PERSISTENT ENVIRONMENTAL CONTAMINANTS

The content below is adapted from A Small Dose of Toxicology by Steven G. Gilbert.

Overview

Persistent bioaccumulative toxicants (PBTs), also known as persistent environmental contaminants, persistent pollutants, or persistent toxic chemicals, are resistant to environmental degradation through chemical, biological, and photolytic processes. They have been observed to persist in the environment, be capable of long-range transport,bioaccumulate in human and animal tissue, biomagnify in food chains, and have potential significant impacts on human health and the environment.

Persistent Environmental Contaminants: Quick Facts
Terminology: has various names depending on agency, e.g. US EPA: Persistent Bioaccumulative and Toxic (PBT) or United Nations: Persistent Organic Pollutant (POP)
Uses: varies, often restricted or banned (but still present in the environment)
Source: industry, waste sites, food chain, and environment
Recommended daily intake: none (not essential)
Absorption: varies
Sensitive individuals: fetus, children, elderly, all species accumulate PBTs
Toxicity/symptoms: range of toxic effects: developmental, learning and memory, cancer, etc.
Regulatory facts: various local, national, and international agencies working to eliminate or greatly reduce
General facts: long history of use, bioaccumulates
Environmental concerns: global environmental contaminants
Recommendations: avoid, work towards phaseouts

Introduction and History

During the 1950s and 1960s there was an enormous increase in the use of chemicals in agriculture, industrial manufacturing, and around the home. DDT was used to remove lice and control mosquitoes, and other pesticideswere used to kill insects and control weeds in an effort to improve crop yields. Lead was added to gasoline to make cars run better and added to house paint to make it last longer. It was also combined with arsenic to spray on fruit trees to control pests. Pulp and paper mills used mercury to control fungi and molds to ensure that paper remained white. Seeds were coated with mercury to stop soil fungi. Thermometers, thermostats, and switches brought mercury into homes and schools; many remember playing with a small silver ball of liquid mercury. Expansion of the electrical power system required chemicals that could withstand heat. For this purpose PCBs seemed to be the answer. All these chemicals appeared to be safe. A small dose did not seem harmful.

During the 1970s we began to appreciate that even a small dose can harm sensitive individuals. In *Silent Spring*, Rachel Carson sounded one of the first alarms about the effects of environmental contaminants. Evidence accumulated that a pesticide like DDT can cause very unexpected effects. The first and most obvious was the thinning of birds' eggshells, which caused a sharp decline in predator bird populations. Predatory birds are at the top of the food chain, where they accumulate and concentrate DDT. We then became aware of the potential of low-level exposures to persistent chemicals to cause diseases like cancer that appear only after many years. Humans, being at the top of the food chain, accumulate DDT in fat. Fat is mobilized during lactation, and mothers who breastfeed pass along the DDT to their infants, who receive a large dose because of their low weight. We also learned that mercury and lead cause developmental effects, harming the developing nervous system for a lifetime. (Also seeBiomonitoring.)

It turns out that most of these chemicals have similar characteristics that contribute to their toxicity to both humans and other species. First, the substances are environmentally persistent. Many of the early pesticides, and certainly the metals, do not break down in the environment, or do so only very slowly. If persistent chemicals are released continually to the environment, the levels tend to rise ever higher. Second, the early pesticides were toxic to many species, not just the target species, and often killed beneficial insects or plants. Third, many of these compounds bioaccumulate or concentrate in species as they move up the food chain. The chlorinated pesticides accumulate in the fat of animals, with animals higher in the food chain accumulating more and more of these pesticides. Most species cannot metabolize or break down the compounds: lead accumulates in bone and methylmercury in muscle. And finally, because of their persistence in the environment and accumulation in various species, the persistent toxicants spread around the world, even to places that never used them. Animals at the top of the food chain, such as polar bears and beluga whales, routinely have fat PCB levels greater than 6 ppm even though these animals live far from where PCBs were used or produced.

To address the public and environmental health concerns caused by these and other compounds, government agencies have initiated various programs and regulations to control or restrict the use of the offending substances. Laws were passed to ensure more rigorous testing of compounds before widespread use, although this was not entirely effective. For example, the US Toxic Substances Control Act (TSCA) was passed in 1976 but has been largely ineffective for chemical management. The US Food Quality Protection Act (FQPA) of 1996 was more effective in implementing pesticide testing requirements. Researchers worked to develop new pesticides and other agents that were more specific in their toxicity and much less persistent. The use of many of the persistent chemical pesticides was restricted or even banned in some places. Individual countries are responsible for regulations, so there are some countries that still use pesticides that are banned elsewhere (see Pesticide Use in Developing Nations). Two global treaties that work to address PBTs are the Stockholm Convention on Persistent Organic Pollutants and the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC).

Lists of persistent chemical pollutants are created to help prioritize efforts to reduce exposure. There are many lists, and even lists of lists, that are often revised as new data become available. The United Nations Environment Programme (UNEP) created a list called Persistent Organic Pollutants (POPs) that focuses on "chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment." The UNEP also created a list of Persistent Toxic Substances. The US EPA created a list of agents called Persistent Bioaccumulative and Toxic (PBT). Both lists included organic chemicals and metals.

Regional groups are also beginning to create lists of persistent chemical pollutants to emphasize and prioritize local issues. For example, Washington State Department of Ecology, in the United States, has created a list of Persistent, Bioaccumulative Toxins (PBTs), with 27 chemicals to be phased out in the state. It is instructive to look at the overlap of these lists. View our table comparing the lists of persistent chemical pollutants from these agencies. Overall, there is considerable agreement on what chemicals are considered a priority. It is also obvious that pesticides are a major class of persistent chemicals, as are flame retardants.

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