UPTAKE KINETICS OF FOUR HYDROPHOBIC ORGANIC POLLUTANTS IN THE EARTHWORM *EISENIA ANDREI* IN AGED LABORATORY-CONTAMINATED NATURAL SOILS

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Conclusions

- The aging period was terminated after 203 days when concentrations of hydrophobic organic compounds in both soils did not statistically differ and thus the physicochemical processes were supposed to be stabilized.
- Aging of hydrophobic organic compounds influenced the shape of accumulation curves and the time needed to reach an equilibrium concentration between soil and earthworms.
- For pyrene, the results surprisingly showed peak-shape accumulation curves despite long aging. It seems there is still significant compound degradation when earthworms are added to the soil and this needs to be considered also when testing historically contaminated and aged soil.
- For lindane, longer aging seems to guarantee stability of the soil-compound-earthworm system and the steady state was reached after 5 days of exposure.
- Although concentrations of p,p´-DDT and PCB 153 in earthworms after 11–15-day exposure did not statistically differ, which is a commonly-used indicator that a steady state was reached, they continuously increased until the end of the exposure. Therefore, despite the aging, longer exposure was probably needed to reach the true equilibrium between concentrations in earthworms and soil.
- Different approaches to BAF calculations were applied. Real differences were evident for p,p'-DDT and PCB 153, BAFs calculated as a ratio of k_s and k_e were 1.6–3.0-times higher compared to BAFs at the end of exposure and 2.2–5.8-times higher compared to BAFs at the first day of steady state. In reality, the concentration in earthworms would still increase even after 21 days so calculating BAFs at steady state or at the end of exposure may underestimate the potential of compounds to accumulate in earthworms.

Materials & Methods

Soil contamination

- Two natural soils (arable S1 and forest S2) with **different TOC contents** (1.57 and 9.30%)
- Concentrations: pyrene - 100 mg.kg^{-1}
  lindane, p,p'-DDT - 10 mg.kg^{-1}
  PCB 153 - 1 mg.kg^{-1}
- **Aged for 203 days**

Bioaccumulation test with earthworms

- Test organism ***Eisenia andrei***
- **8 earthworms** per replicate
- Glass vessels with soil
- Sampling points (day): **1, 3, 5, 7, 9, 11, 13, 15, 17, 19 and 21**

Randall extraction followed by **GC-MS** analysis

Introduction

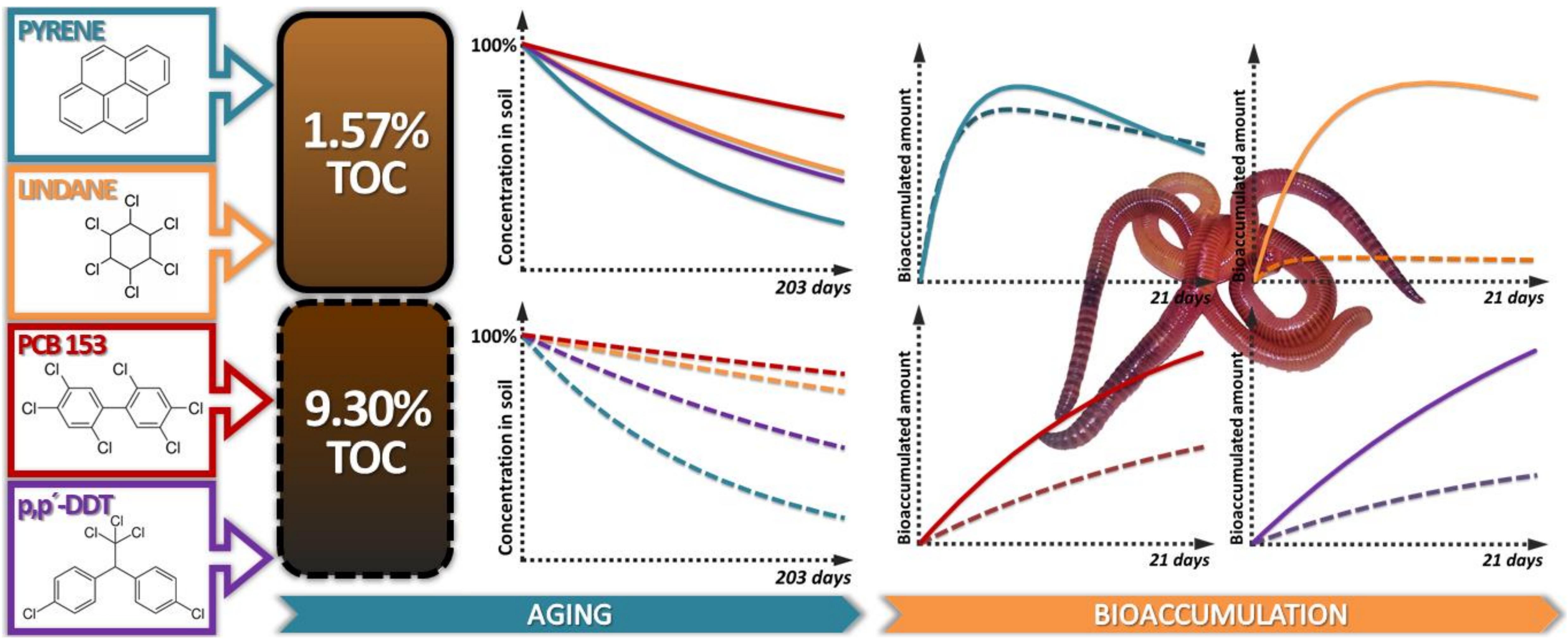
Laboratory studies of pollutant uptake kinetics commonly start shortly after experimental soil contamination when it is not clear if the processes between soil and chemicals are equilibrated and stabilized. For instance, when the soil concentration quickly decreases due to initial degradation, bioaccumulation may show a peak-shape accumulation curve instead of conventional first-order kinetics with a plateau at the end. The results of such experiments with soil freshly contaminated in the laboratory are then hardly comparable to bioaccumulation observed in soils from historically contaminated sites. Therefore, our study focused on the uptake kinetics of four hydrophobic organic compounds (pyrene, lindane, p,p´-DDT and PCB 153) in two laboratory-contaminated natural soils with different soil properties aged for 203 days to mimic long-term contamination.

Objectives

I. Find an aging period resulting in a stable total compound concentration in soil and
II. expose earthworm *Eisenia andrei* in aged soil for 21 days and determine if the exposure time was sufficient to achieve the equilibrium in concentrations between earthworms and aged laboratory-contaminated natural soils.

Hypotheses

I. Equilibrium in concentrations in soils and earthworms may be achieved in aged laboratory-contaminated natural soils (no peak-shaped uptake curves).
II. Accumulation curves differ in soils with different organic carbon content.



Results

Uptake by earthworms

- Kinetic model: $C_a = \frac{k_s \times C_0}{k_e - k_0} \times (e^{-k_0 t} - e^{-k_e t})$
- Steady-state bioaccumulation factor: $BAF_{ss} = \frac{C_a}{C_s}$
- Bioaccumulation factor at the end of exposure: $BAF_{21} = \frac{C_a}{C_s}$
- Kinetic bioaccumulation factor: $BAF_k = \frac{k_s}{k_e}$

Total concentration in soils

- Kinetic model: $C_s = C_0(e^{-k_0 t})$

C_a – concentration in earthworms
C_s – concentration in soil
C_0 – initial concentration in soil
k_0 – degradation rate constant
k_s – uptake rate constant
k_e – elimination rate constant
t – time

	SOIL	BAF_{ss}	BAF_{21}	BAF_k
PYRENE	S1	-	0.64 ± 0.08	0.54 ± 0.22
	S2	-	0.46 ± 0.02	0.41 ± 0.17
LINDANE	S1	35.7 ± 1.7	55.2 ± 3.2	59.5 ± 20.8
	S2	4.1 ± 0.1	7.7 ± 0.6	5.9 ± 2.3
PCB 153	S1	8.2 ± 0.3	11.5 ± 0.7	18.8 ± 8.0
	S2	3.1 ± 0.2	5.0 ± 0.1	9.4 ± 3.3
p,p´-DDT	S1	7.4 ± 0.4	14.0 ± 0.8	42.6 ± 20.0
	S2	3.0 ± 0.1	3.7 ± 0.2	6.4 ± 4.0