Hello, this is Rebecca Wilson, and I'd like to welcome you to the National Institute of Environmental Health Sciences Superfund Research Program monthly Research Brief podcast.

This month, we'll be looking at PCBs and phytoremediation with SRP researchers from the University of Iowa.

The Research Brief, Number 197, was released on May 4, 2011, and was written by SRP contractor Maureen Avakian in conjunction with SRP-supported researcher Dr. Jerald Schnoor.

Polychlorinated biphenyls (PCBs) are transported in the atmosphere via cycles of volatilization and deposition and are found in virtually every component of the global ecosystem - water, soil, sediment, and tissues of animals and plants. The University of Iowa Superfund Research Program studies atmospheric sources of semi-volatile PCBs, with the ultimate goal of preventing exposure or ameliorating the effects of exposure.

Dr. Jerald Schnoor directs engineering research at the Iowa Superfund Research Program that focuses on remediation of sites contaminated with PCBs. Specifically, Dr. Schnoor and his colleague, Dr. Guangshu Zhai, hope to show that plants can provide *in situ* phytoremediation of PCB congeners scavenged from the air emanating from potential sources, such as dredged sediments. Where feasible, phytoremediation is considered an attractive remediation option as it is cost-effective and environmentally friendly. However, because of their high chemical stability and hydrophobicity, PCBs are not readily taken up by plants and are generally resistant to biodegradation by microorganisms.

Drs. Zhai, Lehmler, and Schnoor demonstrated that poplars can take up and translocate some lower chlorinated PCBs and can metabolize PCB3 and PCB77-research featured in Research Brief 182. In recent work, Schnoor's group also investigated another aspect of phytoremediation of PCBs - selective uptake and metabolism of enantiomers - and its effect on the toxic properties and environmental fate of PCBs.

Chiral PCBs were produced and released into the environment as racemic mixtures – 50/50 mixtures of the enantiomers. Detection of nonracemic mixtures suggests enzymatic selectivity of one enantiomer over another. To design and implement effective phytoremediation strategies, it is important to understand the biotransformation mechanisms in plants and to know whether plants can transform chiral PCBs enantioselectively.

Phytoremediation begins with the plant uptake of contaminants by roots and the distribution of contaminants throughout the plant. Using actively growing poplar plants, the research team studied uptake and translocation of PCB95 and PCB136, both highly neurotoxic chiral compounds.

The researchers exposed plants to hydroponic solutions containing 0.003 mg/L of PCB95, 0.002 mg/L of PCB135, or a blank control with no PCBs. Dead poplar plants were used as negative controls that could not biologically bind or metabolize the PCBs but could physically absorb (or uptake) the PCBs and/or support microbial enantioselective transformation.

To monitor the dynamic processes of uptake, translocation, distribution, and transformation of the PCBs in different tissues of poplar plants, they collected samples after 5, 10, and 20 days of exposure and divided each specimen into hydroponic solution, root, bottom bark, bottom xylem, middle bark, middle xylem, top bark, top xylem, and leaf.

The poplar plants absorbed and transported both PCB95 and PCB136, which were detected in various plant tissues. However, the enantioselectivity for PCB95 and PCB136 was quite different. The researchers found that while poplar plants showed no enantioselectivity for PCB136, poplar plants exposed to PCB95 showed enantioselectivity over time and among tissues:

- The hydroponic solution remained racemic throughout the course of the study, indicating that the poplar plants removed the two enantiomers of PCB95 equally from the solution.
- The ratios of the two PCB95 enantiomers changed significantly over time in the bottom and middle xylem. For example, in the middle xylem at day 20, the concentration of E1-PCB95 was less than half the concentration of E2-PCB95.
- These changes were not observed in the dead plant control. This suggests that live plant tissues actively transformed more E1-PCB95 than E2-PCB95 by enzymatic reactions in solution, by enzyme complex formation and binding to cellular tissues, or both.

While the different results for PCB95 and PCB136 could stem from the differences in their molecular masses, Dr. Schnoor suggests that the enantioselectivity exhibited towards PCB95 are most likely the consequence of enantioselective metabolism and enantioselective binding by cytochrome P450 in whole poplars.

Given their huge biomass on the earth, plants likely play an important role in the enantioselective biotransformation and/or translocation of chiral PCBs. By studying the fundamental processes of PCB phytoremediation, Dr. Schnoor's group is establishing the scientific basis for the development and application of land management strategies for intervention at contaminated waste sites. This work supports the development of strategies to break the continuous cycling of PCBs between water, soil, and the atmosphere, ultimately reducing the risk of human exposure.

If you'd like to learn more about this research, visit the Superfund Research Program website at www.niehs.nih.gov/srp. From there, click on "Who We Fund" and follow the links to the University of Iowa research summary. If you have any questions or comments about this month's podcast or if you have ideas for future podcasts, contact Maureen Avakian at avakian@niehs.nih.gov.

Join us next month as we continue the discussion of remediation: Dr. Dibakar Bhattacharyya has developed a double membrane remediation system to remove chlorinated organic contaminants from groundwater.