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Spotlight Air Environmental
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Your Body, Your Health, and Toxic Substances in the Environment: What You Need to Know to Protect Yourself and Your Loved Ones

As noted in the previous posting, heavy metals and other toxins emitted from the ever-expanding industrial activities are increasingly polluting the environment, thus causing serious hazards to human and other life forms. Understanding the processes in which toxic substances enter living bodies and build up to levels which cause serious health hazards requires coming to grips with a set of interrelated terms which name corresponding interrelated processes. These terms include Bioavailability, Bioaccumulation, Bioconcentration, and Biomagnification along with the term Trophic Level.

Bioavailability

Bioavailability refers to the most basic of these processes. In other words, toxic substances accumulate or concentrate in an organism only if they are bioavailable first. Bioavailability refers to the extent to which a toxic substance can penetrate the cell membranes of an organism and thus be absorbed into the blood stream or vascular tissue of plants. In effect, bioavailability of a toxic substance concerns its readiness for uptake by plants and animals, which depends on the nature and form of the substance and the immediate environment in which it is found. We should also note that bioavailability could be a result of what happens at the point of contact between a pollutant and an organism in a specific environment. If we take the case of inorganic mercury (Hg) in aquatic environments, it is known that due to interaction with microorganisms it becomes transformed into the organic mercury Methylmercury (MeHg), which is much more bioavailable and toxic. Methylmercury is known to cause severe damages to the kidney and the central nervous system in humans and is known to be particularly harmful to developing fetuses and children.

Bioaccumulation and Bioconcentration

Both bioaccumulation and bioconcentration are processes that occur in an organism. Bioaccumulation refers to the buildup of a toxic substance in an organism due to intake from all environmental sources (water, air or ingestion of food). Bioaccumulation of heavy metal toxins happens because of their persistent nature and the difficulty to get rid of them through metabolism. In other words, the rate at which they get removed from the body is slower than the rate of their uptake. As the process of buildup continues it reaches a point whereby the level of accumulation of the toxin in the organism is greater than that of the surrounding environment. It is this situation which the term bioconcentration refers to.

Trophic Levels and Biomagnification

While the terms bioaccumulation and bioconcentration refer to processes of toxin buildup in an organism, biomagnification, also sometimes referred to as bio-amplification, stands for what happens as we go up from lower to higher trophic levels of the food chain in the ecosystem.[1] For our purposes, the main and general point to understand is that an organism at one level of the food pyramid consuming an organism from a lower level gets all the toxins already accumulated in the organism it consumes plus all the toxins that it takes directly from other sources in the environment. It is in such a context that we can talk of biomagnification or bio-amplification which refer to a dangerous level of accumulation.

The significance of biomagnification can be usefully illustrated by a brief consideration of mercury pollution in Illinois and the extreme danger it poses to human health. As Max Muller states in his article “Risky Fishing: Power Plant Mercury Pollution and Illinois Sport Fish” (2006), power plants that generate energy by firing coal are by far the largest sources of mercury pollution.[2] According to Muller, coal-burning power plants are the largest source of mercury pollution as the 21 coal-burning power plants existing in Illinois at the time of his report were responsible for 71% of the mercury pollution in the state.[3] On the other hand, data released by the website Statistica in July 2024 indicates that the number of coal-fired power plants in Illinois has gone down to only 8.[4] However, it is not clear whether there is a corresponding reduction in the magnitude of mercury emission in the state. While other industries such as mining and the production of metals and cement add to the degree of pollution, the fact remains that coal-burning power plants as a group are a major contributor of mercury emission in Illinois. In effect, as Muller notes, a lot of the mercury emitted sinks into the water bodies of Illinois where it becomes changed into the notorious neurotoxin Methylmercury and bioaccumulate in small fish at the lower end of the food chain and, then, get biomagnified more and more as the bigger fish at the upper level of the food chain eat the smaller fish. As a neurotoxin Methylmercury endangers everyone, but it is particularly harmful to developing fetuses and children. That is why Illinois’ Methylmercury Advisory regarding “predatory fish” was first issued in 2002 and was updated in 2023. The Advisory was issued because studies found high levels of Methylmercury in predatory fish throughout the Illinois.

The list of predatory fish listed in the Advisory includes "largemouth bass, smallmouth bass, spotted bass, striped bass, white bass, walleye, sauger, flathead catfish, gar, Muskellunge, northern pike, all trout and salmon, and associated hybrids.[5]

Works Cited:

[1] See the title Study Guide of Trophic Levels posted by Inspirit Learning Inc. on March 28, 2023 at https://inspiritvr.com/trophic-levels-study-guide/.

[2] See Muller, Max (2006), "Risky Fishing: Power Plant Mercury Pollution and Illinois Sport Fish" (https://www.csu.edu/cerc/researchreports/documents/RiskyFishingPowerPlantMercuryPollutionIllinoisSportFish2006.pdf).

[3] See the title "Category: Existing Coal Plants in Illinois" on the website Global Energy Monitor WIKI. (https://www.gem.wiki/Category:Existing_coal_plants_in_Illinois)

[4] See the number of active coal-fired power plants in the United State and their distribution by state on the website Statista (https://www.statista.com/statistics/1252352/us-coal-power- plants-by-state/).

[5] See the title "Facts About Illinois' Methylmercury Advisory" on the website of Illinois Department of Public Health (IDPH) (https://dph.illinois.gov/topics-services/environmental-health-protection/toxicology/fish-advisories/methylmercury-facts.html).