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Earthworms accelerate the biogeochemical cycling of potentially toxic elements: Results of a meta-analysis

Tom Sizmur¹ and Justin Richardson²

¹University of Reading, Department of Geography and Environmental Science, Reading, United Kingdom of Great Britain and Northern Ireland (t.sizmur@reading.ac.uk)

²Department of Geosciences, Morrill Science Center, University of Massachusetts, Amherst, MA 01003, USA (jbrichardson@umass.edu)

Earthworms are ecosystem engineers, capable of modifying the soil environment they inhabit. Recent evidence indicates that they increase the mobility and availability of potentially toxic elements in soils, but the systematic synthesis of the evidence required to understand mechanisms and identify soils most susceptible to earthworm-induced potentially toxic element mobilisation is lacking. We undertook a meta-analysis of 43 peer reviewed journal articles, comprising 1185 pairwise comparisons to quantify the impact of earthworms on potentially toxic element mobility in bulk earthworm-inhabited soil and earthworm casts and on plant uptake and concentration. We find that earthworms mobilise potentially toxic elements primarily due to the passage of soil through the earthworm gut and that this results in an increase in the concentration and uptake by plants. Earthworms mobilise potentially toxic elements in uncontaminated soils to a greater extent than contaminated soils. Soils with either very low (<2%) or very high (>10%) soil organic matter content are most susceptible to earthworm-induced potentially toxic element mobilisation. These findings have important implications for exotic earthworms burdening plants with toxic metals, but also offer a promising phenomenon that, if harnessed, may help to alleviate micronutrient deficiencies in degraded soils.