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Earthworms drill the compacted soil but do not decrease its bulk density – a laboratory experiment using two contrasted soils

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Earthworms are known to play a key role on soil ecological processes such as organic matter turnover, nutrient cycling and soil physical properties engineering and soil fertility as a whole. However, their role on numerous soil physical properties is still poorly documented.
The objectives of the present study were to test the effect of two earthworm species (Nicrodrilus nocturnus as anecic, Alollobophora icterica as endogeic species, and both as mixed population with 80% weight of N. nocturnus and 20% of A. icterica) on two different soils. A multi scale approach based on shrinkage analysis and computed tomography was used to assess the impact of earthworms on soil porosities and bulk volume. The study was performed during 23 weeks on microcosms, namely soil columns 30 cm height and 15 cm large, under controlled conditions (constant temperature and constant soil matrix potential). The soils were a silt loam Luvisol and a loamy Anthrosol repacked at field observed bulk density and at compacted bulk density. Therefore, the treatments were 2 soils X 2 levels of compaction X 3 worm species plus controls, 3 replicates each.
At microcosm scale the bulk soil volume increased with the anecic and mixed earthworm treatments whatever the initial level of compaction or type of soils. No bulk soil volume change was recorded when using endogeics. However, when removing the burrow volumes, the soil matrix was significantly compacted by the worms, particularly the endogeic, and the compacted soil matrix was not decompacted. Clod scale observations (150 cm3) revealed different effects of worms according to the considered soil volume: structural porosity and plasmic porosity, respectively. Roughly, the decompaction effect of earthworms was due to the opening of burrows at bulk soil scale, but the matrix volume was either compacted (case of loosened soil) with a decrease of the larger structural pores (>150 um equivalent radius) or unchanged (case of compacted soil), and the compaction of the matrix is larger with endogeic species. The mixed-species treatment induced intermediate effects.