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ECS 188

15 November 2011

Effects and Persistence of Chemicals on the Environment

(2379 Words)

Cancer is a deadly disease that takes away loved ones from our lives. Find four friends, pick straws, and surely one of you will get cancer. When people are diagnosed with cancer most tend to think, "What do I have to do to get rid of it?" but the questions that should be asked are "How?" and "Why did I get cancer?" Humans change their environment to invent new products, and while not thinking about it, cause great damage to themselves and to others. This arrogance towards scientific advancement can fundamentally alter the environment and cause a recession of human life in the process.

Humans invent things to make their lives easier. We construct homes to protect us from storms, build factories to mass produce cars, and create pesticides to get rid of pesky mosquitoes from our habitat. However, people often overlook the consequences of their own actions. For example, pesticides and weed killers were invented to protect crops. While these chemicals seemed like a good idea at the time, many of them were untested and have ended up in our streams and waters. Big companies like A&W root beer dump toxic chemicals into our streams and atmosphere. The questions that need to be asked are "How much are these toxic chemicals affecting us?" and "If it does little harm, does it matter?" In her book *Living Downstream: An*

Ecologist's Personal Investigation of Cancer, Sandra Steingraber explains how these trace amounts of chemicals can add up inside of our bodies and cause deadly illnesses such as cancer.

After World War II, many pesticides were introduced to the United States. In 1950, "less than 10 percent of cornfields were chemically treated," but by 2005, "98 percent were sprayed with pesticides" (Steingraber 4). The book *Silent Spring* by Rachel Carson was written during the genesis of widespread pesticide use. In this book, DDT, lindane, aldrin, dieldrin, chlordane, and heptachlor are all pesticides Carson links to cancer. Lindane was used as an insecticide and wasn't banned completely until as recent as 2006, and can still be used as a lice and scabies treatment. Lindane has been known to be correlated with cancers of the lymph and is still in the air, earth, and sea because of "global distillation"; the transportation of chemicals from the wind in warm climates of the equator to the cold climates in the arctic poles and back to the equator. Because of the natural way the earth recycles itself through wind patterns and the constant temperature changes, the chemicals circulate in our environment and into our bodies. Aldrin was banned in 1975, but was still used for termite control until 1987. "Dieldrin suppresses the immune system and produces abnormal brain waves in mammals" (Steingraber 9). Heptachlor and chlorade were used in most agricultural sites and have both been connected with leukemia for children. With so many chemicals running through our streams, entering our air, and in our water systems, it's difficult to pinpoint which chemicals causes which cancer and other problems we have in our bodies. Regulations on these chemicals are not being enforced.

Steingraber observed how the farming industry has changed over the decades. With farms having become abstracted and remote from consumers, people are less and less aware of the origins of the foods they eat. With profit margins shrinking, farmland has to grow and farmers are forced to turn to chemical pesticides to maintain their field. Soaked with herbicides, the soil

is no longer fit for traditional farming methods such as crop rotations. Without crop rotations to disrupt patterns in plant location, bugs are drawn to the crops and insecticides are used to combat them, adding more to the overall pesticide use.

Increased use of these pesticides on crops has contaminated almost all rivers in Illinois. In 1993, 91 percent of Illinois rivers and streams showed 31 different types of pesticides. Moreover, the chemical dichlorodiphenyltrichloroethane (DDT) was found on 41 percent of kitchen floors according to a study performed in 2006 by the US Department of Housing and Urban Development. DDT is a dangerous chemical because it causes birth defects in animals and people, which are passed on to following generations. It has been linked to "low sperm count, premature birth, diabetes, brain damage, pancreatic cancer, impaired breast feeding, and breast cancer" (Steingraber 5). The pesticide was sprayed commonly in the streets during the 1950s to get rid of insects in the suburban world. Kids used to make games out of the DDT trucks and "run behind the clouds of pesticide to see who could stay longest" (Steingraber 7). DDT was finally recognized as a poisonous chemical and eventually banned. Unfortunately, DDT is a stable chemical compound and studies have shown DDT contamination continues in fish, rivers, and plants today.

DDT and PCBs also have a direct relation with breast cancer. During 1976, research found that women with breast cancer had higher levels of dichlorodiphenyldichloroethylene (DDE) and PCB. "DDT become metabolized in the human body into DDE and acts like a female hormone" (Steingraber 11). Regardless, the study was not conclusive enough, and the connection between DDT and cancer wasn't proved until a thorough mammogram study was conducted in 1993 of 14,290 women from New York City. Compared to healthy women, the study showed women with breast cancer had "DDE levels significantly higher [. . .] (35% higher)" (Wolff 81).

Women with higher DDE levels were four times more likely to have breast cancer. Due to these findings, activists demanded more research and found women born in the US during the period of 1947 to 1958 had "almost three times the rate of breast cancer" (Steingraber 12) from PCBs and other pesticides. As time passed, research revealed that the reason DDT caused so much breast cancer was due to high exposure during adolescence. Children of the '50s, '60s, and '70s have some of the largest numbers of breast cancer when they became adults due to the mass use of chemicals.

In order to observe chemical effects on live bodies during adolescence, animal testing is necessary. Bioassays are procedures that analyze the effects of a chemical substance by exposing animal subjects to suspected chemicals. Bioassays for carcinogenicity on rodents takes up to two years from application to observe and record the effects of a particular chemical over time making it a time-consuming and resource-intensive process. Nevertheless, the International Agency for Research on Cancer has performed such tests since 1971 and has tested "about nine hundred chemicals and identified four hundred of these as human carcinogens or potential carcinogens" (Steingraber 128).

By controlling the moment of exposure to the chemical, these bioassays can be used to observe risk of breast cancer occurring during maturation. According to Steingraber, terminal end buds present in the breasts during pubescence are "extremely susceptible to chemical carcinogens" (132). Chemicals that increase the number of these buds or inhibit maturation--prolonging the buds' presence--greatly increase the risk of contracting breast cancer. The substances do not have to be carcinogenic themselves to be a cancer threat; they can also be cancer-promoting substances.

Once breast cancer has been contracted, its growth is intimately linked to the estrogen

levels in the body of the host. For this reason, studies have been conducted to examine chemical substances which mimic estrogen. Ana Soto and Carlos Sonnenschein, researchers from Tufts University, demonstrated to Steingraber the hormonal effects of one such chemical using three petri dishes of breast cancer cells. Two of the dishes were control dishes; one control dish didn't contain any estrogen while the other contained estradiol, a potent form of estrogen. The experimental third dish contained the chemical endosulfan. The results revealed that while the estradiol exhibited the most growth, the dish with the endosulfan showed accelerated growth as well. This shows the ability of endosulfan to mimic estrogen and, while it may not be a carcinogen itself, can contribute to the affects of cancer.

Endosulfan is an organochlorine insecticide that has been in use in the US since 1954. In past years, the US has used "1.4 million pounds each year - on tobacco, tomatoes, and a variety of fruits and vegetables" (Steingraber 124). It is a persistent organic pollutant that is able to leak out of farms and into the envrionment. Steingraber notes that it has become a common contaminant in the Imperial Valley's Alamo River and has been found in the fat of Arctic seals and fish. In 2011, the Stockholm Convention has "approved the recommendation for elimination of production and use of endosulfan and its isomers worldwide" (Mathew).

Obesity and weight gain are other important risk factors for breast cancer as well as many other cancers. The reasons for this increased risk are not well understood but are believed to be due to the resulting changes in hormone levels and inflammatory processes. Fat tissues secrete estrogen and weight gain can hasten the onset of puberty in girls, thereby increasing the risk of breast cancer. The American Cancer Society attributes one-third of cancer diagnoses to obesity, weight gain, sedentary lifestyles, and inadequate intake of fruits and vegetables.

Though obesity and weight gain are usually a result of poor diet, chemical pesticides in

our environment may also have contributing role. Atrazine is a triazine herbicide that been in use since 1959. This chemical works by poisoning a chain reaction that occurs in the chloroplasts of weeds. It binds to proteins in the chloroplasts to block the reception of electrons needed for the photosynthetic process. Toxic products of oxidation build up and cause the chloroplast to swell and burst, eventually killing the weed. The structure of the chloroplasts atrazine operates on closely resemble that of an animal's mitochondria. To observe the potential effects of atrazine on humans, research in Korea was conducted to the impact of atrazine on mitochondria. They concluded that chronic exposure to low concentrations of atrazine "damages mitochondrial function, affects insulin signaling, and induces insulin resistance and obesity" (Lim).

In animals and humans, atrazine is a proven endocrine disruptor. Prenatal exposure in mice showed the development of female mammary glands were affected. It can disrupt hormonal messages from the pituitary gland that play a role in ovulation. Atrazine also "wreaks havoc with the sex lives of adult male frogs, emasculating three-quarters of them and turning one in 10 into females" (Sanders). Though studies on adult human exposure have not shown any links to breast cancer, information has yet to be gathered on fetal or childhood exposure.

While atrazine is not an estrogenic substance, it can potentially contribute to breast cancer growth by stimulating the production of aromatase. Aromatase is an enzyme that converts male androgen hormones into estrogen. These effects can occur at concentrations as low as two parts per billion, which is lower than the legal limit. Sadly, the manufacturer of atrazine, Syngenta, insists that there are no environmental concerns:

> Atrazine poses no threat to the safety of our drinking water supplies. In 2008, none of the 122 Community Water Systems monitored in 10 states exceeded the federal standards set for atrazine in drinking water or raw water. (Syngenta)

Maybe one chemical exposure in small doses isn't a problem; however, the combination of these trace chemicals can cause detrimental effects on our drinking water, rivers, and food.

Atrazine attacks by being absorbed into soil water and taken up through the roots of the weed. The water-solubility of this chemical allows it to easily leak out from the soil into nearby bodies of water. From there, atrazine can attack aquatic plants it comes in contact with. Once it has become a part of the water system, it can precipitate into a component of rainfall. The inability to properly contain this chemical has led to its ban in the European Union under the precautionary principle.

By entering the water system, all of these chemical pesticides have the ability to spread to distant areas through multiple methods. As an example, transitional cell carcinomas have been found in beached beluga whale carcasses in the St. Lawrence River. Whales with bladder cancer were found in 1985 and with breast cancer in 1988. "By 2002, 129 stranded carcasses had been autopsied, and cancer was found in 27 percent of whales, a percentage similar to that found in humans living in the area" (Steingraber 135). In contrast, beluga whales to the north in the Arctic Ocean did not have any such cancer. This makes environmental contamination the likely culprit. Sampling the blubber of the beluga whales, researchers found several traces of organic pollutants. PCBs and DDT in the water could be explained by historical usage in the local area. Chlordane and toxaphene found in the water and sediments are assumed to have been blown in on wind currents from the southern areas of the country. Mirex, which was not found to be present in the water or sediment, may have been introduced by contaminated eels which migrated from Lake Ontario. Nearby aluminum smelters also polluted the river with chemicals that played a critical role.

Benzo[a]pyrene is a type of polycyclic aromatic hydrocarbon found in coal tar pitch used

for aluminum smelting. When introduced into the body, benzo[a]pyrene becomes activated when cellular enzymes insert oxygen in an attempt to break down and detoxify the molecule. When activated, the compound is able to bond tightly to DNA strands and become a DNA adduct. PCBs can interact with these adducts to easily cause genetic mutations by transforming the benzo[a]pyrene into a mutating carcinogen. The beached beluga whales contained a high number of these adducts in their brain tissue.

As we've seen through this report, use of chemicals can have wide-ranging and long-lasting effects to the environment. Chemicals that have been produced for sake of convenience, expedience, and profit over public safety have created irreparable damage. They soak into the ground, leak into the water supply, and evaporate into the atmosphere to rain back down on distant soils and begin the process anew. These substances have not only had an adverse effect on public health, but also have the capability to spread out and contaminate the land, sea, and air. We should learn to fully recognize the extent of our influence on the environment when developing such chemicals and technologies.

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