

- Very few studies to investigate risk of microplastics to soil biota and incorporation into terrestrial food chain.
- Studies focus on earthworm species but *Colombola*, isopods and chickens have also been tested
- HDPE, LDPE, PVC, PS, PU have all been tested, as well as a plastic residue mix. PE is most commonly used for testing.
- Some studies test for adverse effects, whilst others investigate the role of soil-dwelling organisms in the transport/distribution of microplastics.

# SCIENTIFIC REPORTS

## OPEN Microplastic transport in soil by earthworms

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### Histopathological and molecular effects of microplastics in *Eisenia andrei* Bouček<sup>49</sup>

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## OPEN Field evidence for transfer of plastic debris along a terrestrial food chain

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Although plastic pollution happens globally, the micro- (<5 mm) and macroplastic (5–150 mm) transfer of plastic to terrestrial species relevant to human consumption has not been examined. We provide first-time evidence for micro- and macroplastic transfer from soil to chickens in traditional Mayan home gardens in Southeast Mexico where waste mismanagement is common. We assessed micro- and macroplastic in soil, earthworm casts, chicken feces, crops and gizzards (used for human consumption). Microplastic concentrations increased from soil (0.87 ± 1.5 particles g<sup>-1</sup>), to earthworm casts (14.8 ± 28.8 particles g<sup>-1</sup>), to chicken feces (129.8 ± 82.3 particles g<sup>-1</sup>). Chicken gizzards contained 10.2 ± 13.8 microplastic particles, while no macroplastic was found in crops. An average of 45.82 ± 42.6 macroplastic particles were found per gizzard and 11.1 ± 15.3 macroplastic particles per crop, with 1–30 mm particles being significantly more abundant per gizzard (31.8 ± 27.27 particles) compared to the crop (1 ± 2.2 particles). The data show that micro- and macroplastic are capable of entering terrestrial food webs.

Globally, hot spots of plastic pollution are confined to the oceans, landfills, open waste disposals and home gardens<sup>1–3</sup>. Plastic packaging constitutes 37% of all plastic wastes. Low density polyethylene is the most abundant polymer in the world<sup>4</sup> with an estimated accumulation rate of 25 million tons per year<sup>5</sup>. In the Yucatan Peninsula in Southeastern Mexico, traditional Mayan home gardens in both urban and rural areas suffer from waste management problems<sup>6</sup>. Home gardens are agroforestry land use systems consisting of multipurpose trees and shrubs whose biomass is often used<sup>7</sup>. These gardens are rich in debris for their high organic matter content<sup>8,9</sup>.



- Adverse effects
  - e.g. reduction in growth and reproduction in collembolans<sup>1</sup>, histopathological damage in earthworms<sup>2</sup>
  - transfer of contaminants e.g. PBDE<sup>3</sup>
  - No adverse effects at low concentrations or for isopods
- Evidence of microplastic transport through predator-prey relationships – microplastics pass up through the food chain<sup>4</sup>
- Fragmentation of microplastics in earthworm gut<sup>5</sup>
- Evidence of trophic transfer that may potentially introduce microplastics to the human food chain
  - MPs in poultry (10.2 MPs per gizzard)<sup>6</sup>

## Fate of microplastics in soils

- **Transfer:** Runoff/erosion from wind and water – particles potentially transferred to other environments e.g. aquatic systems (and may eventually reach the ocean)
- **Accumulation:** aggregation, agricultural practices (tilling etc.), bioturbation, and burial due to successive flooding may lead to the accumulation of microplastics into the soil profile
- Microplastics in the soil profile may be leached to groundwater aquifers, but this has not yet been investigated.
  - Incorporation of microplastics into burrows (e.g. by earthworms) may increase the risk through preferential flow.
  - Although this may be highly dependent on properties such as particle size and surface charge