SCIENCE FOR ENVIRONMENT POLICY

Microplastic digestion by earthworms damages male reproductive system

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Kwak, J.I. and An Y-J. (2021) Microplastic digestion generates fragmented nanoplastics in soils and damages earthworm spermatogenesis and coelomocyte viability. *Journal of Hazardous Materials* 402. doi: 10.1016/j.jhazmat.2020.124034

Contact:
anyjoo@konkuk.ac.kr

New research investigating microplastic digestion by earthworms shows that it damages the male but not the female reproductive system, and that it produces smaller particles that are on the nanoscale.

The EU Plastics Strategy plans establish measures to restrict the use of microplastics in products[1] and reduce the unintentional release of microplastics into the environment. While there has been a wealth of evidence into the impact of microplastics on marine organisms there is a lack of research on the possible adverse effects of microplastics on the reproductive systems and immune cells of organisms that live in soil.

Earthworms are hermaphrodites, meaning an individual worm has both male and female reproductive organs. They provide important benefits to the soil environment such as increased nutrient availability, better drainage, and a more stable soil structure. Soil is a major component of their diet and earthworms are likely to digest microplastics present within the soil layers they inhabit. Through digestion, these microplastics may break down into smaller particles.

To help provide more insight into this area researchers studied earthworms exposed to two different sizes of polyethene microplastics (180–212 micrometers (10^{-6} m) and 250–300 micrometers (10^{-6} m)) for 21 days; and analysed the effects on different aspects of their biological systems by comparing them to earthworms with no microplastics in their surrounding soil. The test soil used in the study did not contain any other contaminants.

Both sizes of microplastics notably damaged male reproductive organs. Seventeen per cent of earthworms exposed to smaller microplastics showed normal development of the seminal vesicles (which store sperm and are important for fertility), while this was the case for only 5% of earthworms exposed to larger microplastics. In comparison, 65% of earthworms with no microplastics in their environment had normal development of the seminal vesicles.

Despite the negative effects of microplastics on the male reproductive organs, the study found that the microplastics produced negligible toxic effects in the ovaries of earthworms.

European Commission

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Microplastic digestion by earthworms damages male reproductive system (continued)

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The researchers also investigated the effects of microplastics at a cellular level within the immune system by studying coelomocytes – cells that play an important role in the immune response in earthworms. This showed that there was a decrease in the proportion of live healthy coelomocytes in those earthworms exposed to microplastics, demonstrating adverse effects of microplastics at both a cellular and organ level.

Finally, by examining the earthworm casts (soil that has been digested by worms and expelled onto the surface of the ground), the researchers assessed whether the digestive activity of earthworms caused microplastics to fragment into even smaller nanoplastics. Using the cutting-edge techniques of scanning electron microscopy (which produces images by scanning a sample with a focused beam of electrons) and energy dispersive X-ray analysis, researchers found fragmented plastic particles as small as 256 nanometres (nm) on the surface of microplastics found in the casts, proving that earthworm digestion leads to generation of smaller particles. This is important information for future studies on how microplastics are dispersed within the environment.

This is the first study to report on the negative effects of microplastics on the male reproductive system of soil invertebrates. When considered with previous research showing an inhibition of reproduction in invertebrates exposed to microplastics, the study indicates that microplastics have negative effects on sperm production itself. However more research is needed to detect the presence of microplastics in the reproductive system and their effect on other male reproductive organs to prove effects on overall function.

1. https://echa.europa.eu/hot-topics/microplastics