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Sea level rise and the impact of salinity on soil invertebrates

Sea level rise may cause soils in coastal regions to become more saline. In a recent study, reproduction in soil invertebrates was impaired in soils containing salt levels below the threshold used currently to define saline soils. The authors recommend community-level studies to further investigate the salt concentrations that are harmful to soil organisms.

Salinisation of soil damages ecosystem function, as it can harm soil organisms which play important roles in decomposing organic matter, nutrient cycling and maintaining the physical structure of the soil. The quality and fertility of the soils may therefore be impaired. This phenomenon may gradually increase under climate change, which is expected to cause global sea levels to rise. Soils in coastal areas such as countries around the Mediterranean Sea are at risk of becoming increasingly salty through salt water intrusion.

This laboratory study investigated the effect of increasing concentrations of sodium chloride (salt) and seawater on the reproduction of three commonly found soil-dwelling invertebrates: the springtail *Folsomia candida*, the enchytraeid (pot worm) *Enchytraeus crypticus* and the mite *Hypoaspis aculeifer*.

For the sodium chloride toxicity tests, 10 individuals from each species were placed in containers of artificial soil prepared according to Organisation for Economic Co-operation and Development (OECD) standards. Eight of the containers were contaminated with increasingly concentrated salt solutions, ranging from 0.5 to 4.5 g of sodium chloride per kg of solution for springtails and enchytraeids, and from 1.6 to 42.9 g/kg for mites. Previous studies had shown that mites were less sensitive to saline soils than the other two test species. The ninth container was the control, to which no salt solution was added.

The same set-up was used to test the effect of seawater, collected from the Portuguese coast, on the test species. Distilled water was added to the seawater to give dilutions ranging from 5 to 45% by volume of seawater. These dilutions gave a similar electrical conductivity range (a measure of the ion content in the soil) as the salt tests.

After 28 days, the researchers counted the number of organisms in each of the containers. They also analysed all treatments to calculate the salt and seawater concentrations that caused a 20% and a 50% reduction in reproduction (Effective Concentrations EC_{20} and EC_{50}) in the test species, compared with the control. All three species were differently affected by the contaminated soils. Mites were the least sensitive. Springtails and enchytraeids showed similar but greater sensitivity to sodium chloride contaminated soils compared with the control. The EC_{20} and EC_{50} were around six times higher for mites compared with springtails and enchytraeids.

Reproduction in mites was not significantly affected by any of the seawater contaminated soils, whereas springtails and enchytraeids were. Soils contaminated with more than 25% and 33% seawater significantly reduced reproduction in springtails and enchytraeids respectively, indicating that springtails were the most sensitive to the seawater contaminated soil.

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Source: Pereira, C.S., Lopes, I., Sousa, J.P. & Chelinho, S. (2015) Effects of NaCl and seawater induced salinity on survival and reproduction of three soil invertebrate species. *Chemosphere*. 135: 116–122.DOI:10.1016/j.chemosphere.2015.03.094

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In some cases, the effects on soil organisms were manifest at levels beneath the threshold currently used to define saline soils (4000 µS/cm, a measure of electrical conductivity). Although mite reproduction was only significantly affected at levels above 4325 µS/cm, reproduction in springtails and enchytraeids was significantly impaired at conductivities below the threshold (1679 and 1505 µS/cm in seawater and sodium chloride contaminated soils, respectively).

The threshold of 4000 µS/cm is used by numerous soil classification systems, including the World Reference Base, the international standard for soil classification. However, the value is based on measurements of agricultural crops, rather than impacts on soil fauna.

This study makes an important contribution to ongoing discussions on soil classification and thresholds for monitoring, but alone provides insufficient evidence for defining new thresholds for saline soils. To establish a more accurate threshold, the researchers say additional tests should be performed, using soils and organisms collected from the field, communities rather than individual organisms and under different conditions, such as varying temperatures and humidity. Broader studies of this kind could help to determine the salt concentrations that are needed to protect soil.

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