicologists, and the array of sampling units spread over quite a large area was one of the early systems for monitoring the distribution of potentially hazardous materials. I was either too young or too naive to understand the implications of the monitoring system that Uncle Walter had shown me.

Uncle Walter had a company car and had graduated from Penn State University. Naturally, I wanted to attend Penn State and major in biochemistry – probably a major factor in this decision was the fact that Uncle Walter's company provided him with a full-time car for his use. Careers have begun with less inspiration than the possibility of a car! Besides, at 17 and just out of high school, I was not ready to select a career. Some of my best friends and colleagues, such as Sam Roback, knew what they wanted to do for the rest of their life at a far earlier age, and their joy in their profession continued until they died.

In a summer position (I think in 1941) at the Eastern Regional Research Laboratory at Wyndmoor, Pennsylvania, I worked the midnight to 8 am shift, so my contact with the research staff was minimal. Still, I learned about the team work needed for research despite being a sub-professional 6 – the lowest technician rank. I also learned the importance of careful data gathering and recording. Then came World War II, and any thoughts of research were postponed.

After World War II, I finished my undergraduate degree at Swarthmore College and began my graduate studies at the University of Pennsylvania in the zoology department in fall 1947. As a returning veteran with a wife and child, I needed to finish undergraduate school and begin graduate school as soon as possible.

Swarthmore students could have small research projects, and the faculty did research to the extent possible. Graduate students and faculty at Penn all conducted research projects and were delighted to discuss them.

During my first academic year at Penn, I took "The Fundamentals of Systematics," a two-semester course at the Academy of Natural Sciences Philadelphia (ANSP) taught by Drs. Ruth Patrick and Radclyffe Roberts. Neither Ruth Patrick nor I could know that she would offer me a position in spring 1948 on one of the field survey teams at ANSP and that she would eventually become my mentor.

Until spring 1948, the general attitude toward science was respectful, but not well informed. A few typical movies showed mad scientists or the absent-minded scientist, but they were in the poking-fun spirit. In fall 1948, I was offered a full-time curatorial position and was taught how to carry out toxicity tests with fish by Dr. W. B. Hart, a pharmacologist, who, with ichthyologist Dr. Peter Doudoroff and J. Greenbank, had developed a toxicity test using bluegill sunfish (*Lepomis macrochirus*). The river survey team had studied the effects of industrial waste discharges on the Conestoga Creek in Pennsylvania and continued to carry out such studies all over the United States for various companies. My new responsibility, in addition to my work on the river survey team as protozoologist, was to carry out toxicity tests on actual or simulated wastes (for plants under construction). The Limnology Department at ANSP carried out surveys and toxicity tests for E. I. DuPont de Nemours & Company, Procter & Gamble, Potomac Electric Power, and so on from 1948 through 1966.

During this entire period, I was given permission to publish the findings from all projects suitable for scientific journals. The corporations for whom I did studies felt that publication in a peer-reviewed scientific journals increased credibility. Discussions of the results were always civil, and none of the studies with which I was involved were politicized. Some academicians were scathing about any studies carried out for industry. "Dirty money" was a term often used for such grants and contracts. I always felt that how the money was used was the key issue, and any study that could be published in a peer-reviewed scientific journal was professionally ethical. In short, none of the witch hunts* in the news in 2010 occurred during this period.

The best indication that polarization was beginning to occur was the uproar associated with Rachel Carson's book *Silent Spring*, published in 1962. She was a superb writer about the interconnections in natural systems (e.g., *Under the Sea Wind, The Sea Around Us* [which remained on the *New York Times* best seller list for 86 weeks], *The Edge of the Sea*). However, a headline in the *New York Times* in July 1962 captured the response to *Silent Spring* well: "*Silent Spring* in now noisy summer." The book alarmed many people and resulted in a national debate about the responsibilities of scientists, producers of chemical pesticides, and unrestrained technological progress. The situation was not helped by the Cold War and the Senator McCarthy witch hunts for communists, with their generation of intolerance and suspicion, which were landmarks of that era. Some of the lack of civility spilled over into the *Silent Spring* debates. The chemical industry, which was the economic basis for American prosperity, felt threatened. Suddenly, the relationship between humankind and nature shifted. Science and scientists, in their dazzling white lab coats, were oracles of the future. Chemistry and physics, the hard sciences, were held in high esteem. Biology, a soft science, was held in low esteem. However, Rachel Carson had another major asset in that era of scientific specialization – she wrote for the general public. The "outsider" role had a distinct advantage when her opponents were large corporations. With only a MA in zoology and being a woman, her employment opportunities were limited, so she combined science and writing. During her teenage years, the Pittsburgh, Pennsylvania, area was known for sooty air and polluted water. These conditions probably made her well aware of the drawbacks to industrialization, and she became one of the leading writers on natural systems. In 1945, she tried to interest *Readers Digest* in writings on chemical stress in the environment. In 1957, she thought that persistent, hazardous chemicals were a long-term threat to natural systems. She began to assert that scientific and technological use for profit had no accountability for environmental damage. She also believed that science should not be used to dominate nature, especially when long-term effects of bioaccumulation in the biota were not well understood. Finally, Carson discussed the link between environmental and human health, but the scientific community was slow to acknowledge this concept. She was labeled an "out-of-control" woman, and the chemical industry spent large sums of money to discredit her ideas. Finally, scientists were forced to admit they had little knowledge about the field now called eco-toxicology. An environmental movement began to demand more accountability from the producers of hazardous chemicals – for example, chlorofluorocarbons (CFCs) were created in 1928 and introduced as refrigerants by DuPont in the 1930s. In 1974, M. J. Molina and F. S. Rowland published research that demonstrated the ability of CFCs to break down ozone catalytically in the presence of high frequency UV light. However, not until 1985 did Farman, Gardner, and Shanklin describe research carried out by the British Antarctic Survey that showed ozone levels had dropped to 10% below normal January levels. The satellite data had not shown a drop during the Antarctic spring. The National Aeronautics and Space Administration found that the drop had been missed in spring because the computer program had been designed to discard sudden, large drops in ozone as errors.

**witch hunt – an investigation usually conducted with much publicity, supposedly to uncover subversive political activity, disloyalty, etc., but really to harass and weaken the entire political opposition*

Carson's *Silent Spring* is a wake-up call that the free market system is not effective in preventing pollution. In the United States, some essential legislation has been passed (e.g., Clean Water Act, Clean Air Act), but environmental protection was weakened during the two terms of US President George W. Bush. Six years after Carson's death, the first Earth Day was celebrated – a testament to the validity of her belief in the interconnectedness of human activities and the environment. She was one of the first to accept that scientific evidence would inevitably have uncertainties, just as all aspects of life do.

Climate change is another issue that has brought attacks upon the scientific community. Although the scientific data base and information grew throughout the 20th century, the number of publications on global climate change from 1990 to 2010 increased at a phenomenal rate. However, the information was often not what society and corporations wanted to hear, and the response was a denial of climate change and attacks on science and scientists. Most of the attacks were from individuals without training and credentials in science and were not in peer-reviewed, scientific journals but in the popular news media. Hoggan (2009) discusses tobacco apologists and then partisan, political spin doctors who lead attacks on global climate change science. Others (Gelbspan 1997, 2004) have uncovered first-hand evidence of an organized campaign, largely financed by coal and oil industries, to make the public think that climate science is somehow still controversial and unproven.

In theory, scientists should be able to develop any hypothesis and gather evidence to either confirm or falsify it. In fact, most research requires both money and time – as it should – for every hypothesis does not deserve to be tested. However, if science is to flourish, societies should neither tolerate nor encourage egregious (i.e., conspicuously bad or offensive) attacks on scientific freedom. In the United States at present, anti-science persons use theory or hypothesis as if they were synonymous with a guess. However, a theory/hypothesis is a carefully structured statement in order to test its logical or empirical consequences. To be widely accepted, the results must be congruent with other validated theories.

The decade beginning with 2010 is witnessing a marked increase in the threat to scientific freedom – for example, the attempt by Senator James Inhofe "to criminalize and prosecute 17 leading climate scientists" (http://climateprogress.org/2010/02/25/sen-inhofe-inquisition-seeking-ways-to-criminalize-andprosecute-. . .). This attempt is definitely an escalation of the political assaults on scientists and science in general. The attacks on science prompted an editorial ("Climate of Fear") in the prestigious scientific journal *Nature* (http://climateprogress.org/2010/03/10/nature-editorial-scientis-msut-now-emphasize-the-science-while-. . .), which notes: "Climate scientists are on the defensive, knocked off balance by a re-energized community of global-warming deniers who, by dominating the media agenda, are sowing doubts about the fundamental science." The situation has worsened since "people who say human-induced climate change is a fact that demands urgent action are described as 'believers' or 'climate evangelists,' while those who reject the concept are 'deniers,' 'skeptics' or 'atheists.' Those in the middle who say they are unconvinced either way are 'agnostics'" (Lovell 2010).

The sixth extinction crisis, "the first such wave to occur during the existence of *Homo sapiens*," is the worst time to distract scientists by attacking both them and their science (Ceballos et al. 2010). If scientists must take a significant amount of time to refute deniers, they must reduce the amount of time spent on gathering and analyzing information. If the denigration of scientists worsens or even remains at the present level, the situation could cause the downfall of civilization and the extinction of the human species. After a lifetime of scientific research, I view the attacks on the scientific community as a horrible situation!

Even though I have expressed my reasons for concern, I can also state reasons for guarded optimism about the relationship between scientists and the general public. A recent Yale/George Mason University survey finds that 74% of Americans trust scientists as a source of information about climate change (one of the current environmental crises). In addition, Mother Nature is providing a continual stream of evidence that climate change is happening, which should convince even more of the general public of the crisis. Almost all deep love involves pain – when the loved person dies, when physical limitations prevent visits to treasured ecosystems. Scientific research under the attack of deniers is also painful – joy of research is being supplanted by the pain of anti-science zealots. Few would trade the love of a person or a career to ease or eliminate the pain. Jeannie and I were together for 64 years and married for 61. Alzheimer's and Parkinson's resulted in much pain for 5-6 years before she died, which has continued for over five years after her death (at present time). I would not trade any of our days together to reduce the pain. Science is not similar, but it does provide joy, and I would not diminish the joy that being a scientist and doing research has brought to me to reduce the pain, even if it were possible.

In short, responding in a major way to the skeptics further worsens a painful situation with no assurance it would help science. This situation cannot even be resolved by more robust evidence. Why not stick with reason! A good way for scientists to begin the dialogue with the general public would be to describe how the scientific process works – not in theory but in one's professional life.

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