

## **Persistent Organic Pollutants (POPs)**

### **General Facts**

- Persistent organic pollutants (POPs) are organic compounds that resist environmental breakdown via biological, chemical, and photolytic processes, some taking as long as a century to degrade.
- POPs exposed to the environment are proven to travel long distances from their origin via wind and ocean currents. Precipitation has been found to carry PCBs (polychlorinated biphenyls)
- POPs therefore can be found globally, even in areas such as the Arctic and Antarctica, far from their source. Human exposures in certain Arctic areas are among the highest worldwide.
- POPs bio-concentrate as they move up through the marine food chain and accumulate in the fatty tissues of living organisms at higher trophic levels.
- Marine mammals around the world carry high burdens of POPs.
- Although many countries have banned these chemicals, they remain stockpiled, are produced or used illegally, or, because of lengthy half-lives, they continue to exist in soil, or other environmental media.
- The United Nations is currently considering the elimination or reduction of twelve of some of the most damaging POPs through the formulation of an international treaty. Nine of the POPs chemicals under consideration are pesticides that have been extensively used in both developed and developing countries.

### **General Health Effects**

- POPs can disrupt the endocrine, reproductive, and immune systems. The developing brain and nervous system may be most vulnerable.
- POPs are capable of causing behavioral problems, cancer, diabetes and thyroid problems.
- According to a landmark longitudinal study, babies whose mothers ate large amounts of highly contaminated fish (PCBs were

measured) from Lake Michigan had lower birth weights, smaller head circumferences and shorter attention spans than babies whose mothers did not eat fish. Followed over 11 years, the exposed children have continued to do poorly in a range of skills and development tests, including deficits in general intellectual functioning, short- and long-term memory, and attention span.

- The health of marine mammals has deteriorated significantly over the past two decades. Many of the newly emerging and resurgent diseases are associated with immune system dysfunction and suggest a broad environmental distress syndrome.
- Marine mammals present a metabolic imbalance, so they are considered one of the most vulnerable organisms with respect to long-term toxicity of man-made chemicals such as organochlorines. Cetaceans (whales and dolphins) are known to have a poor ability to detoxify organic pollutants because they lack isozymes that are required to detoxify DDT and PCBs.

### **"The Dirty Dozen"**

These 12 POPs are often referred to as the "dirty dozen":

**Aldrin** – an organochlorine insecticide;

- A pesticide used to control soil insects. It has been widely used to protect crops such as corn and potatoes, to protect wooden structures from termites.
- It is oxidized in the insect to form dieldrin, a neurotoxin.
- It is a carcinogen as well as a mutagen.
- It binds strongly to soil particles, is resistant to leaching into ground water. It is released from soil by volatilization.
- Due to its persistent nature, aldrin is known to bio-concentrate.
- Aldrin is toxic to humans causing headache, dizziness, nausea, general malaise, and vomiting, followed by muscle twitchings, myoclonic jerks, and convulsions.
- Occupational exposure to aldrin, in conjunction with dieldrin and endrin, has been associated with a significant increase in liver and biliary cancer. -Aldrin may affect immune responses.
- Many countries, including the US have ended its usage and manufacture
- It is a carcinogen as well as a mutagen.

**Chlordane** – a manufactured pesticide;

- Chlordane is a broad spectrum contact insecticide that has been used on agricultural crops as well as being used extensively in the control of termites
- Banned in US in 1988 by the EPA;
- Chlordane sticks strongly to soil particles at the surface and is not likely to enter groundwater. As a result it can stay in the soil for over 20 years and breaks down very slowly.
- Bio-concentrates in fish, mammals, and birds;
- In both humans and animals, it can damage nervous and digestive systems, and liver - Has caused convulsions and death;
- Recent human studies have linked chlordane exposure with prostate and breast cancers.

**DDT** – a synthetic pesticide

- DDT is a toxicant;
- It has a half life of 2-15 years, and is immobile in most soils
- Breakdown products in the soil environment are DDE and DDD, which are also highly persistent and have similar chemical and physical properties.
- Banned in the US for most uses in 1972.
- Subsequently banned for agricultural use worldwide, but is still used to a limited extent in mosquito control in certain parts of the world
- The use of DDT was found to be a major factor in the bald eagle and the peregrine falcon population decline, as it caused the birds' egg shells to thin.
- DDT and its metabolic products DDE and DDD magnify through the food chain
- DDT bio-concentrates significantly in fish and other aquatic species, leading to long-term exposure to high concentrations.
- At the chronic level, individuals who consumed contaminated fish increased diabetes occurrences;
- The EPA, in 1987, classified DDT as a probable human carcinogen.
- In 2007 a Canadian study found a positive association between DDE and non-Hodgkins Lymphoma.
- Tests conducted by the CDC in 2002 showed that more than half of subjects tested had detectable levels of DDT or metabolites in their blood,
- The USDA tested cows milk samples in 2005 and found that 85% had detectable levels of DDE.

**Dieldrin** – an insecticide;

- Closely related to aldrin which itself breaks down to form dieldrin
- it accumulates as it is passed along the food chain.

- Long-term exposure is toxic to many animals (humans included) far greater than to the original insect targets;
- Currently banned in most of the world;
- Linked to Parkinson's disease, breast cancer and immune, reproductive, and nervous system damage.

**Endrin** – an insecticide/rodenticide;

- Banned in many countries;
- It is likely to adsorb onto the sediments in surface water.
- An insecticide used on cotton, maize, and rice; a rodenticide used to control mice and voles
- It can bio-concentrate in the fatty tissues, of organisms living in water. It is very toxic to aquatic organisms, namely fish, aquatic invertebrates, and phytoplankton.;
- Half-life in soil estimated at over a decade;
- endrin poisoning in humans primarily affects the nervous system. Food contaminated with endrin has caused several clusters of poisonings worldwide, especially affecting children.

**Heptachlor** – an insecticide;

- Similar to the insecticide chlordane
- The U.S. has banned the sale of heptachlor products in the United States and virtually eliminated its use for any purpose
- Has a very stable structure, thus it can remain in environment for decades;
- Possible human carcinogen.

**Hexachlorobenzene (HCB)** – a fungicide;

- A fungicide formerly used as a seed treatment, especially on wheat.
- Known animal carcinogen (liver, kidney, thyroid);
- Probable human carcinogen;
- After its introduction as a fungicide in 1945, for crop seeds, this toxic chemical was found in all food types.
- Banned in the U.S in 1966;
- In humans it can cause liver disease, skin lesions, ulceration, hair loss, thyroid damage;
- Human and animal studies have demonstrated that HCB crosses the placenta to accumulate in fetal tissues and is transferred in breast milk.
- Extremely toxic to aquatic creatures. Risk of bioaccumulation in an aquatic species is high

**Mirex** – an insecticide, flame retardant;

- Listed as a persistent, accumulative, and toxic pollutant by EPA in the U.S.
- It was used to control fire ants and as a flame retardant in plastic, rubber, paint, paper and electronics.
- Mirex is transported across the placenta and can be passed from mother to child through breast milk;
- Most effected in animals is the liver;
- Proven to cause cancer in mice and rats and is a carcinogenic risk to humans;
- toxic for a range of aquatic organisms, with crustacea being particularly sensitive.
- Mirex induces pervasive long-term physiological and biological disorders in vertebrates.
- There is evidence of accumulation of mirex in aquatic and terrestrial food chains to harmful levels
- Mirex is one of the most stable of the organochlorine insecticides and is it is widespread in the environment.
- All uses of mirex as a pesticide were banned in the U.S. in 1978.
- mirex is still used in the USA mainly as a flame-retardant in plastics, rubber, paint, paper and electronics.
- Effects on organisms combined with its persistence suggest that mirex presents a long-term hazard for the environment

### **PCBs** (polychlorinated biphenyls)

- Used as coolants/insulating fluids, also used in flexible PVC coatings of electrical wiring and electronic components, pesticide extenders, cutting oils, flame retardants, hydraulic fluids, sealants (used in caulking, etc), adhesives, wood floor finishes, paints, and in carbonless copy paper.
- PCBs are very stable compounds and do not degrade readily.
- Despite being banned in the 1970s due to their high toxicity, PCBs still persist in the environment
- Prior to the ban estimates have put the total global production of PCBs on the order of 1.5 million tons
- PCBs have been detected globally in the atmosphere, from the most urbanized areas that are the centers for PCB pollution, to regions north of the Arctic Circle, carried by wind currents.
- Bio-concentrates in animals;
- PCBs can be transmitted to children via breast milk as well as through the placenta.
- In humans, PCBs can cause liver disease, ocular lesions, lessened immune response

- Babies born to women exposed to PCBs have been shown to weigh less, have problems with motor skills, a decrease in short-term memory, and compromised immune systems.
- PCBs alter estrogen levels in the body and contribute to reproduction problems.
- Endocrine Disrupting Chemicals (EDC's) such as PCBs pose a serious threat to reproduction in top-level predators.
- Biological magnification of PCBs has led to polar bears and whales that have both male and female sex organs and males that cannot reproduce.
- Effects on animals are liver, stomach, thyroid damage, plus immune system changes, changes in behavior, impaired reproduction
  - Some studies indicate that PCBs are associated with cancer in humans, such as cancer of the liver and biliary tract. Recent research by the National Toxicology Program has confirmed that PCB126 is a carcinogen.
  - PCBs are known to induce Vitamin A deficiency in mammals, an affect that may be associated with impairment of the immune system, reproduction and growth.

**PCDDs (Polychlorinated dibenzodioxins) – commonly referred to as DIOXINS;**

- Dioxins are teratogens (cause birth defects), mutagens, potential human carcinogens;
- Known to accumulate in humans and wildlife due to dioxins' ability to dissolve in fats and oils and their tendency to be water insoluble. This means that even small amounts in contaminated water can bio-concentrate up the food chain to dangerous levels.
- In humans, they can cause effects in reproductive/sexual development, plus immune system damage, thyroid disorders, nervous system disorders, endometriosis and diabetes.
- In animals and fish, studies have shown dioxin exposure to cause cancer birth defects, liver damage, endocrine damage, and immune system suppression.
- Studies have shown that exposure to dioxin increases the ratio of female births to male births among a population.
- Concentrations of dioxins are found in all humans today, with higher levels found in persons living in more industrialized countries.
- The estimated elimination half-life for dioxins in humans ranges from 7.8 to 132 years.

- Dioxin enters the general population almost exclusively from ingestion of food, specifically through the consumption of fish, meat, and dairy products since dioxins are fat-soluble and readily climb the food chain
- Because Dioxins are lipophilic, breast fed children usually have substantially higher dioxin body burdens than non-breast fed children until they are about 8 to 10 years old.
- According to the EPA, 80% of Dioxin emissions are caused by coal burning plants, municipal waste incinerators, metal smelting, diesel trucks, land application of sewage sludge, burning treated wood and trash burn barrels. Dioxins are also generated in bleaching fibers for paper and textiles.

### **Polychlorinated dibenzofurans**

- highly toxic;
- Properties and chemical structure similar to dioxins;

### **Toxaphene** – an insecticide;

- highly toxic
- Banned in US in 1990, outlawed in 1991 by the Stockholm Convention
- Exposure can cause damage to lungs, nervous system, kidneys and can be fatal

### **Additional POPs**

#### **PBDEs** – (Polybrominated diphenyl ethers) flame retardants

- PBDEs are used in plastic, foam and textiles in clothing, computers, televisions, furniture and cars.
- PBDEs have been found at high levels in indoor dust
- Research has linked some chemicals in the flame retardants to effects on thyroid function on brain function, reduced male fertility and damaged ovarian development and the development of the embryonic nervous system, impacting motor skills and behavior.
- These chemicals were banned in Europe in 2004/2005. In August 2003, California became the first state to ban two forms of the fire retardants chemicals known to accumulate in the blood of mothers and nursing babies. In April 2007 Washington banned the use of PBDEs and in May 2007, the state of Maine passed a bill phasing out the use of DecaBDE.
- levels of concentration in humans and marine mammals continue to increase, particularly in the United States.

- Studies have found that PBDEs accumulate in human blood, fat tissue and breast milk. It has been found that a woman can pass these chemicals to her unborn child through the placenta.
- In the United States levels in human breast milk are 40 times higher than in Europe and are steadily rising.
- Marine mammals like bottlenose dolphins, harbor porpoises, pilot and beluga whales have been found to be contaminated with PBDEs. Birds including cormorants and glaucous gulls, and popular food fish including salmon and tuna have also been found to carry high concentrations of PBDEs

**PFCs** – perflorinated compounds;

- PFCs are used as industrial and commercial surfactants - wetting agents that lower the surface tension of liquid.
- In contrast to the majority of organic pollutants that are deposited in fatty tissue, perflorinated contaminants circulate in the blood and accumulate primarily in the liver.
- PFCs are synthetic molecules that are thought to bioaccumulate and are believed to be extremely resistant to physical degradation, biodegradation, and biotransformation.
- Science has begun to demonstrate clear links between chemicals such as phthalates, bisphenol A, and perflorinated compounds found in consumer products including baby bottles, toys, and cosmetics to reproductive disorders.



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