ENSC 201 Environmental Toxicology and Chemical Risks

DETAILED NOTES

Week 1 first January 10: The history and scope of Environmental Toxicology, Pamela M. Welbourn

Reference reading W&W chapter 1, pp 1 – 20. Also check the Glossary in the text for any unfamiliar terms

Classical toxicology and occupational diseases

Classical (human) toxicology is the older science – essentially an offshoot of pharmacology. It emphasizes the adverse effects of chemicals on humans. Effects already known from older activities especially mining and smelting, grew as more and more chemicals were manufactured, notably beginning in the nineteenth century and continuing to the present day. For classical toxicology, most of the early real-world information came originally from observations based on occupational exposure.

There are two early works that should be noted, Paracelsus' "On Miner's Sickness and Other Diseases of Miners" (Published posthumously in 1567) and Ramazzini's "Discourse on the Diseases of Workers" 1700. In a sense, the workplace provided some of the earliest epidemiological evidence for the effects of toxic substances. At least correlations were shown between handling or other exposure to certain substances and certain health effects or syndromes. One that has got into common parlance relates to the effects of mercury: "As mad as a hatter".

Until the 1960s, the main concern about toxic substances was for human health. This continues, but with added concern for other biota, frequently not directly linked to human health.

The beginnings of environmental toxicology

The emergence of environmental toxicology can conveniently be traced to the dawn of the "Environmental Movement" which is usually dated from the publication of Rachel Carson's "Silent Spring" in 1962.

The environmental movement

Carsons wrote in a startling and somewhat dramatic mode concerning the harmful effects of pesticides, particularly on wildlife. She is credited with sensitizing the public and thus politicians to the dangers of chemical pesticides. Her chapter headings and style were not dispassionate and scientific!

She has since been highly criticized for the liberties she took with "truth", the manner in which she selected information to make her points and excluded other information – i.e., she was not objective; yet she is still acclaimed for her courage in exposing the dangers of pesticides. At the time, it was arguably necessary to use such an approach. Today, while the Movement is still very strong, there are varied opinions of the techniques used by some of the environmental activist groups, as well as some concern for their use of

science. There is a large literature, (not dealt with here), concerning the philosophical and moral aspects of environmentalism and its relationship to "objective" (value free?) science. Whatever one's position, there is no question that environmental concerns have become politicized. (PW in 1992 gave a series of public lectures, The McLean Lectures at Trent University: "The Environmental Movement: Science or Politics" and since then many books have been published in the general area)

The scientist's role in the environmental movement

The dilemma of the scientist in the context of the social and political aspects of environmental risks from chemicals is very real. It was elegantly expressed by the British scientist, Lord Eric Ashby, in his 1978 series of lectures given by invitation to Stamford University. A few extracts are read from his text. One of the key points that he makes concerns facts vs. values. As scientists, we are left to decide for ourselves the extent of our responsibilities. Do we stay in the laboratory and publish our findings in the "objective" scientific literature and leave others to take it further, or, at the other extreme, do we use our credentials as scientists to publicize and perhaps dramatize our findings and apply values to them? Since there is always uncertainty in science, how much "proof" is needed in order to go public? In my McLean lectures, I polled a range of environmental scientists who were colleagues, (not a systematic survey) and found the complete spectrum from the detached scientist whose responsibility ended at the door of his laboratory or office, to the frank activist.

Until the nineteen sixties, time, pesticides were generally not regulated with concern for their long-term effects, particularly on non-target organisms, indeed there was a paucity of information on these matters. Originally, the main concern was for the efficacy of the chemical. This is reflected in that originally, the Federal Department with major responsibility for pest control products was Agriculture Canada. Now, for the past several years the lead agency is Health Canada.

Perhaps the insecticide DDT (dichlorodiphenyl trichloroethane) is the best-known example of the adverse effects of a pesticide. It was marketed as an insecticide in 1942 and during WW 2 was widely used as fumigant to control insect-borne human diseases. Starting in the 1960s, DDT it was used for control of the insect pests of plants, e.g. the beetle that carries Dutch Elm Disease and for control of "nuisance" insects.

Although not foreseen, this substance caused mortality and reproductive failure in songbirds and raptors. One of the properties that make DDT and other chlorinated organics particularly troublesome is persistence. Generally speaking, the molecule or its toxic products do not break down to less harmful chemicals in the environment. Another troublesome property is the tendency to biomagnify. This food chain or food web process is unique to environmental contaminants. The example given has the following concentrations all in parts-per-million (ppm) by weight:

Phytoplankton (primary producer)	0.00005
Zooplankton (primary consumer)	0.04
Stickleback (secondary consumer)	0.26
Flounder (predatory fish)	1.28
Cormorant (fish-eating bird)	26.40

DDT was banned in many countries in the early 1970s, although it is still in use in less developed countries. To my knowledge, this is the first major example of a chemical being regulated (in this case, eventually banned) because of its impact on a non-human target.

The relationship between the science of environmental toxicology and the environmental movement

Since the '60s, the development of the scientific study of the effects of potentially harmful chemicals on the environment has gone hand in hand with the environmental activists and advocates, and political responses (statues, regulations, guidelines), which themselves have been affected by the Movement. What came first? It is really not possible to sort out cause and effect in terms of research, regulation and pressure from activists. Suffice it to say that the science is relatively new, is still a "hybrid" of a number of disciplines – ecology, geochemistry, biochemistry, analytical chemistry, physiology, statistics etc. and that it has grown and continues to grow very rapidly.