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EARTHWORMS' BIOTURBATION UNDER CONTRASTING CONDITIONS OF IONIZING RADIATION AND SOIL HUMIDITY

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THE IRRASOIL PROJECT

There are still many uncertainties that contribute to **persisting controversy on the ecological effects of nuclear pollution**, which are limiting the implementation of environmental protection criteria. The main objective of the IRRASOIL project is to **investigate the effects of ionizing radiation on soil communities and associated functional processes (bioturbation, leaf litter decomposition, nutrient recycling, carbon flux) in interaction with predicted climate change**. More specifically, using a combined approach of **laboratory experiments under controlled conditions (IRSN Micado'Lab irradiation platform) and field experiments (Fukushima prefecture, Japan)**, this project aims studying how different functional groups of the soil macrofauna community, such as earthworms (endofauna) and litter layer-dwelling macrofauna (epifauna) interactively affect processes under such combined stresses. **The preliminary results presented here are issued from a first laboratory bioturbation experiment.**

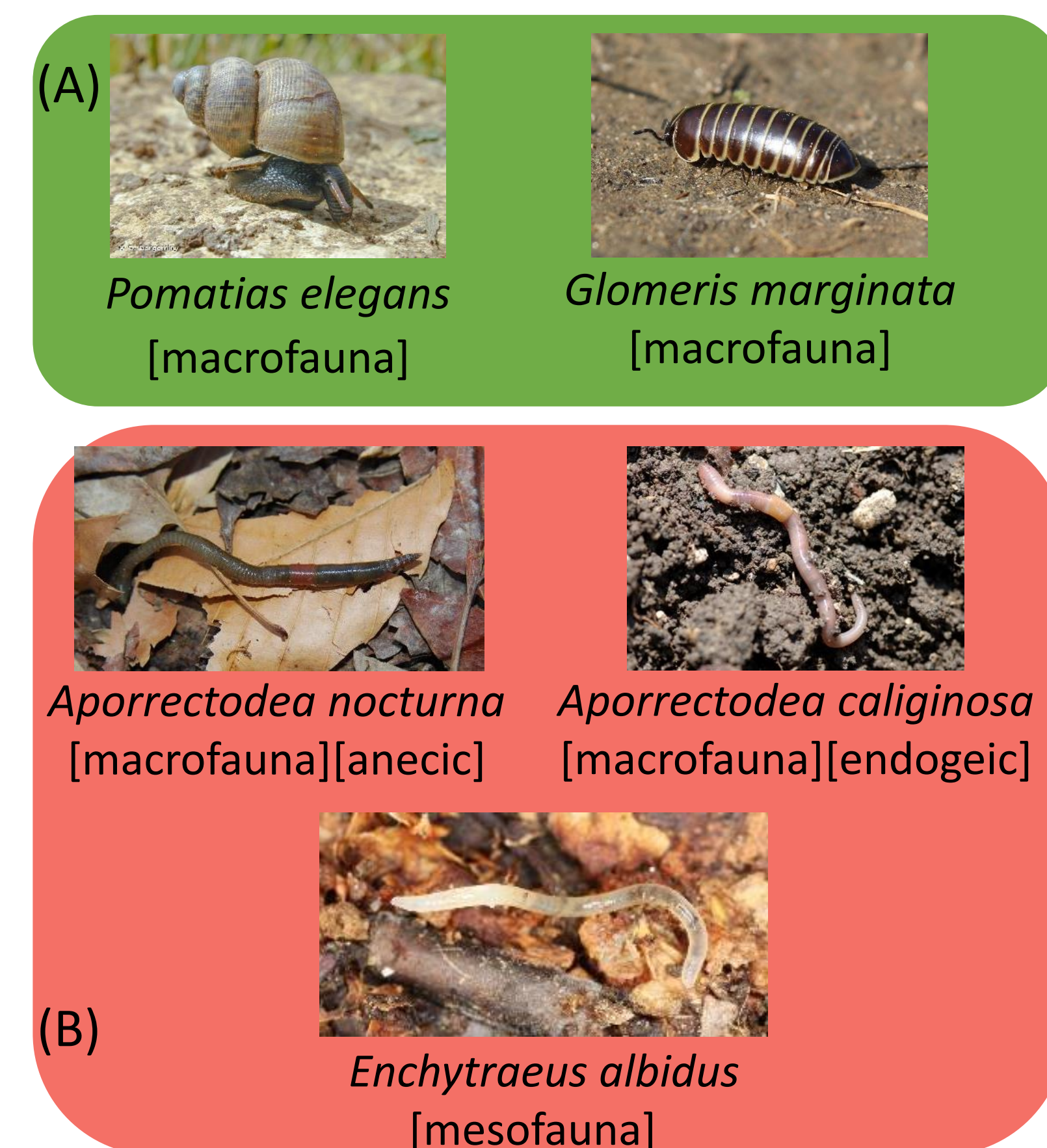
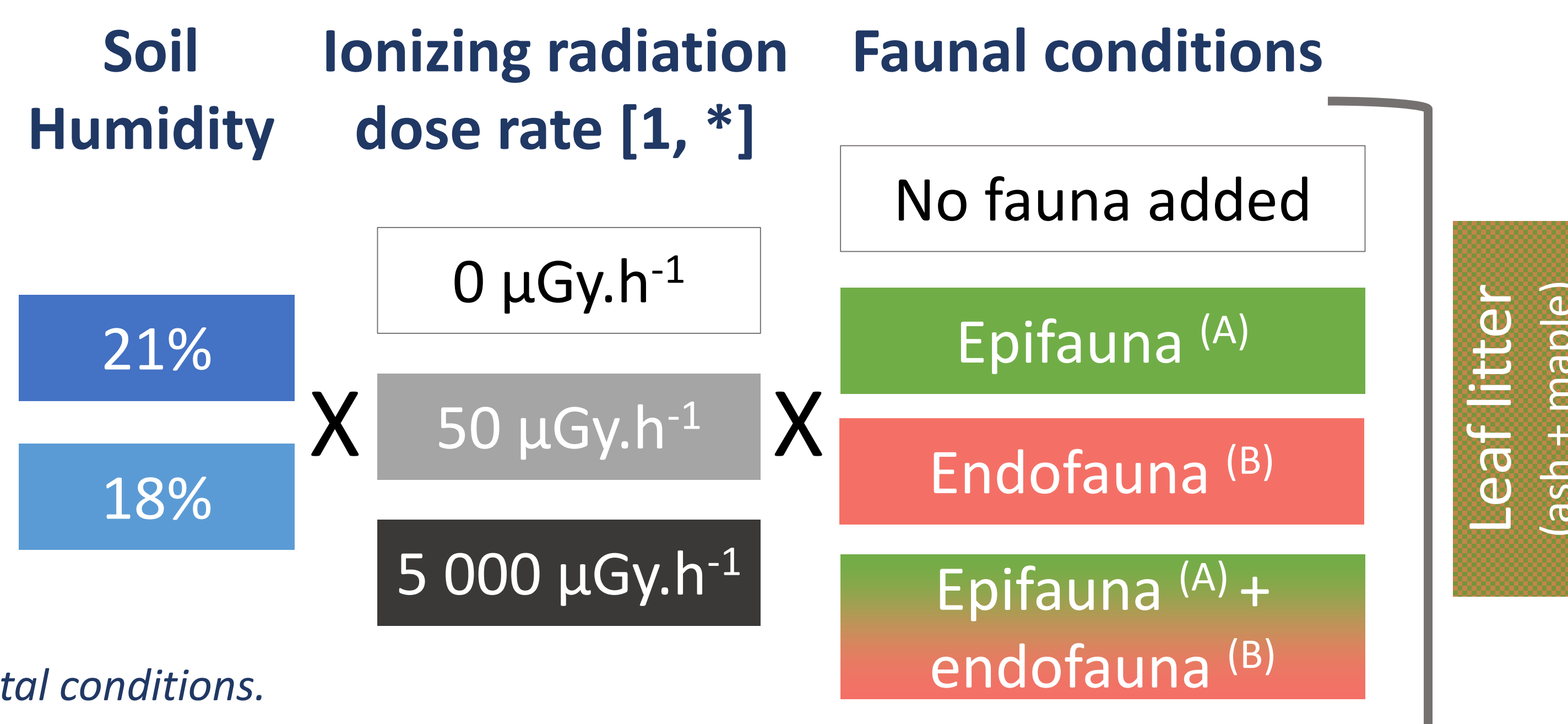


Fig. 1. Soil columns and their different experimental conditions.

One hundred and twenty 20-cm high soil columns (diam.: 16 cm) were build from natural soil (sieving, reconstruction including the addition of **fluorescent particulate tracers**) and then exposed to different experimental conditions within different climatic chambers (Fig. 1). **After 90 days of experimentation**, all the soil columns were recovered and bioturbation activity was quantified using complementary **X-ray tomography and fluorescent particulate tracer methods [2]**.

Not surprisingly, no tracer movement was detected in the control soils. In the "epifauna" soils, if the surface organisms moved slightly downwards in the soil [what was not detected by x-ray tomography], it was not deep enough to reach either of the tracer layers placed at 4-cm and 10-cm depth, respectively (data not shown).

In presence of endofauna, results showed **no global effect of humidity change** on both the total macroporosity production and the transfer of tracers by earthworms (*A. nocturna* and *A. caliginosa*) within soils (Figs 2C left & 2D left). On the other hand, the **macroporosity production tended to decrease with increasing applied ionizing radiation dose rate** (Fig. 2C right). Partial results of **tracers displacement** (only three on five replicates analysed so far) also indicated **significant differences as a function of the irradiation dose**, but without any clear trend (Fig. 2D right).

These preliminary results need to be completed and analysed more precisely, especially in order to:

- allow deconvolution of the specific "radiation dose" and the "moisture" effects;
- discriminate the gallery networks constructed by the two earthworm species;
- compare the X-ray tomography and particulate tracers results;
- conclude whether or not a reduction in soil moisture and the application of an ionizing stress had any effect on the processes studied.

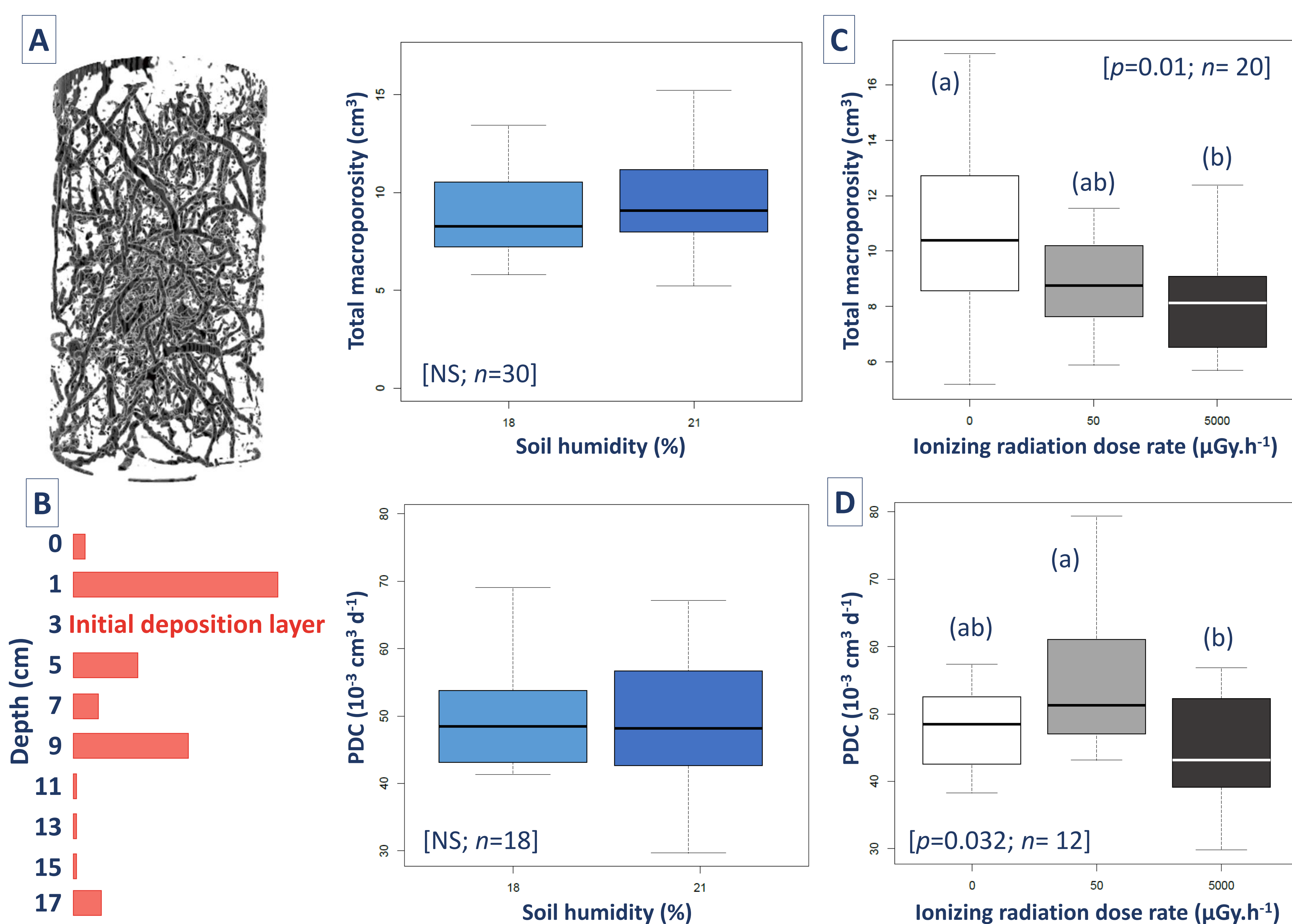


Fig. 2. Examples of a burrow system produced by endofauna (A) and of a vertical distribution of tracers in the soils around the deposition layer (B) in the experimental soil cores, after 90 days. Mean percentage of total macroporosity volume created by earthworms within the soils columns (C) and computed particle displacement coefficient (PDC; [2]) (D), in the different experimental conditions. For a better poster reading, only the results obtained with pink tracers initially deposited at 4-cm depth are presented here.

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References: [1] Jean-Marc Bonzom JM *et al.* 2016. Effects of radionuclide contamination on leaf litter decomposition in the Chernobyl exclusion zone. STOTEN 562: 596-603. <https://doi.org/10.1016/j.scitotenv.2016.04.006>. *: Examples of radioactive ambient dose rates and corresponding estimated total dose rates for different soil-living species in 2010 are presented in this paper.
 [2] Capowiez Y *et al.* 2021. Depth distribution of soil organic matter and burrowing activity of earthworms - mesocosm study using X-ray tomography and luminophores. Biol. Fertil. Soils 57: 337-346. <https://doi.org/10.1007/s00374-020-01536-y>.

