NEW ITEMS IN THE NBMA RESOURCE LIBRARY

Ode to a worm August 2014

TITLE: Heavy metal concentrations in earthworms from soil amended with sewage sludge

Author: Beyer, W.N., R.L. Chaney, and B. M. Mulhern
Source: J. Environ. Qual. 1982 11:381-385
Abstract: Metal concentrations in soil may be elevated considerably when metal-laden sewage sludge is spread on land. Metals in earthworms (Lumbricidae) from agricultural fields amended with sewage sludge and from experimental plots were examined to determine if earth- worms are important in transferring metals in soil to wildlife. Earthworms from four sites amended with sludge contained significantly ($P < 0.05$) more Cd (12 times), Cu (2.4 times), Zn (2.0 times), and Pb (1.2 times) than did earthworms from control sites, but the concentrations detected varied greatly and depended on the particular sludge application. Generally, Cd and Zn were concentrated by earthworms relative to soil, and Cu, Pb, and Ni were not concentrated. Concentrations of Cd, Zn, Cu, and Pb in earthworms were correlated ($P < 0.05$) with those in soil. The ratio of the concentration of metals in earthworms to the concentration of metals in soil tended to be lower in contaminated soil than in clean soil. Concentrations of Cd as high as 100 ppm (dry wt) were detected in earthworms from soil containing only 2 ppm Cd. These concentrations are considered hazardous to wildlife that eat worms. Liming soil decreased Cd concentrations in earthworms slightly ($P < 0.05$) but had no discernible effect on concentrations of the other metals studied. High Zn concentrations in soil substantially reduced Cd concentrations in earthworms.
Document#: BIN.EA.5.1

TITLE: Fate and uptake of pharmaceuticals in soil−earthworm systems

Author: Carter, L.J., C.D. Garman, J. Ryan, A. Dowle, E. Bergström, J.Thomas-Oates, and A.B. Boxall
Source: Environ. Sci. Tech. 2014 48:5955-5963
Abstract: Pharmaceuticals present a potential threat to soil organisms, yet our understanding of their fate and uptake in soil systems is limited. This study therefore investigated the fate and uptake of 14C-labeled carbamazepine, diclofenac, fluoxetine, and orlistat in soil−earthworm systems. Sorption coefficients increased in the order of carbamazepine < diclofenac < fluoxetine < orlistat. Dissipation of 14C varied by compound, and for orlistat, there was evidence of formation of nonextractable residues. Uptake of 14C was seen for all compounds. Depuration studies showed complete elimination of 14C for carbamazepine and fluoxetine treatments and partial elimination for orlistat and diclofenac, with greater than 30% of the 14C remaining in the tissue at the end of the experiment. Pore-water-based bioconcentration factors (BCFs), based on uptake and elimination of 14C, increased in the order carbamazepine < diclofenac < fluoxetine and orlistat. Liquid chromatography−tandem mass spectrometry and liquid chromatography−Fourier transform mass spectrometry indicated that the observed uptake in the fluoxetine and carbamazepine treatments was due to the parent compounds but that diclofenac was degraded in the test system so uptake was due to unidentifiable transformation products. Comparison of our data with outputs of quantitative structure−activity relationships for estimating BCFs in worms showed that these models tend to overestimate pharmaceutical BCFs so new models are needed.
Document#: BIN.EA.5.2

TITLE: Bioaccumulation of pharmaceuticals and other anthropogenic waste indicators in earthworms from agricultural soil amended with biosolid or swine manure

Author: Kinney, C.A., E.T. Furlong, D.W. Kolpin, M.R. Burkhardt, S.D. Zaugg, J.P. Bossio, and M.J. Benotti
Source: Environ. Sci. Tech 2008 42:1863-1870
Abstract Analysis of earthworms offers potential for assessing the transfer of organic anthropogenic waste indicators (AWIs) derived from land-applied biosolid or manure to biota. Earthworms and soil samples were collected from three Midwest agricultural fields to measure the presence and potential for transfer of 77 AWIs from land-applied biosolids and livestock manure to earthworms. The sites consisted of a soybean field with no amendments of human or livestock waste (Site 1), a soybean field amended with biosolids from a municipal wastewater treatment plant (Site 2), and a cornfield amended with swine manure (Site 3). The biosolid applied to Site 2 contained a diverse composition of 28 AWIs, reflecting the presence of human- use compounds. The swine manure contained 12 AWIs, and was dominated by biogenic sterols. Soil and earthworm samples were collected in the spring (about 30 days after soil amendment) and fall (140-155 days after soil amendment) at all field sites. Soils from Site 1 contained 21 AWIs and soil from Sites 2 and 3 contained 19 AWIs. The AWI profiles at Sites 2 and 3 generally reflected the relative composition of AWIs present in waste material applied. There were 20 AWIs detected in earthworms from Site 1 (three compounds exceeding concentrations of 1000 μg/kg), 25 AWIs in earthworms from Site 2 (seven compounds exceeding concentrations of 1000 μg/ kg), and 21 AWIs in earthworms from Site 3 (five compounds exceeding concentrations of 1000 μg/kg). A number of compounds that were present in the earthworm tissue were at concentrations less than reporting levels in the corresponding soil samples. The AWIs detected in earthworm tissue from the three field sites included pharmaceuticals, synthetic fragrances, detergent metabolites, polycyclic aromatic hydrocarbons (PAHs), biogenic sterols,

disinfectants, and pesticides, reflecting a wide range of physicochemical properties. For those contaminants detected in earthworm tissue and soil, bioaccumulation factors (BAF) ranged from 0.05 (galaxolide) to 27 (triclosan). This study documents that when AWIs are present in source materials that are land applied, such as biosolids and swine manure, AWIs can be transferred to earthworms.
Document#: BIN.EA.5.3

TITLE: Polybrominated diphenyl ether accumulation in an agricultural soil ecosystem receiving wastewater sludge amendments

Author: Sellström, U. C.A. DeWit, N. Lundgren, and M.Tysklind
Source: Environ. Sci. Tech. 2005 39:9064-9070
Abstract: Few studies have addressed bioaccumulation of organic pollutants associated with land-application of biosolids. We thus examined PBDE burdens within a soil ecosystem receiving long-term sludge amendments and a reference soil ecosystem receiving only manure inputs. No PBDEs were detected in reference site samples, but sludge-amended soils contained 17 600 ± 2330 μg/kg $\sum_{3-7}$PBDE (total organic carbon (TOC) basis). $\sum_{3-7}$PBDE burdens were highest in soil invertebrates with the greatest contact with sludge-amended soil (e.g., $\sum_{3-7}$PBDE of 10 300 ± 2670 and 3000 ± 200 μg/kg lipid for earthworms and detritivorous woodlice, respectively). PBDEs were below quantitation limits in vegetation from the sludge-amended site. Surprisingly, we measured quantifiable PBDE burdens in only a single sample of predaceous ground spiders from the sludge-amended site. BDE-209 burdens in sludge-amended soil and earthworms were 7500 ± 2800 μg/kg TOC and 6500 ± 4100 μg/kg lipid, respectively. BDE 209 was detected in fewer taxa, but the burden in a detritivorous millipede composite was high (86 000 μg/kg lipid). PBDE congener patterns differed among species, with worms and ground beetles exhibiting Penta-BDE-like patterns. Penta-BDE biota-soil accumulation factors (BSAFs) ranged from 0.006 to 1.2, while BDE-209 BSAFs ranged from 0.07 to 10.5. δ13C and δ15N isotope signatures were poorly correlated with PBDE burdens, but sludge-amended samples were significantly δ15N enriched.
Document#: BIN.EA.5.4

TITLE: Effect of sewage-sludge application on concentrations of higher-brominated diphenyl ethers in soils and earthworms

Author: Sellström, U., C.A. DeWit, N. Lundgren, and M. Tysklind
Source: Environ. Sci. Tech. 2005 39: 9064-9070
Abstract: Polybrominated diphenyl ethers (PBDEs), including octa- decaBDEs, were found in soil and earthworm samples collected in 2000 from three research stations (reference plots and sewage-sludge-amended plots) and two
farms (reference and amended/flooded soils) in Sweden. Sewage-sludge amendment at the research stations increased concentrations of all BDE congeners 2- to 13-fold, with the highest increases for BDE-209. Concentrations 100- to 1000- fold higher were seen in contaminated soils at both farms. BDE-209 was the predominant congener in all soils. ∑PBDE concentrations in worms ranged from 3.1 to 38 000 ng/g lipid weight and were correlated to soil concentrations, including the octa-decaBDEs. Biota-soil accumulation factors declined in the following order: TeBDE > PeBDE > HxBDE > OcBDE > NoBDE > DeBDE, and ranged from 0.3 to 2 for the octa-decaBDEs. Thus, higher- brominated PBDEs, including BDE-209, are bioavailable from soils and accumulate in earthworms, presenting an exposure pathway into the terrestrial food web. High levels found at one farm 20 years after the last use of PBDEs indicate high persistence of PBDEs in soils, including BDE- 209. No evidence of photolytic debromination of BDE-209 in soils was seen.
Document#: BIN.EA.5.5