

1.3: Short history

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Learning Objective:

You should be able to

- summarize the history of environmental toxicology
- describe the increasing awareness over time of environmental and health risks

Keywords: Paracelsus; Rachel Carson (Silent Spring); Awareness; SETAC; standards

History

From earliest times, man has been confronted with the poisonous properties of certain plants and animals. Poisonous substances are indeed common in nature. People who still live in close contact with nature generally possess an extensive empirical knowledge of poisonous animals and plants. Poisons were, and still are, used by these people for a wide range of applications (catching fish, poisoning arrowheads, in magic rituals and medicines). The first Egyptian medical documentation (written in the Ebers Papyrus) dates from 1550 BC and demonstrates that the ancient Egyptians had an extensive knowledge of the toxic and curative properties of natural products. A good deal is known about the information regarding toxic substances possessed by the Greeks and the Romans. They were very interested in poisons and used them to carry out executions. Socrates, for example, was executed using an extract of hemlock (*Conium maculatum*). It was also not unusual to use a poison to murder political opponents. Poisons were ideal for that purpose, since it was usually impossible to establish the cause of death by examining the victim. To do so would have required advanced chemical analysis, which was not available at that time.

Early European literature also includes a considerable number of writings on toxins, including the so-called herbals, such as the Dutch "Herbarium of Kruidtboeck" by Petrus Nylandt dating from 1673. Poisoning sometimes assumed the character of a true environmental disaster. One example is poisoning by the fungus *Claviceps purpurea*, which occurs as a parasite in grain, particularly in rye (spurred rye) and causes the condition known as ergotism. In the past, this type of epidemic has killed thousands of people, who ingested the fungus with their bread. There are detailed accounts of such calamities. For example, in the year 992 an estimated 40,000 people died of ergotism in France and Spain. People were not aware of the fact that death was caused by eating contaminated bread. It was not until much later that it came to be understood that large-scale cultivation of grain involved this kind of risk.

Paracelsus

It was pointed out centuries ago that workers in the mining industry, who came into contact with a variety of metals and other elements, tended to develop specific diseases. The symptoms regularly observed as a result of contact with arsenic and mercury in the mining industry were described in detail by the famous Swiss physician Paracelsus (Figure 1) in his 1567 treatise "Von der Bergsucht und anderen Nergkrankheiten" (miners sickness and other diseases of mining). During the emergence of the scientific renaissance of the 16th century, Paracelsus (1493 - 1541) drew attention to the dose-dependency of the toxic effect of substances. In the words of Paracelsus, "all Ding sind Gifft ... allein die Dosis macht das ein Ding kein Gifft is" (everything is a poison ... it is only the dose that makes it not a poison). This principle is just as valid today. At the same time, it is one of the most neglected principles in the public understanding of toxicology.



Figure 1: A portrait of Paracelsus (PORTRAIT PRESUME DU MEDECIN PARACELSE (1493-1541) (Source: <https://commons.wikimedia.org/wiki/File:Paracelsus.jpg>)

A work from the same period "De Re Metallica" by Gergius Agricola (Georg Bauer, 1556), deals with the health aspects of working with metals. Agricola even advised preventive aspects, such as wearing protective clothing (masks) and using ventilation.

Scrotum cancer in chimney sweepers: carcinogenicity of occupational exposure

Another example of the rising awareness of the effects of poisons on human health came with the suggestion, by Percival Pott in 1775, that the high frequency of scrotum cancer among British chimney sweepers was due to exposure to soot. He was the first to describe occupational cancer.

A part of the essay by Percival Pott "The fate of these people seems singularly hard; in their early infancy, they are most frequently treated with great brutality, and almost starved with cold and hunger; they are thrust up narrow, and sometimes hot chimnies, where they are bruised, burned, and almost suffocated; and when they get to puberty, become peculiarly liable to a most noisome, painful, and fatal disease." See the rest of the original text of his essay [here](#).

Soot consists of polycyclic aromatic hydrocarbons (PAHs) and their derivatives. The exposure to soot came with concurrent exposure to a number of carcinogens such as cadmium and chromium. From the 1487 cases of scrotal cancer reported, 6.9 % occurred in chimney sweepers. Scrotal and other skin cancers among chimney sweepers were at the same time also reported from several other countries.

Peppered moth in polluted areas

Changes in the environment due to environmental pollution led to interesting insights in the potential of species to adapt for survival and the role of natural selection in it. A famous example of such micro-evolution is the peppered moth, *Biston betularia*, that is generally a mottled light color with black speckles. This pattern gives them good camouflage against lichen-covered tree trunks while resting during the day. During the industrial revolution, the massive increase in the burning of coal resulted in the emission of dark smoke turning the light trees in the surrounding areas dark. As a consequence, the dark, melanic form of the peppered moth took over in industrial parts of the United Kingdom during the 1800s. The melanic forms used to be quite rare, but their dark color served as a protective camouflage from bird populations in the polluted areas. This allowed them to become dominant in areas with soot-covered trunks. Two British biologists, Cedric Clarke and Phillip Sheppard, discovered this when they pinned dead moths of the two types on dark and light backgrounds to study their predation by birds. The dark moths had an advantage in the dark forests, a result of natural selection. In areas where air pollution has decreased the melanic form became less abundant again.

[Video on peppered moths](#)

Awareness in the 1950s and 1960s

After the second world war, synthetic chemical production became widespread. However, there was limited awareness of the environmental and health risks. In the 1950s, Environmental Toxicology came to light as a result of increasing concern about the impact of toxic chemicals on the environment. This led toxicology to expand from the study of the toxic impacts of chemicals on

man to that of toxic impacts on the environment. An important person in raising this awareness was Rachel Carson. Her book "Silent Spring", published in 1962, in which she warned of the dangers of chemical pesticides, triggered widespread public concern on the dangers of improper pesticide use.

First have a look at an historical clip on the use of dichlorodiphenyltrichloroethane, commonly known as DDT, that was developed in the 1940s as the first modern synthetic insecticide.



<https://www.youtube.com/embed/Ipbc-6IvMQI>

Silent Spring - Rachel Carson



<https://www.youtube.com/embed/SeJNRaE11A0>

DDT is very persistent and tends to concentrate when moving through the food chain. As a consequence, the use of DDT led to very high levels, especially in organisms high in the food chain. Bioaccumulation in birds appeared to cause eggshell thinning and reproductive failure. Because of the increasing evidence of DDT's declining benefits and its environmental and toxicological effects, the United States Department of Agriculture, the federal agency responsible for regulating pesticide use, began regulatory actions in the late 1950s and 1960s to prohibit many of its uses. By the 1980s, the use of DDT was also banned from most Western countries.

Large environmental disasters

As a result of large environmental disasters, awareness amongst the general public increased. An enormous industrial pesticide disaster occurred in 1984 in Bhopal, India, when more than 40 ton of the highly toxic methyl isocyanate (MIC) gas leaked from a pesticide plant into the towns located near the plant. Almost 4000 people were killed immediately and 500,000 people were exposed to the poisonous substance causing many additional deaths because of gas-related diseases. The plant was actually initially only allowed to import MIC but was producing it on a large scale by the time of the disaster and safety procedures were far below (international) standards for environmental safety. The disaster made it very clear that this should be changed to avoid other large-scale industrial disasters.

The Sandoz agrochemical spill close to Basel in Switzerland in 1986 was the result of a fire in a storehouse. The emission of large amounts of pesticide caused severe ecological damage to the Rhine river and massive mortality of benthic organisms and fish, particularly eels and salmonids.

At the time of these incidents, environmental standards for chemicals were still largely lacking. The incidents triggered scientists to do more research on the adverse environmental impacts of chemicals. Public pressure to control chemical pollution increased and policy makers introduced instruments to better control the pollution, e.g. environmental permitting, discharge limits and environmental quality standards.

Our Common Future

In 1987, the World Commission on Environment and Development released the report "Our Common Future", also known as the Brundtland Report. This report placed environmental issues firmly on the political agenda, defining sustainable development as "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Another influential book was "Our stolen future" written by Theo Colborn and colleagues in 1996. It raised awareness of the endocrine disrupting effects of chemicals released into the environment and threatening (human) reproduction by emphasizing it not only concerns feminization of fish or other organisms in the environment, but also the human species.

Please watch the video "Developments in Environmental Toxicology - Interview with two pioneers" included at the start of the Introduction of this book.

SETAC

Before the 1980s, no forum existed for interdisciplinary communication among environmental scientists -biologists, chemists, toxicologists- as well as managers and others interested in environmental issues. The Society of Environmental Toxicology and Chemistry (SETAC) was founded in North America in 1979 to fill this void. In 1991, the European branch started its activities and later SETAC also established branches in other geographical units, like South America, Africa and South-East Asia. SETAC publishes two journals: Environmental Toxicology and Chemistry (ET&C) and Integrated Environmental Assessment and Management (IEAM). SETAC also is active in providing training, e.g. a variety of online courses where you can acquire skills and insights in the latest developments in the field of environmental toxicology. Based on the growth in the society's membership, the meeting attendance and their publications, a forum like SETAC was clearly needed. Read more on SETAC, their publications and how you can get involved here.

Where SETAC focuses on environmental toxicology, international toxicological societies have also been established like EUROTOX in Europe and the Society of Toxicology (SOT) in North America. In addition to SETAC, EUROTOX and SOT, many national toxicological societies and ecotoxicological counterparts or branches became active since the 1970s, showing that environmental toxicology has become a mature field of science. One element indicative of this maturation, also is that the different societies have developed programmes for the certification of toxicologists.

References

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Colborn, T., Dumanoski, D., Peterson Myers, J. (1996). *Our Stolen Future: Are We Threatening Our Fertility, Intelligence, and Survival? A Scientific Detective Story*. New York: Dutton. 306 p.

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1.3. Question 1

Paracelsus is famous for the dose-dependency of the toxic effect of substances. What is meant by dose-dependency?

1.3. Question 2

What is the difference between toxicology and environmental toxicology?

1.3. Question 3

How was sustainable development defined in "Our Common Future" also known as the Brundtlandt report?

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