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Worms bear sludge load

Researchers find that perfumes and drugs bioconcentrate in earthworms collected from soils treated with biosolids and manure.

Pharmaceuticals and personal care products (PPCPs) end up in the tons of solid sludge left behind by wastewater treatment processes. Those so-called biosolids are often repackaged and sold as fertilizers for both industrial and small-scale agriculture. In a new survey, published in *ES&T* (DOI: 10.1021/es702304c), researchers show for the first time that those compounds can turn up in earthworms.

USGS

Dana Kolpin of USGS collected worms from three agricultural fields, two of which were treated with biosolids or swine manure.

The findings illustrate the wide array of PPCPs that can be carried from treatment facility to field. Biosolids provide "great value as sources of organic carbon and nutrient compounds," says coauthor Edward Furlong of the U.S. Geological Survey (USGS), but "you still have to understand the trace constituents." The proof-of-concept study also demonstrates that worms are taking up some of the compounds into their tissues and bioconcentrating them there, with unknown effects, says study coauthor Dana Kolpin, also of USGS.

Bioaccumulation of PPCPs by worms is not entirely a surprise, according to Stockholm University's Cynthia De Wit, who points to her own work looking at PBDEs and other persistent compounds in earthworms. However, the new research underscores that worms could serve as monitoring organisms, she says. Because the worms seem to concentrate compounds that may be present at undetectable levels in the soils, they can be "a sort of sentinel, or magnifying glass of what's in the soil," she adds.

Kolpin collected worms and soil samples from three sites several times during a growing season: a soybean field amended with biosolids (which were not tilled into the soil) from a wastewater treatment plant, a corn field treated with swine manure that was tilled into the soil, and a soybean field not amended with biosolids or

manure.

After the worms emptied their guts, whole-body analyses gave the team an idea of what the creatures carried in their tissues. The worms' levels of some PPCPs were several orders of magnitude higher than concentrations of the same compounds in the soil samples. The scientists also found varying concentrations of wood preservatives and PAHs in the amended fields; some substances, including triclosan (an antimicrobial used in soaps) and the synthetic musks galaxolide and tonalide, turned up at surprisingly high levels.

Even the unamended field, which was to serve as a control site, had high concentrations of perfumes and triclosan in some places. Nuria Lozano, a visiting scientist at the U.S. Department of Agriculture (USDA), comments that triclosan levels in particular were an order of magnitude higher than those she has found in her own work. The result partly underscores how hard it can be to find an uncontaminated site, says Cliff Rice, Lozano's colleague at USDA. The authors conjecture that the source of these contaminants may be nearby septic systems or surface runoff.

Rice notes that biosolids tend to clump together and sit atop soils for months during dry spells if not tilled into the ground. As a result, the team's second sample collection, after the biosolids were applied, "may be more representative than the first," he says.

Tammy Jones-Lepp, a research chemist at the U.S. EPA Office of R&D Environmental Chemistry Branch in Las Vegas, Nev., notes that a couple of the results seem contradictory with regard to bioconcentration, with some substances appearing at much higher levels in the soils than in the worms. She would like to have seen "blank" worms, raised in a clean test plot for comparison with the wild worms from the fields. Still, Jones-Lepp says, "there definitely is a bioconcentration factor going on," and the data raise more questions, for example, as to whether the worms break down the contaminants in soils in which they live.

Robert Hale of the Virginia Institute of Marine Science observes that earthworms are mobile and that the most bioaccumulative chemicals likely remain near the surface. "Where were the worms prior to sampling?" he asks, raising the issue of "habituation" and possible avoidance behaviors by the worms. The fields were treated only once, whereas in practice, biosolids may be applied many times to the same plot, he notes. "The field study incorporates many variables, so simple interpretation is difficult."

Lead author Chad Kinney of Colorado State University Pueblo says this "one project is leading to more questions." Now that the researchers know that earthworms pick up PPCPs and other anthropogenic indicator compounds from biosolids, they plan to take the "next logical step," he says, to see what it means for the worms —and for other organisms that might eat them. —NAOMI LUBICK