

# Study of earthworm behaviour in contaminated soils. Critical assessment of standard ecotoxicity bioassays

**Supervisors:** Prof. Philippe Baveye; Dr. Julia Clause; Dr. María Balseiro-Romero

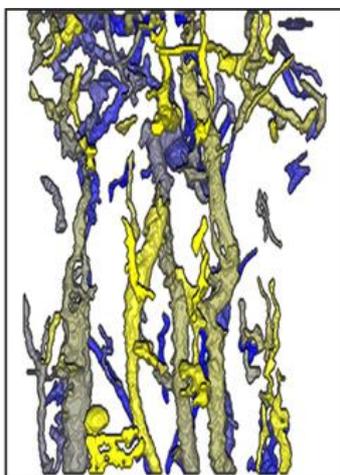
**Location:** University of Poitiers and AgroParisTech, Grignon

**Timeframe:** February 1 – July 31, 2018

**Monthly stipend:** 554.4 € per month

Ecotoxicity of contaminated soils has been generally characterized using a variety of bioassays that measure different growth features and/or behavioural aspects of soil micro- (bacteria), meso- (earthworms, springtails –*Collembola*-) and macroorganisms (plants) to assess the toxicity of soils contaminated with organic chemicals<sup>1-3</sup>. These bioassays are usually used in ecological risk assessment and have been standardized, among others, by the Organization for Economic Cooperation and Development (OECD) or International Organization for Standardization (ISO). Both organizations include several tests using earthworms: “Test 207-Earthworm acute toxicity test”, and “Test 222-Earthworm reproduction test”, by OECD; “17512-1: Soil Quality-Avoidance Test for Determining the Quality of Soils and Effects of Chemicals on Behaviour”, by ISO). For example, OECD tests should be performed in artificially spiked and homogenised soils. When these tests are applied in real contaminated soil samples, and even in the field, the validity of the results may be questioned: Soil contamination in real soils is not homogeneous, and earthworms will probably avoid the zones with the highest contaminant concentration, providing potentially confusing results on soil toxicity.

Earthworm burrow systems have been recently characterized using 3D-microimaging, in particular using X-ray computed tomography (CT)<sup>4,5</sup> (Figure 1). This technique allows a 3-dimensional reconstruction of earthworm movement in soil and its monitoring with time. Therefore, the use of this technique will help us to determine any modification that may occur in the behavioural patterns of earthworms when they are introduced in an ecotoxic environment.



**Figure 1.** Example of three-dimensional burrow system of a soil cores scanned using X-ray CT. In yellow: burrows in the foreground; in blue: burrows in the background<sup>5</sup>.

The aim of the proposed internship will be to study the behaviour of different earthworm species in mesocosm configurations containing soil samples with different properties and contaminated in different configurations (homogeneous contamination, contaminated in linear gradients<sup>6</sup> or soil with a discrete contamination spot). In parallel, the burrow system of earthworms will be monitored with time using CT imaging, in order to discern earthworm behaviour in the contaminated scenarios considered. On the other hand, other basic toxicity features, such as reproducibility and survival will be assessed for each scenario, following OECD guidelines. These experiences will be a base for the discussion of the validity of standardized bioassays to be used in the field or in actual contaminated soil samples.

In close collaboration with Dr. Julia Clause and Dr. María Balseiro-Romero, who are in charge of the research, the intern will carry out a subset of the experiments, as permitted within the 6 months of the internship. A definite objective of the internship will be the writing of a publication (in English) on which the intern will be a co-author. The intern will also present a poster concerning his/her work at an international workshop to be held in June 2018 in Saint Loup Lamairé (Deux-Sèvres, France).

For further information or to apply contact [maria.balseiro@inra.fr](mailto:maria.balseiro@inra.fr)

#### References

- (1) Wang, Y.; Wu, S.; Chen, L.; Wu, C.; Yu, R.; Wang, Q.; Zhao, X. Toxicity assessment of 45 pesticides to the epigeic earthworm *Eisenia fetida*. *Chemosphere* **2012**, *88* (4), 484–491.
- (2) Anyanwu, I. N.; Semple, K. T. Effects of phenanthrene and its nitrogen-heterocyclic analogues aged in soil on the earthworm *Eisenia fetida*. *Appl. Soil Ecol.* **2016**, *105*, 151–159.
- (3) Lemtiri, A.; Liénard, A.; Alabi, T.; Brostaux, Y.; Cluzeau, D.; Francis, F.; Colinet, G. Earthworms *Eisenia fetida* affect the uptake of heavy metals by plants *Vicia faba* and *Zea mays* in metal-contaminated soils. *Appl. Soil Ecol.* **2016**, *104*, 67–78.
- (4) Auclerc, A.; Capowiez, Y.; Guérol, F.; Nahmani, J. Application of X-ray tomography to evaluate liming impact on earthworm burrowing activity in an acidic forest soil under laboratory conditions. *Geoderma* **2013**, *202–203*, 45–50.
- (5) Pelosi, C.; Grandeau, G.; Capowiez, Y. Temporal dynamics of earthworm-related macroporosity in tilled and non-tilled cropping systems. *Geoderma* **2017**, *289*, 169–177.
- (6) Lowe, C. N.; Butt, K. R.; Cheynier, K. Y. M. Assessment of avoidance behaviour by earthworms (*Lumbricus rubellus* and *Octolasion cyaneum*) in linear pollution gradients. *Ecotoxicol. Environ. Saf.* **2016**, *124*, 324–328.