6th Symposium on sustainable use of pesticides Directive (SUD)
Integrated Pest Management

Brussels, January 31st 2018

How pesticides are affecting earthworms?

Céline PELOSI

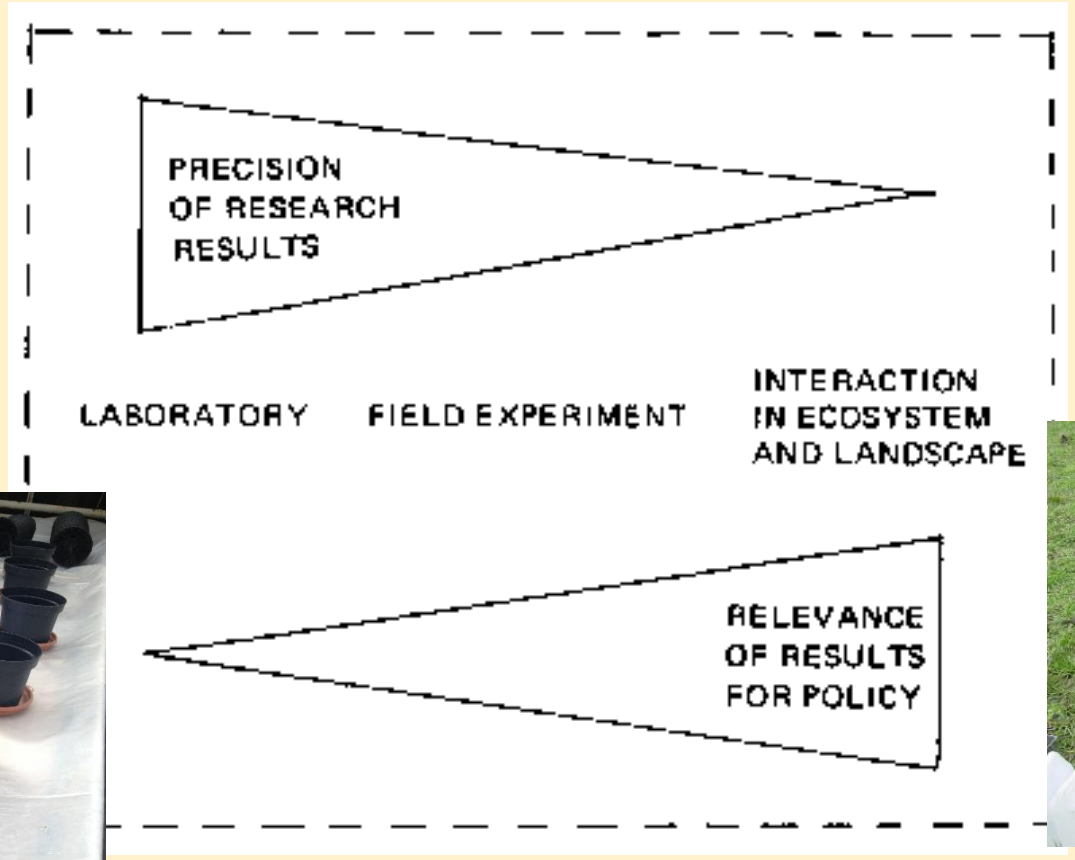
Researcher

UMR ECOSYS, INRA, AgroParisTech, Université Paris-Saclay, Versailles, France

celine.pelosi@inra.fr

----- Anthropic activities and threats to ecosystems

Biomonitoring procedures



Ellenberg et al. 1991

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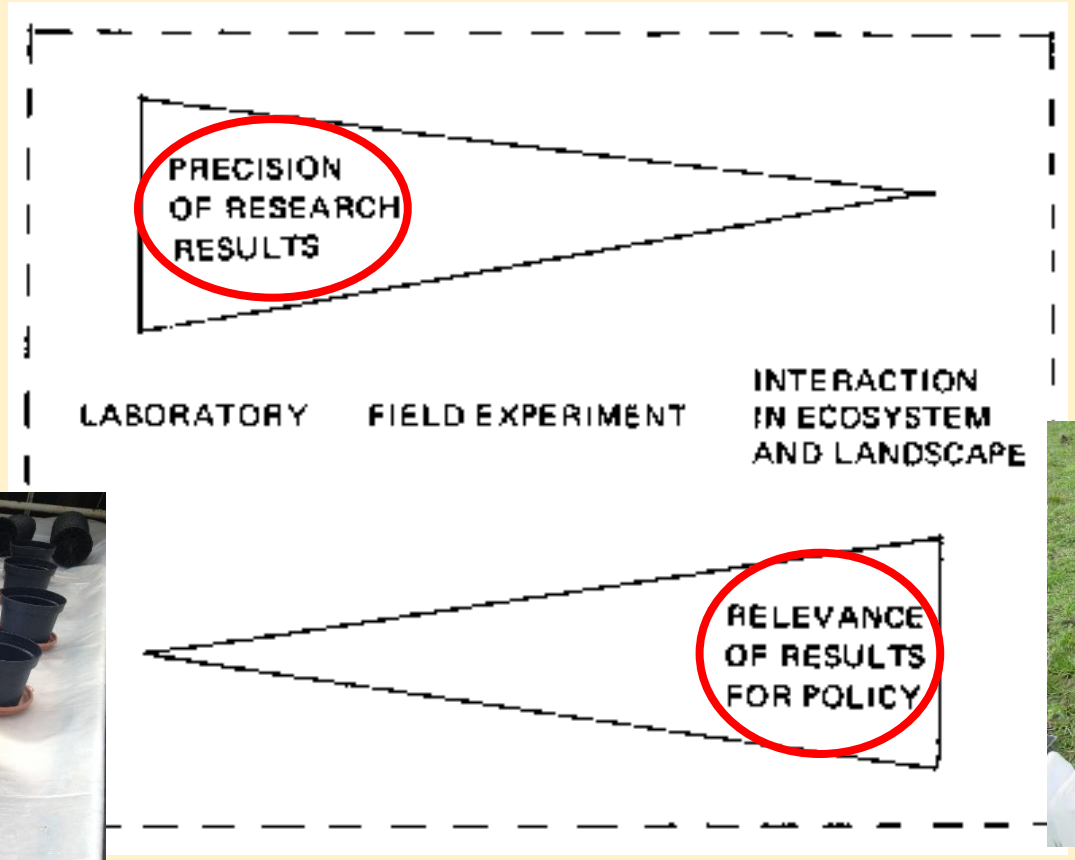
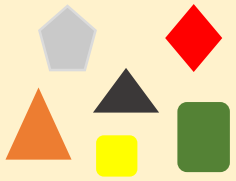


Ellenberg et al. 1991

----- Bioindicators



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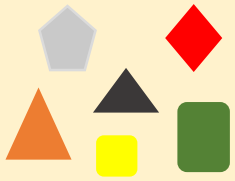

- Assess the impacts
- Describe the systems
- Follow their evolution

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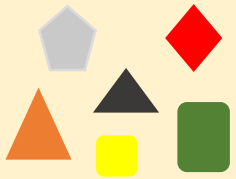

Representativity
Functional role
Sensitivity (« agri »)

- Assess the impacts
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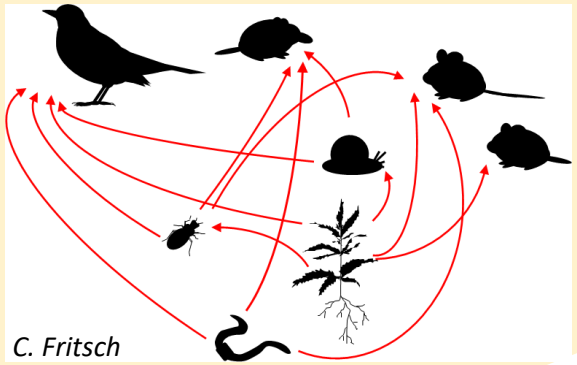

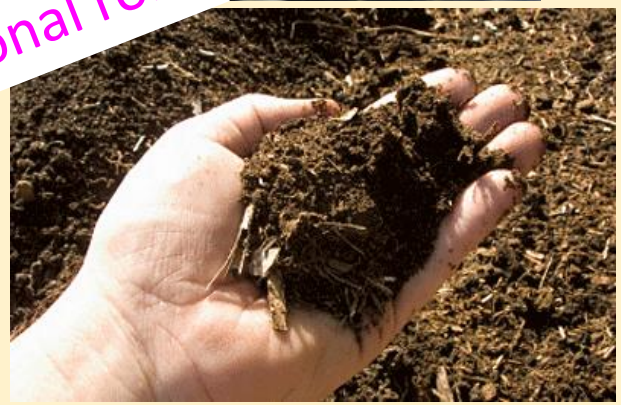

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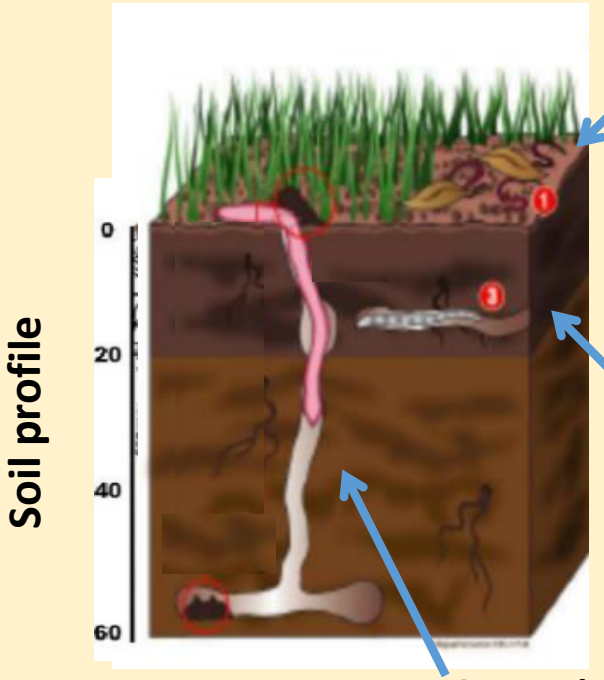

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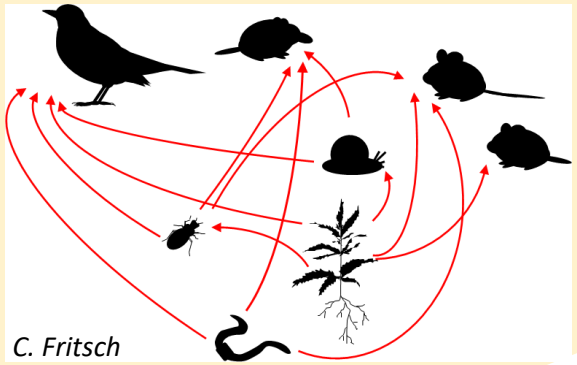
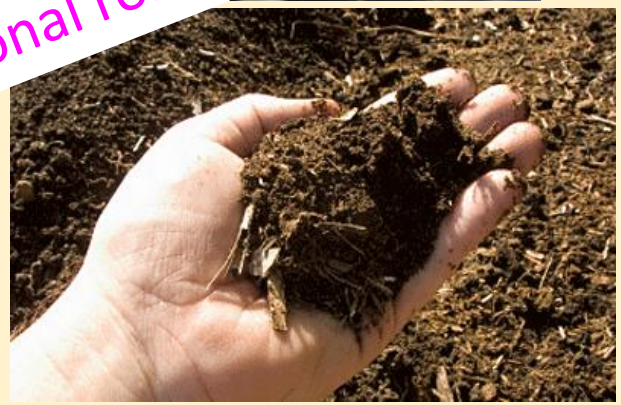
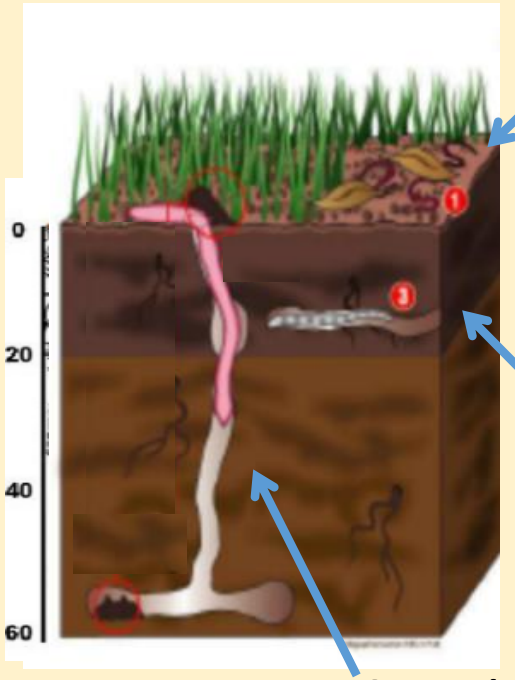


C. Fritsch

Functional role





----- Bioindicators

Representativity
Functional role
Sensitivity (« agri »)

- Assess the impacts
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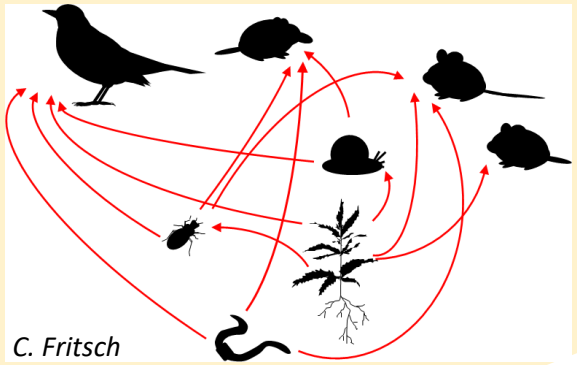
- Follow their evolution

Physiological, morphological, phenological or behavioral changes/responses

Representativity



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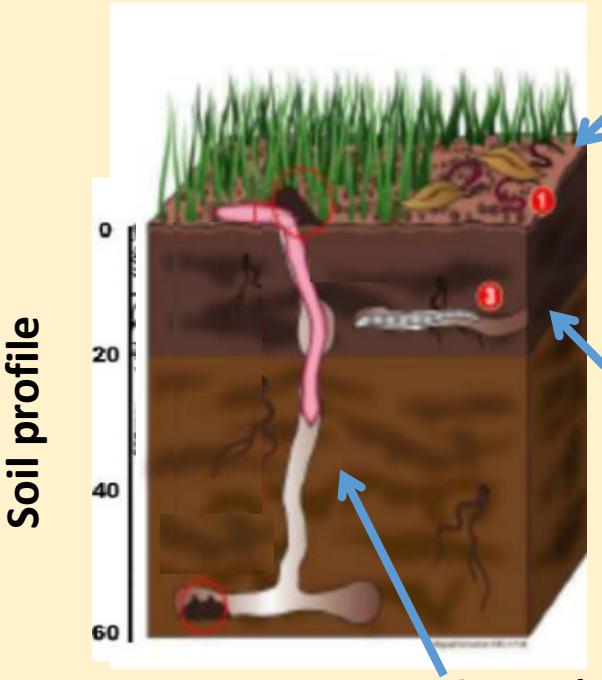

----- Earthworm sensitivity to pesticides

OECD publishing
OECD Guidelines for Testing of Chemicals Section 3: Degradation and Accumulation

International Organization for Standardization
ISO

Eisenia fetida

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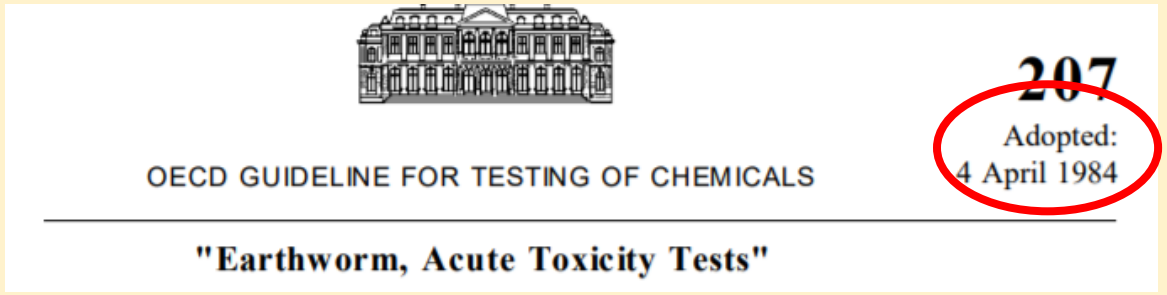
Eisenia fetida

Since the 80's

Short generation time
Easy to breed



OECD GUIDELINE FOR TESTING OF CHEMICALS

207

Adopted:
4 April 1984

"Earthworm, Acute Toxicity Tests"

----- Earthworm sensitivity to pesticides

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→ Ecotoxicological studies

Pelosi et al. 2014

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(LC50: lethal concentration for 50% of exposed individuals)

Meta-analysis
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2 times
less sensitive

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Aporrectodea caliginosa

More than
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----- Earthworm sensitivity to pesticides

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<

2 times less sensitive

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More than 3 times less sensitive

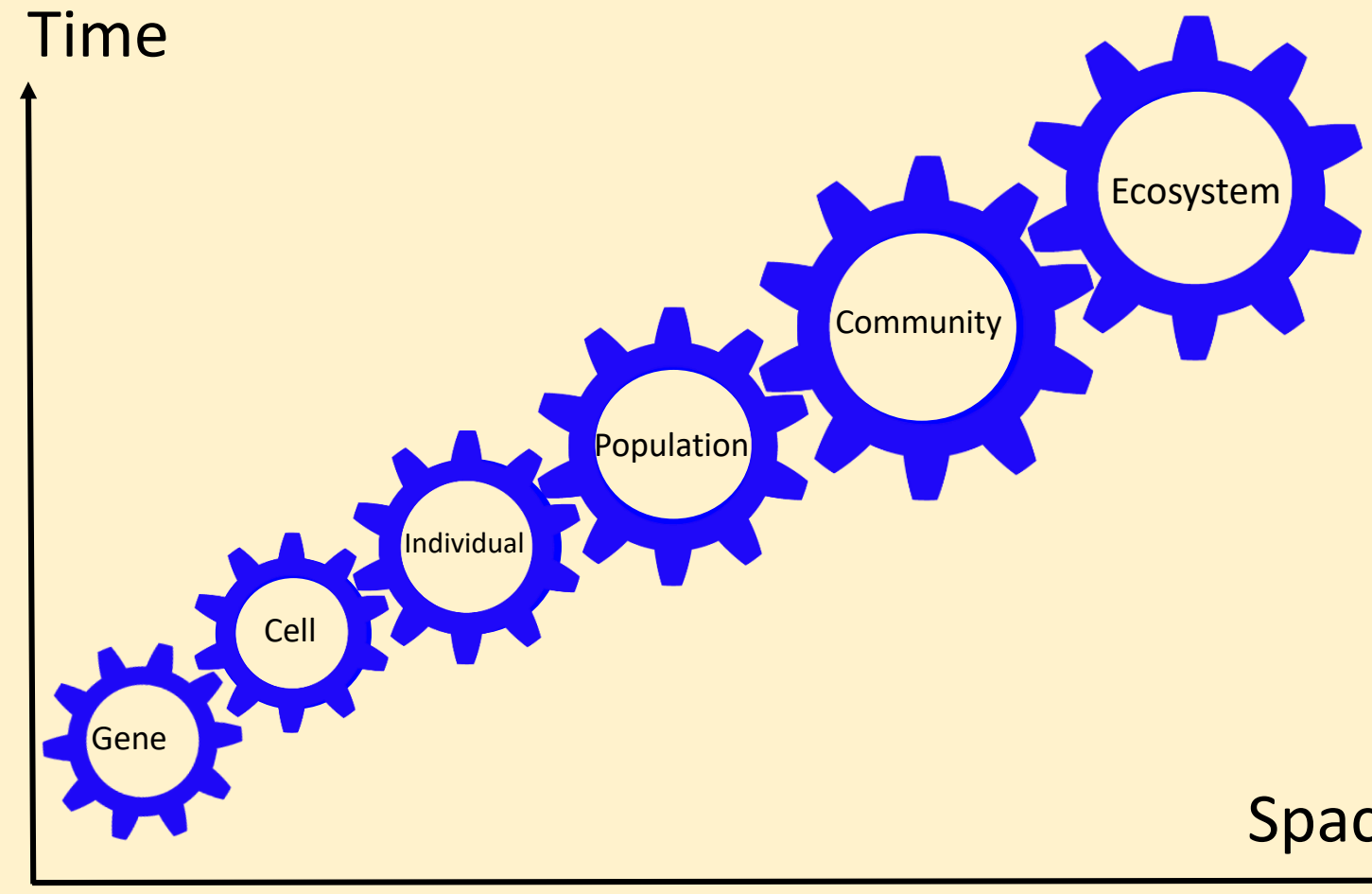
(LC50: lethal concentration for 50% of exposed individuals)

Species found in natural conditions
Natural soils
Realistic concentrations (Recommended Dose)
Commercial formulations:

- Representative of practices for cereal crops
- Potential effects (toxic reference values – recommended dose)

Meta-analysis
Pelosi et al. 2013, Chemosphere

----- Effects at different levels of biological organization



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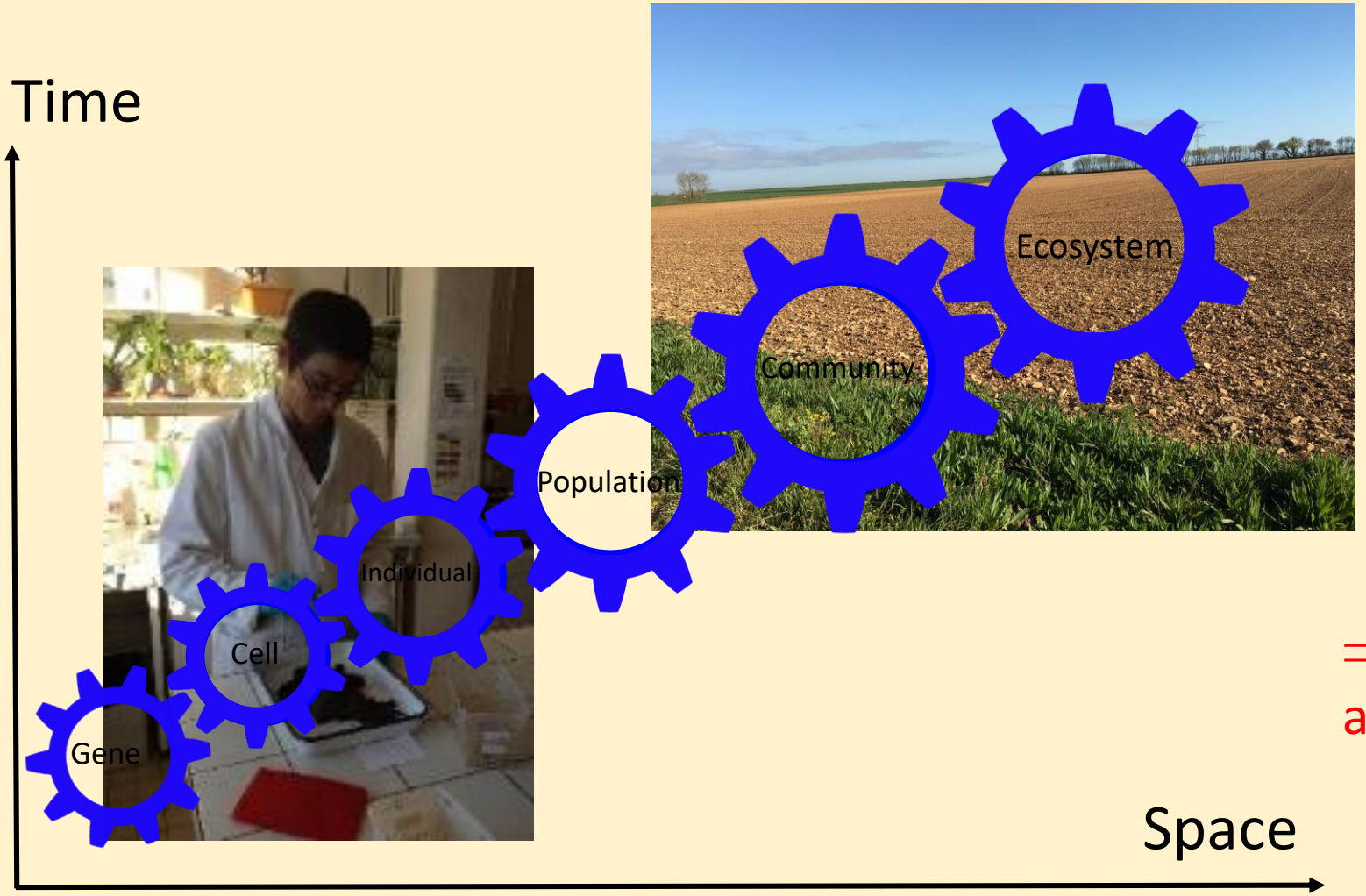
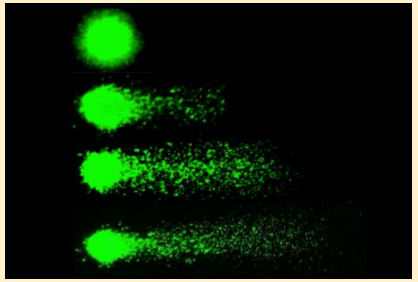


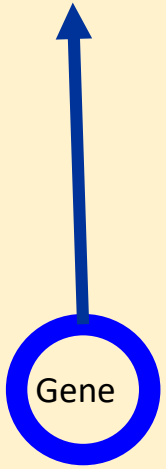
⇒ Overview of the potential effects at the different levels of organization

----- At the gene level

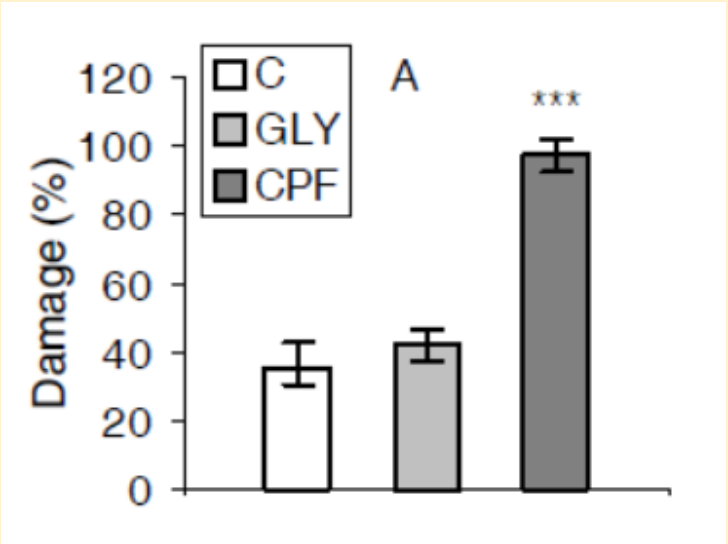


DNA damage

ATANOR 48®, chlorpyrifos, insecticide, *E. fetida andrei*



97% damage (compared to the control)



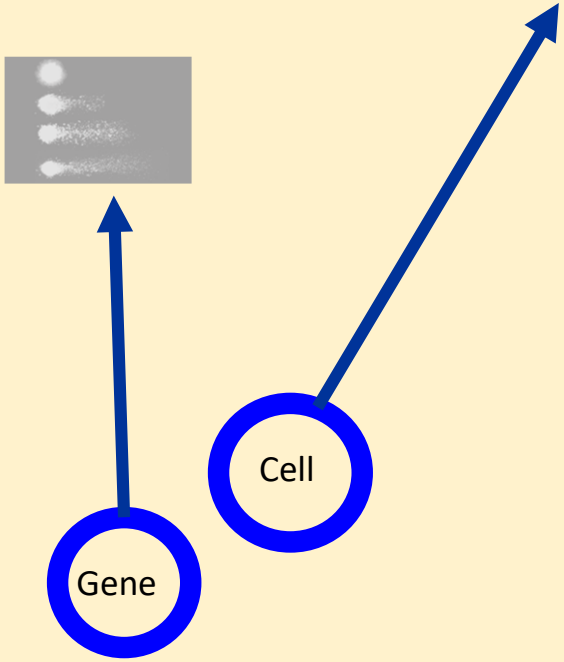
Casabé et al. 2007

----- At the cell level

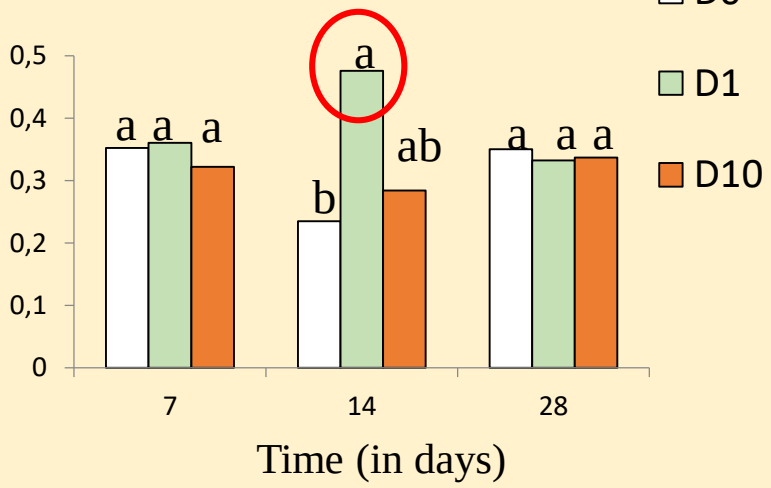
Opus®, epoxiconazole, fungicide, *Allolobophora icterica*

Transitory effects on an **enzymatic activity** (cell defense towards oxidative stress)

+ decrease in **energy reserves**

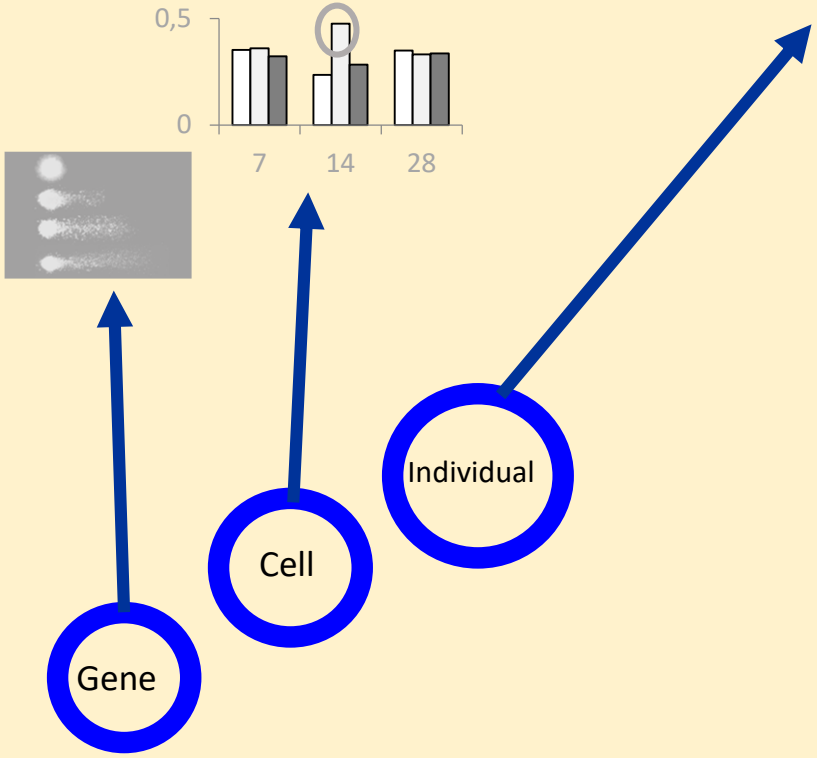


GST activity
(glutathione-S-transferase)



Pelosi et al. 2016

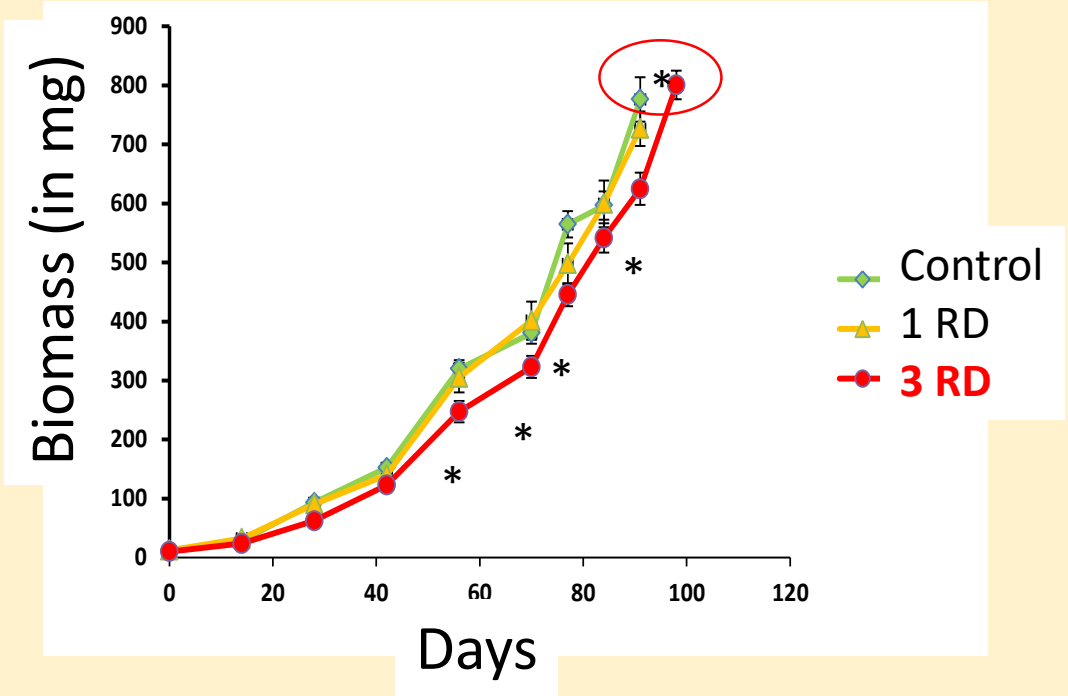
----- At the individual level



Swing Gold®, fungicide, epoxiconazole & dimoxystrobin,
Aporrectodea caliginosa

Reproduction: RD: - 35% cocoons, - 20% hatchlings
3 RD: - 50% cocoons, - 33% hatchlings, + 5 days to hatch

Growth : + 9 days to become adult

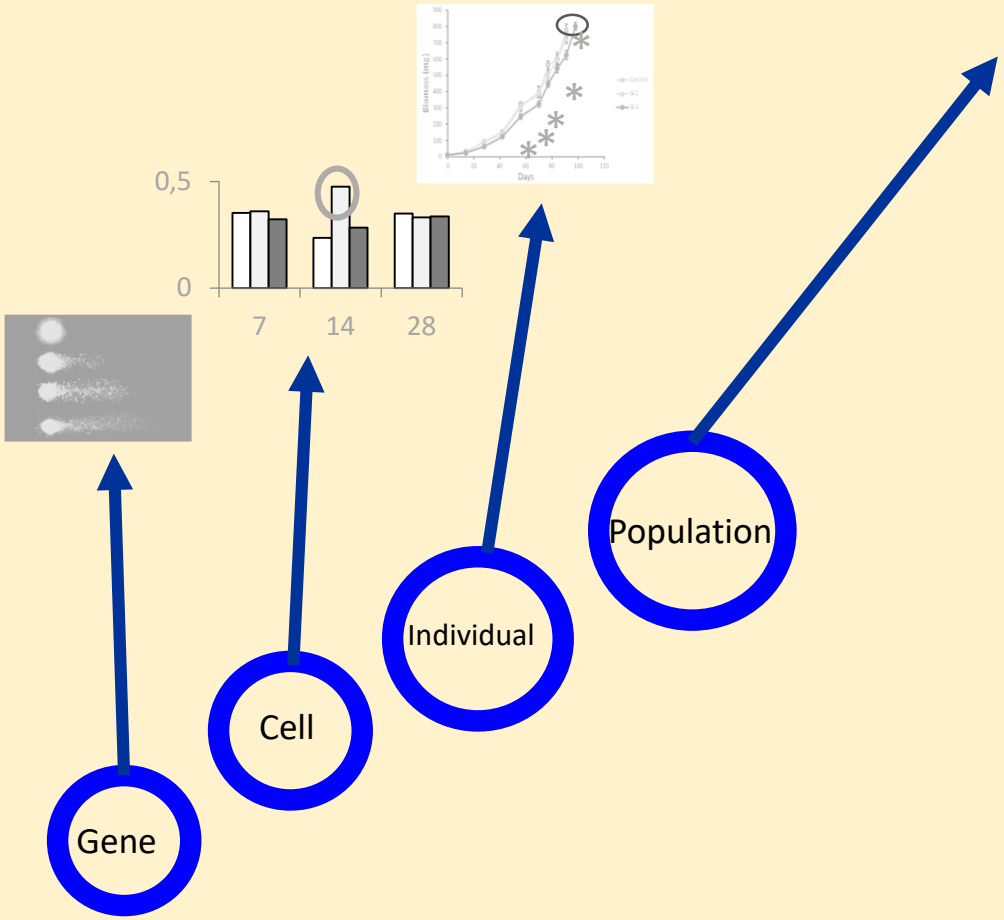


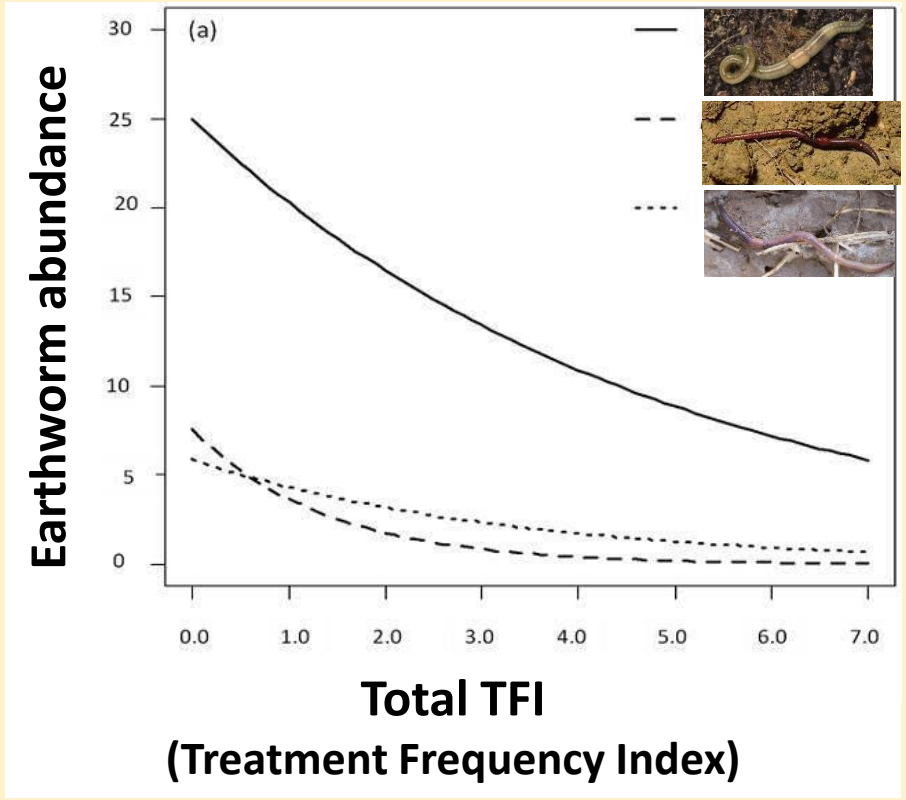
Bart et al., in prep.

----- At the population level

Organic and conventional cropping systems

Loamy soils, neutral pH, ploughed, winter wheat, organic inputs (type and proportions)





Pelosi et al. 2013

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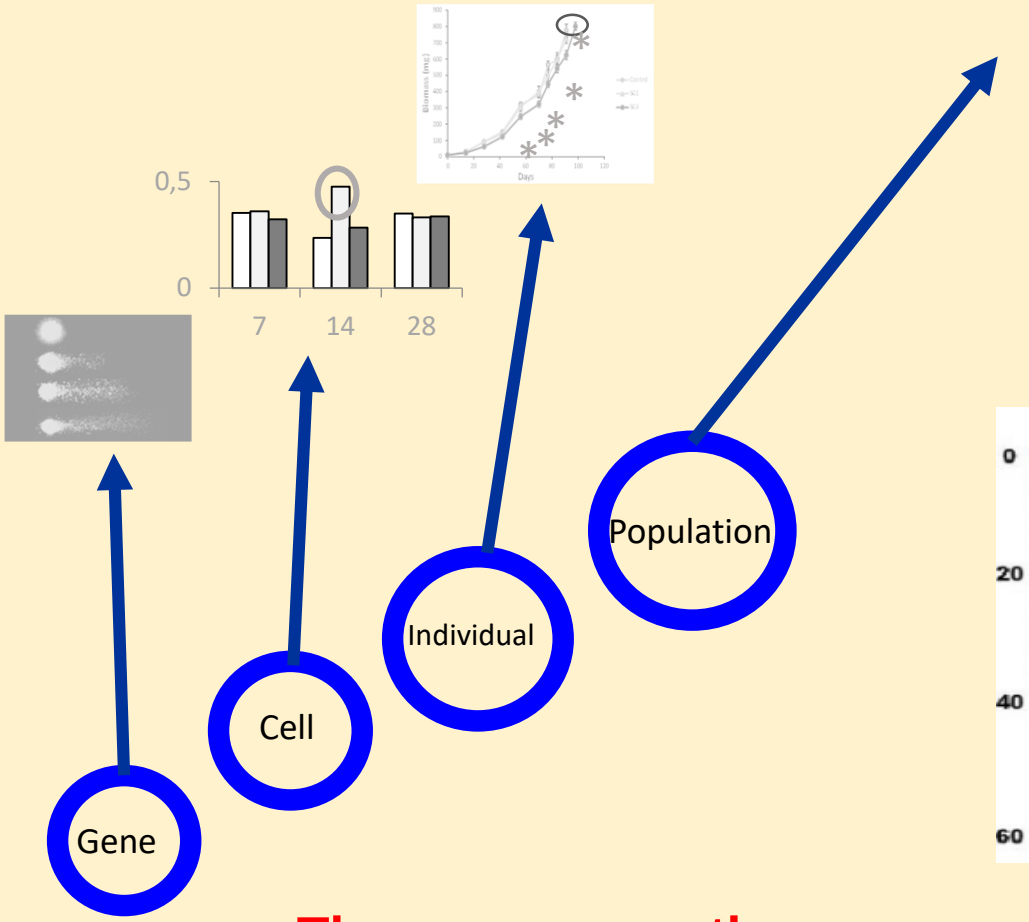

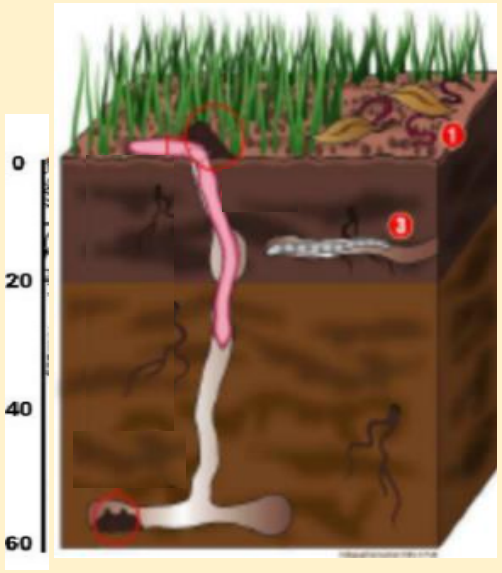

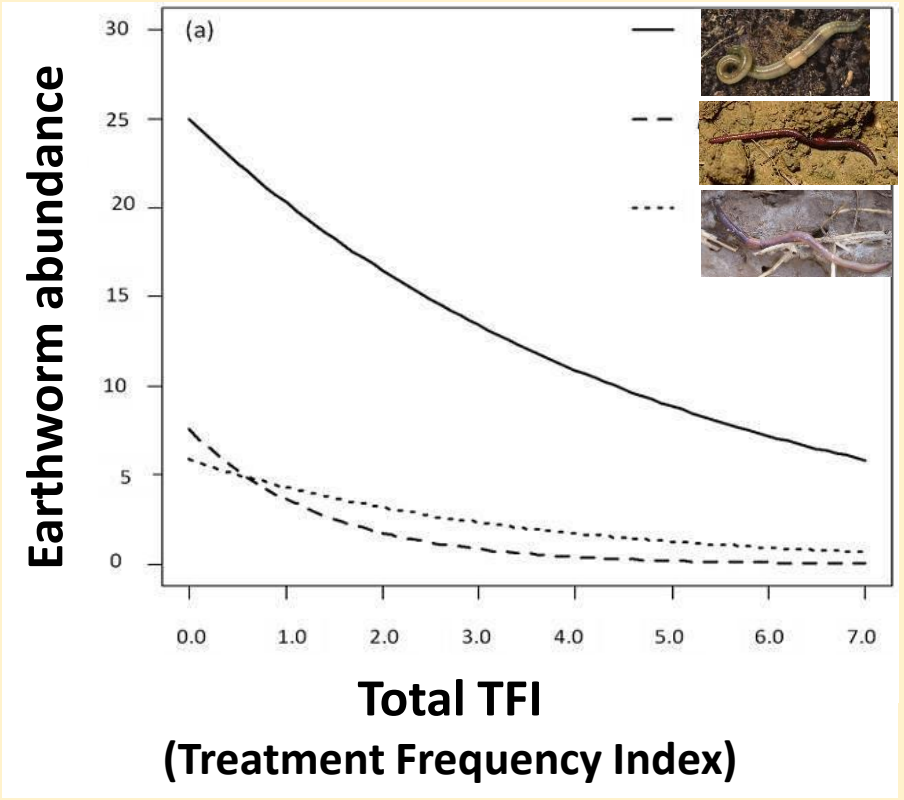

The more an earthworm species lives near the soil surface, the more it is affected by pesticide applications

Pelosi et al. 2013

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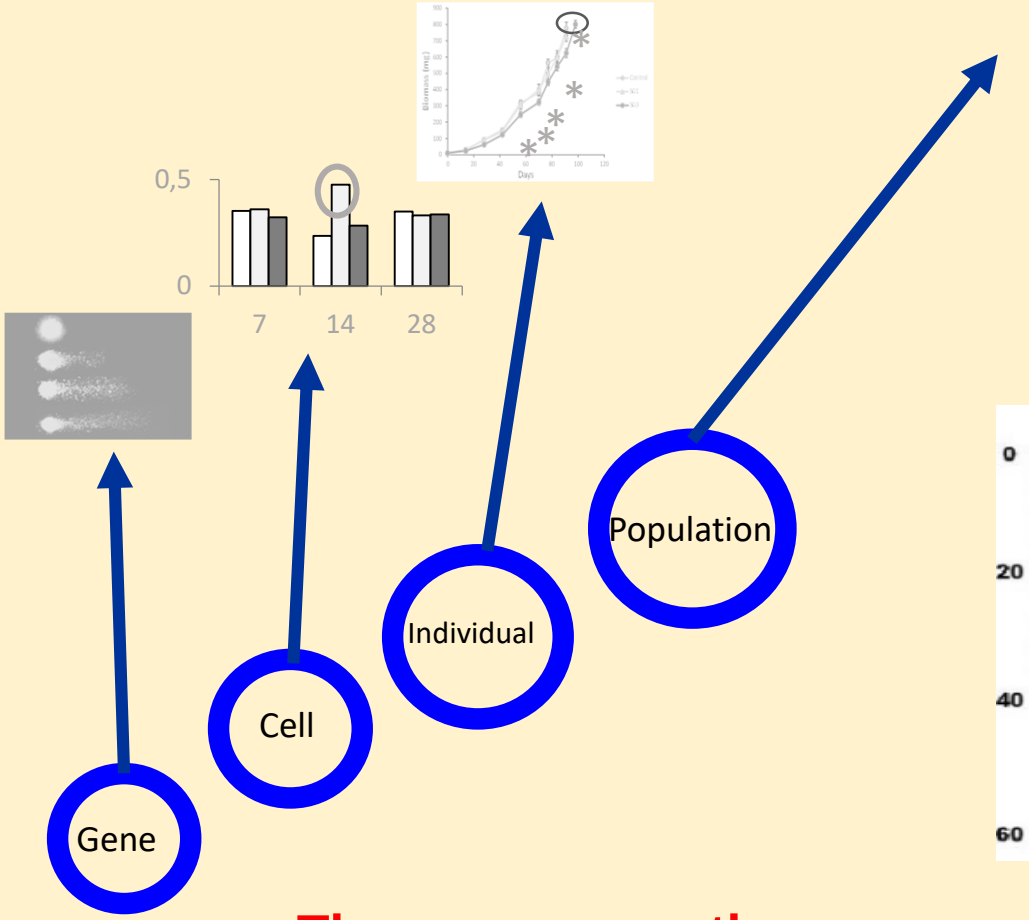

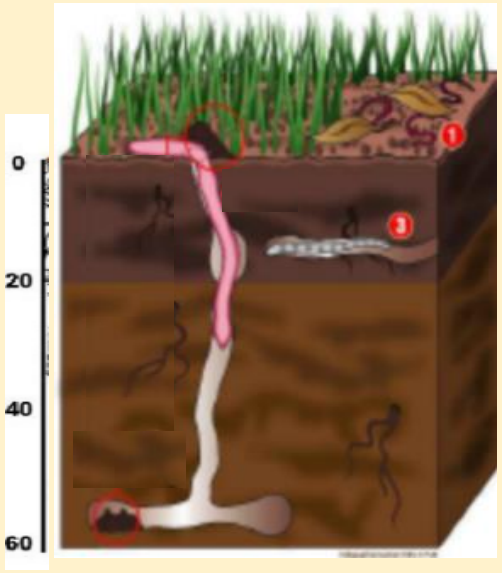

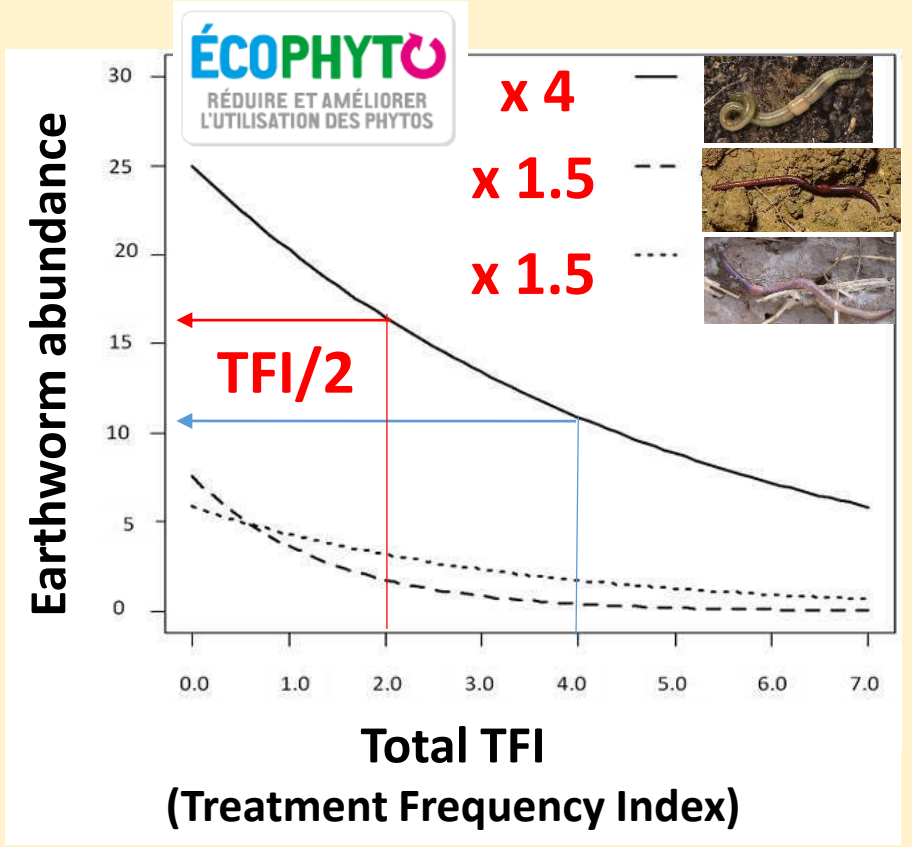

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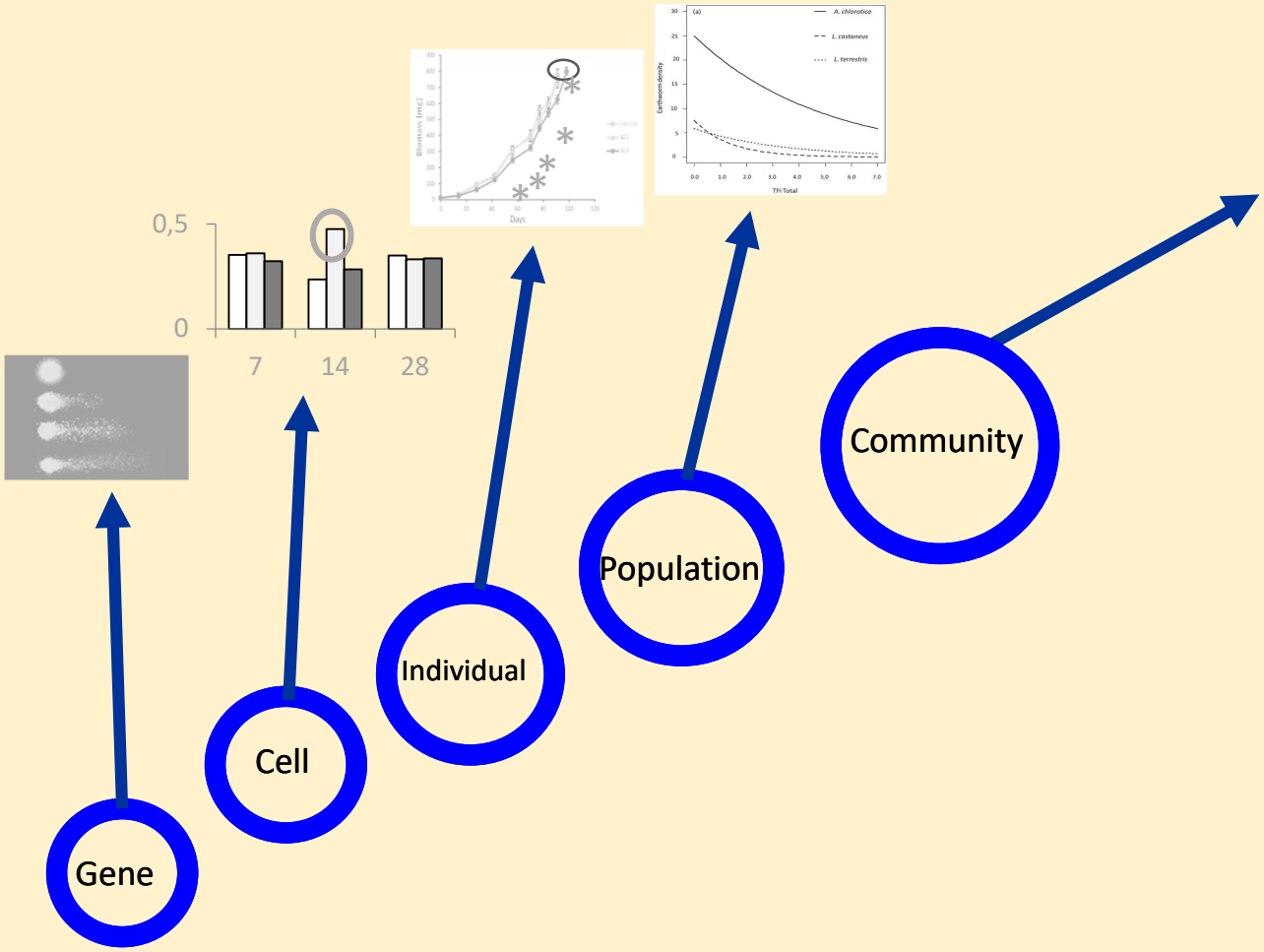
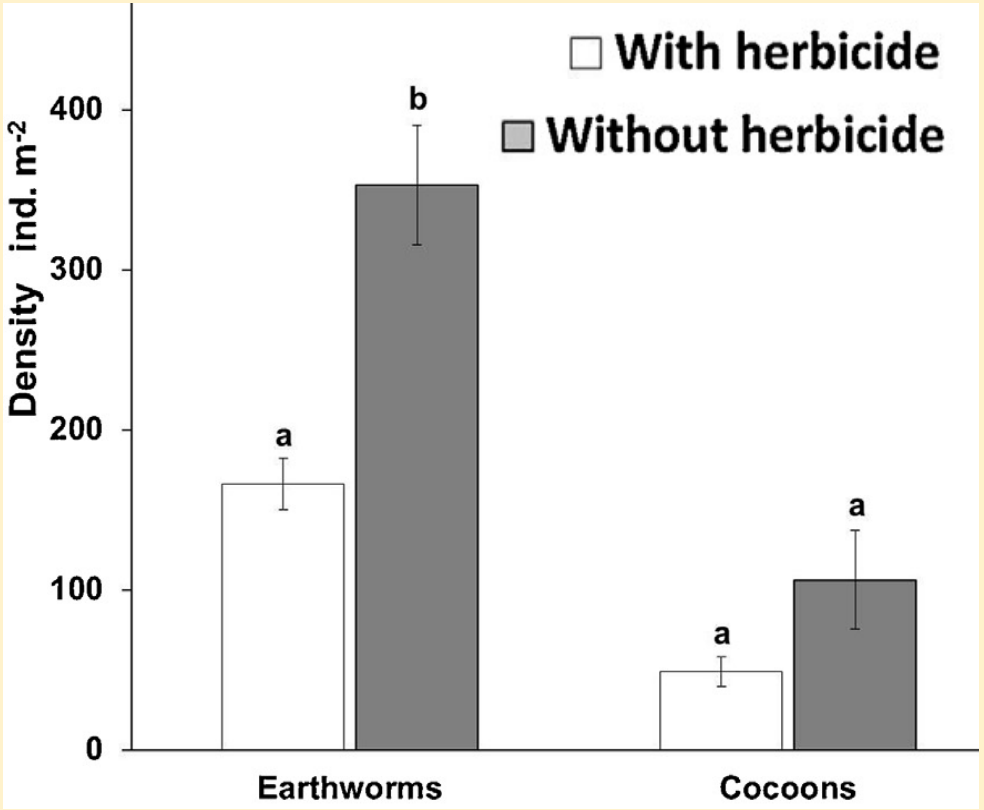
Pelosi et al. 2013

----- At the community level



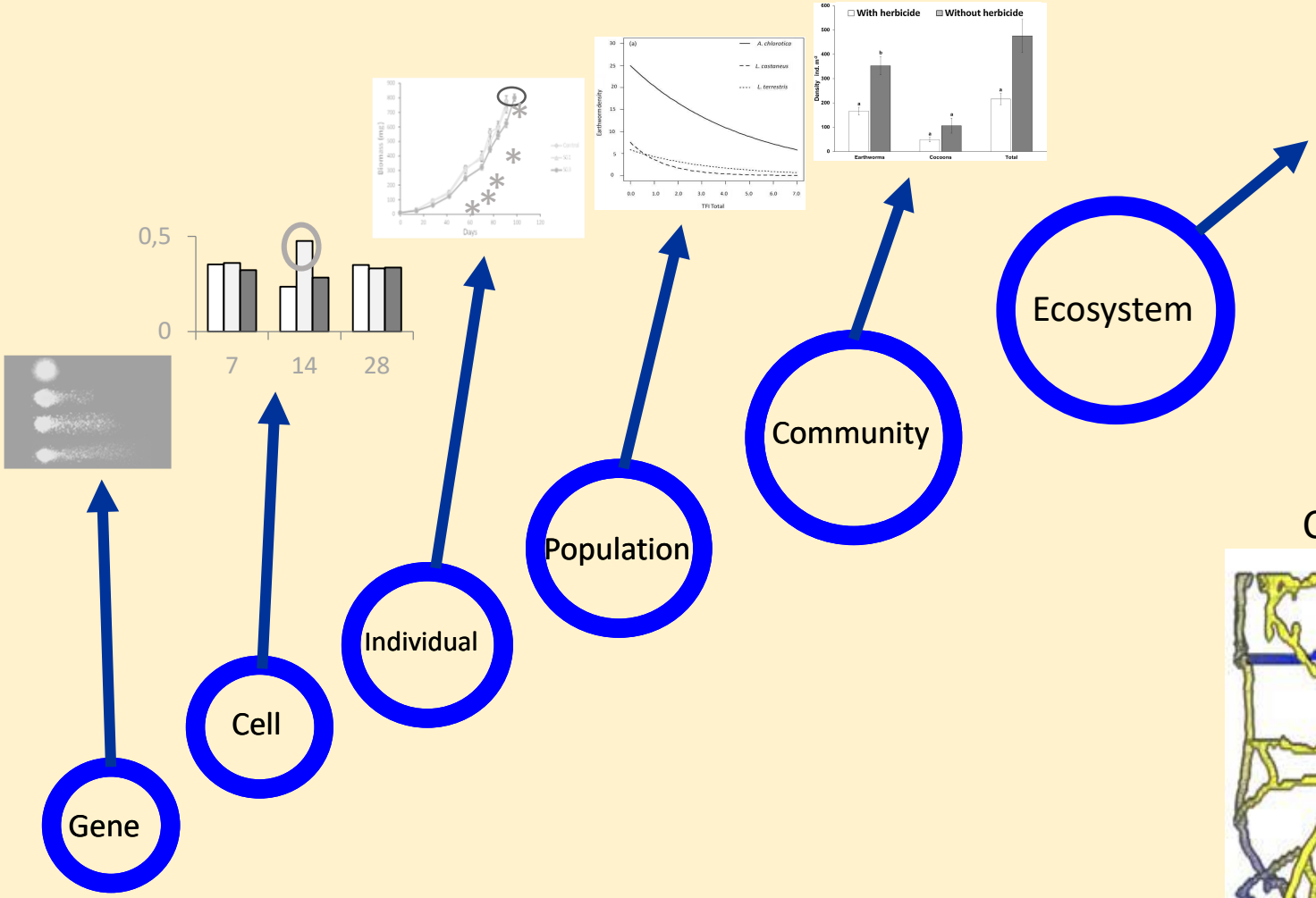
Shaded coffee plots
With and without glyphosate application



García-Pérez et al. 2014

Capowiez et al. 2006

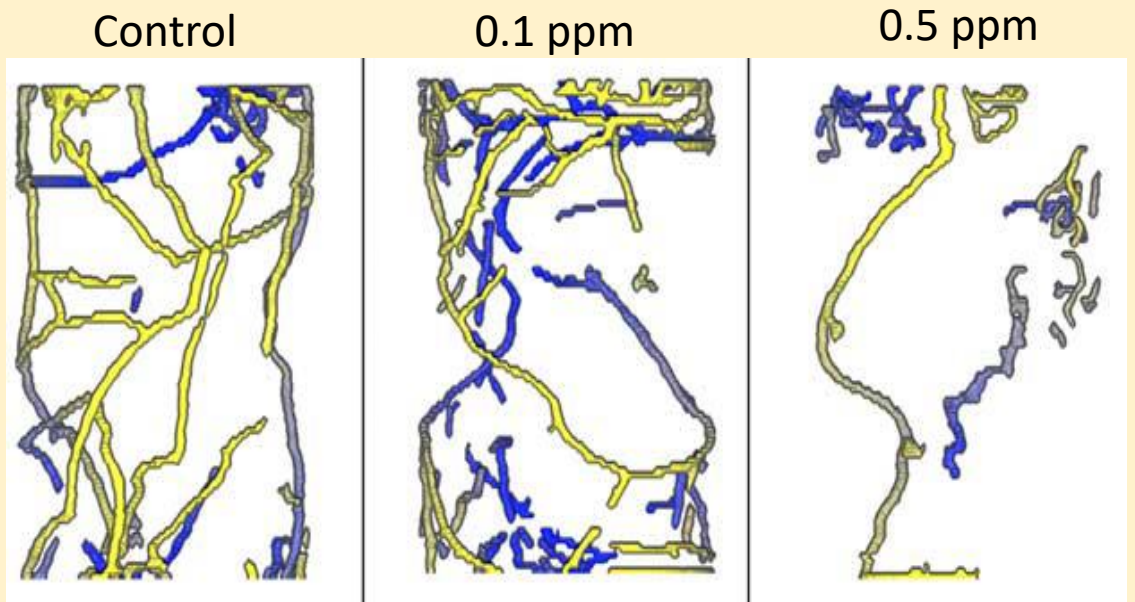
- - - - - At the ecosystem level



Confidor®, imidacloprid, insecticide, *Aporrectodea nocturna*

Predictive Environmental Concentration

Burrowing behavior => soil structure



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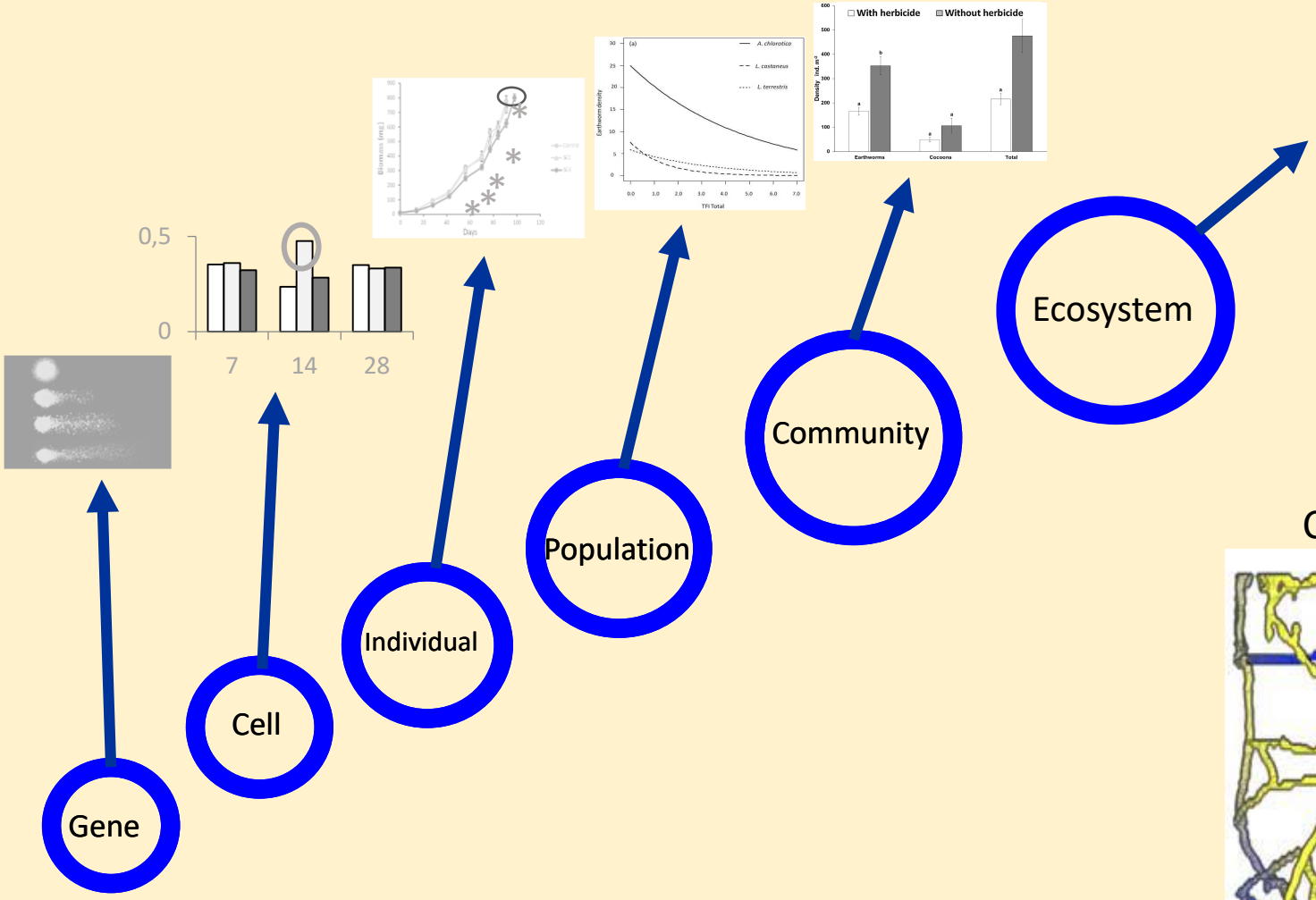

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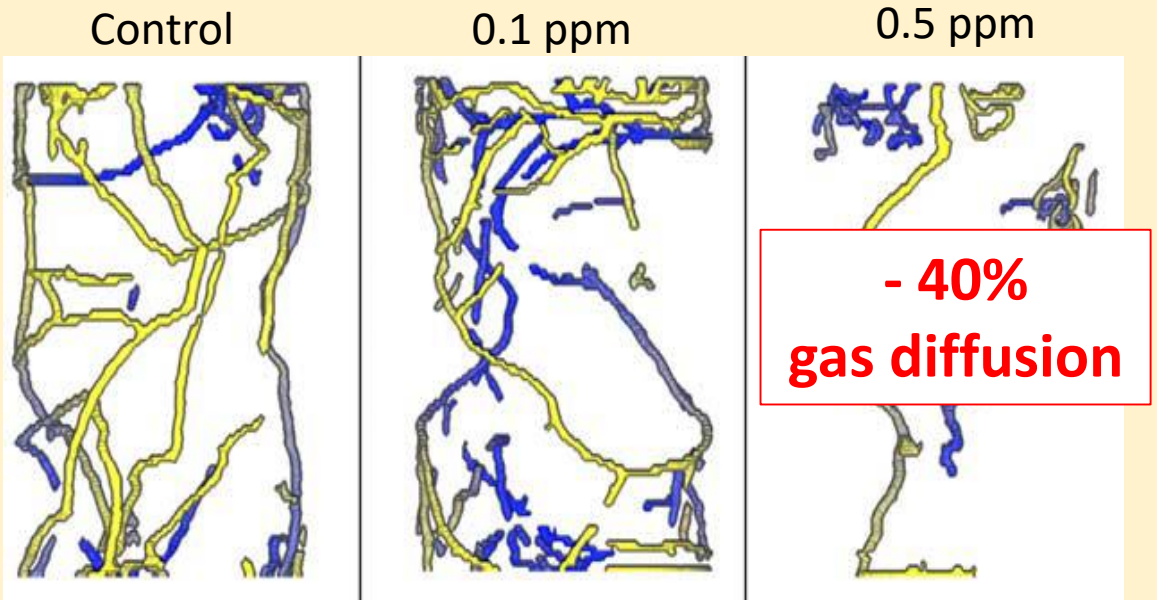
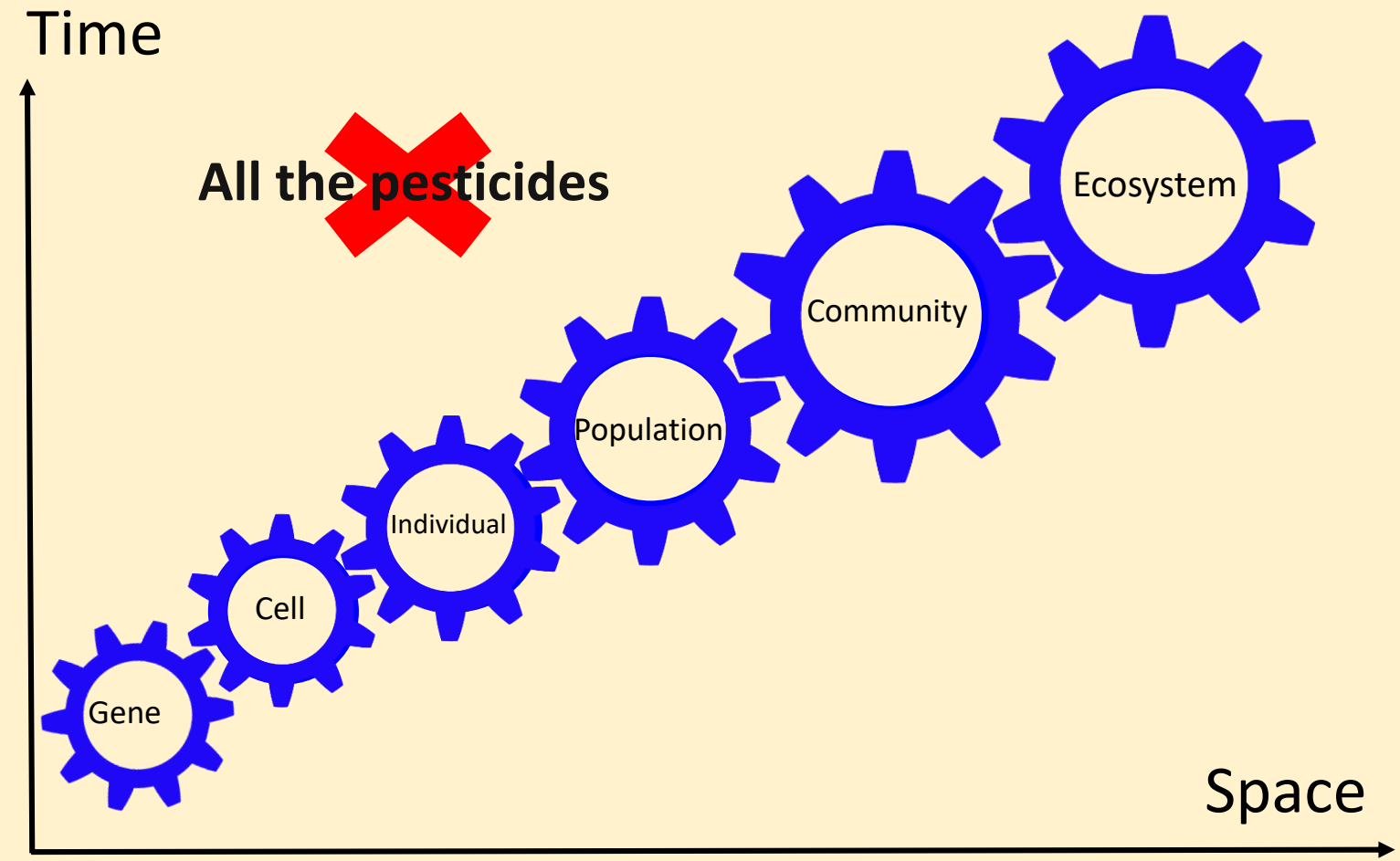
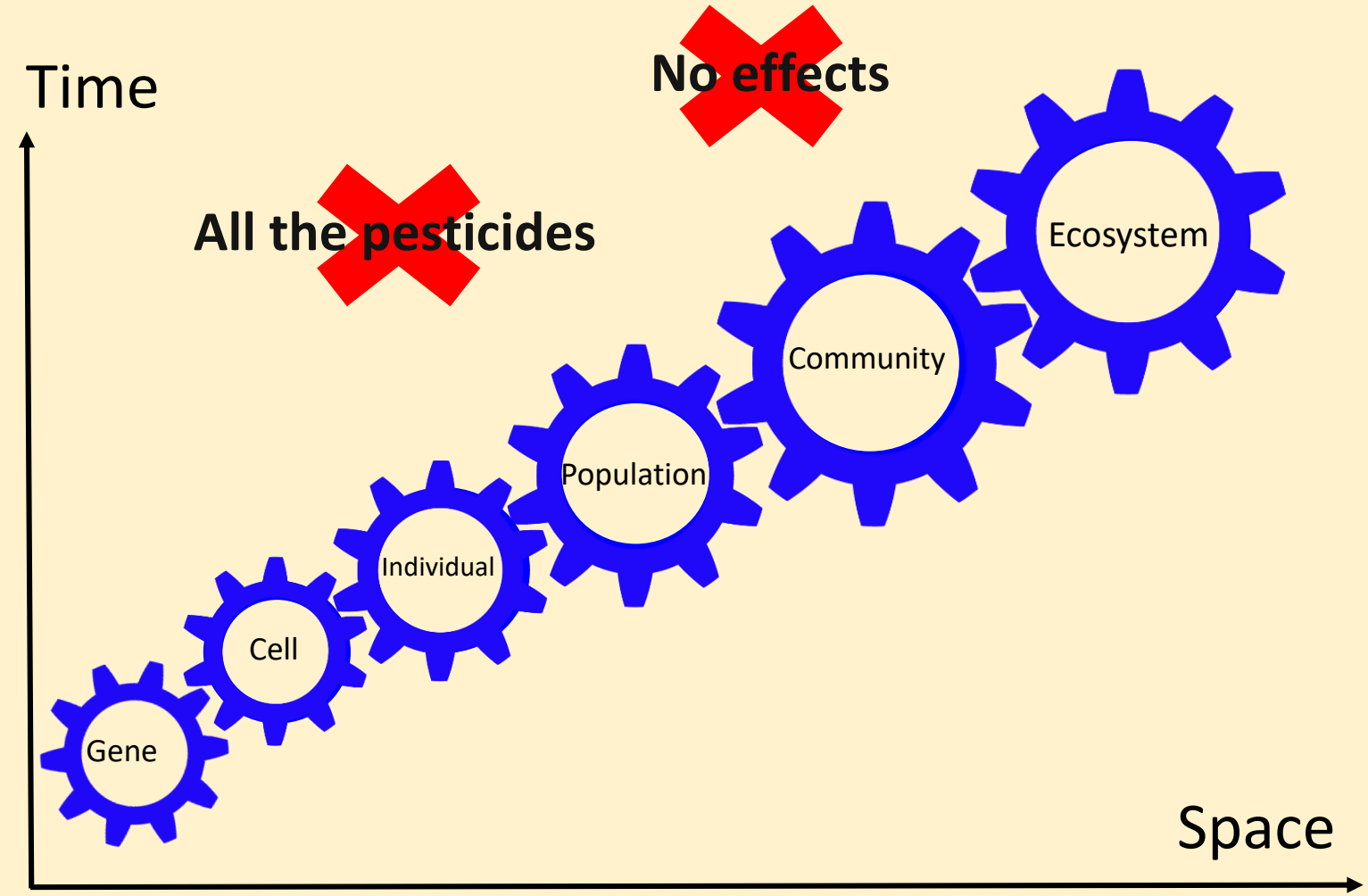


----- Conclusion


Time
All the pesticides
Gene
Cell
Individual
Population
Community
Ecosystem
Space

----- Conclusion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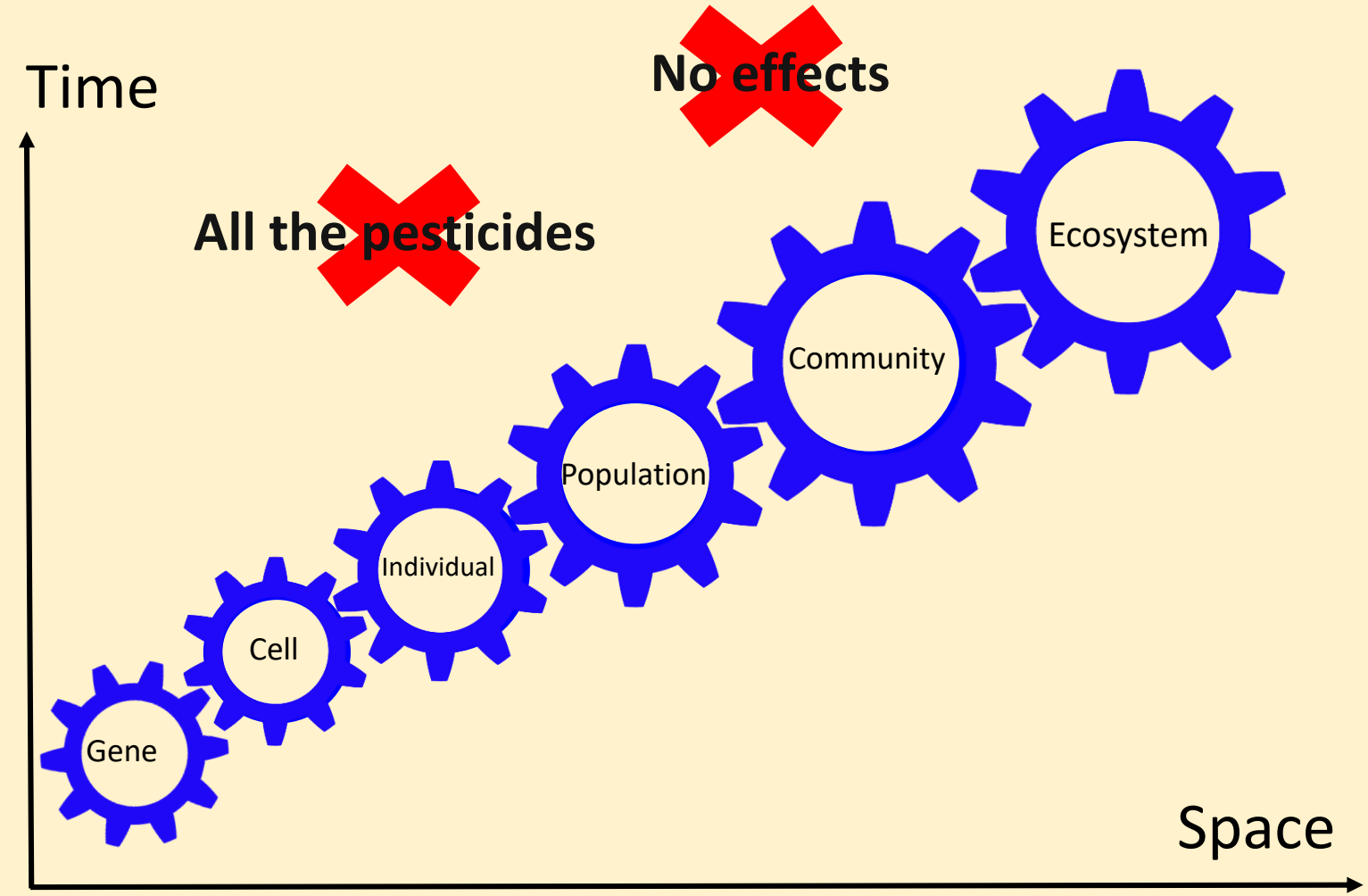
Some pesticides commonly used in Europe at realistic concentrations
=> negative effects on earthworms



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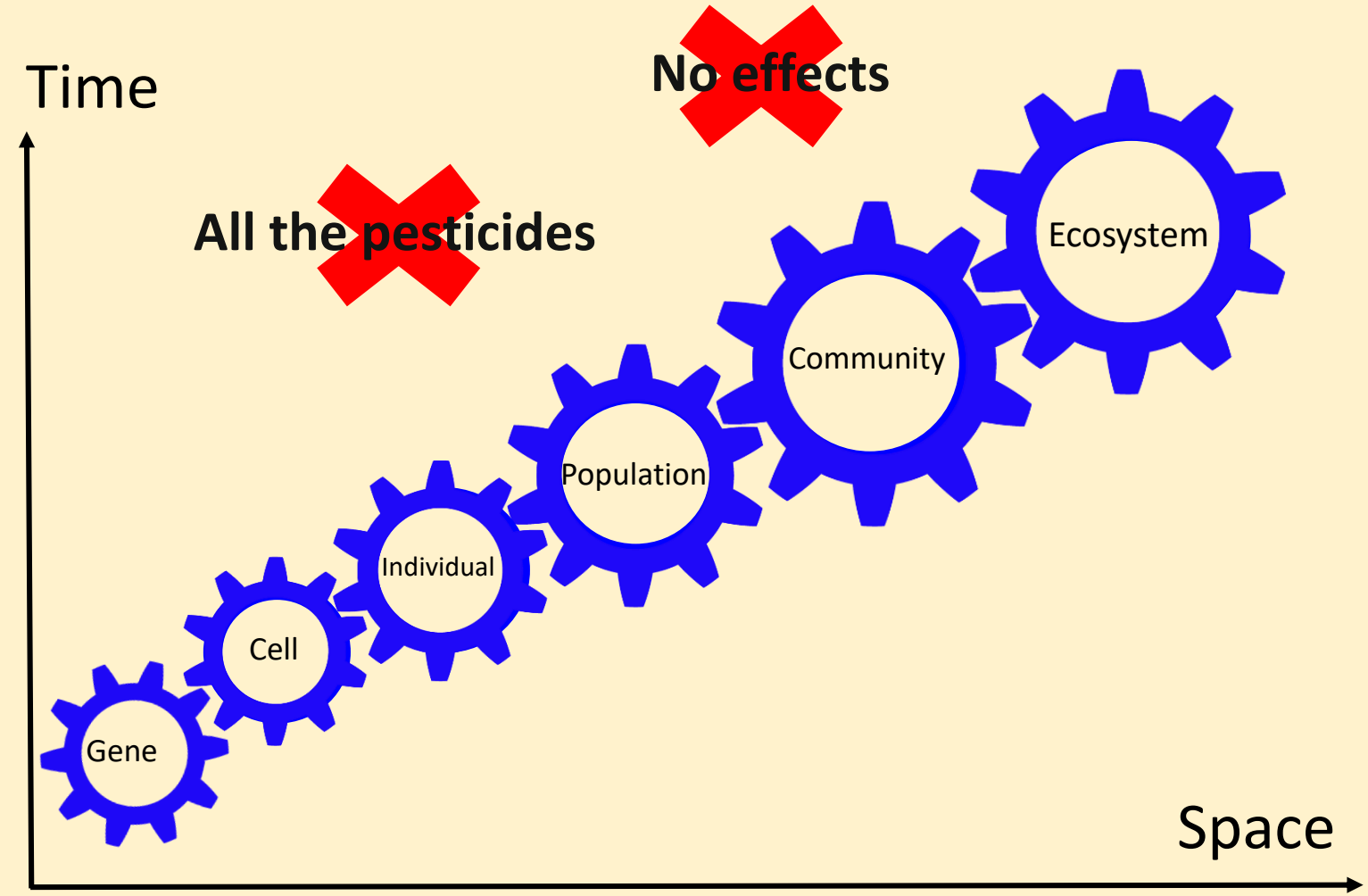

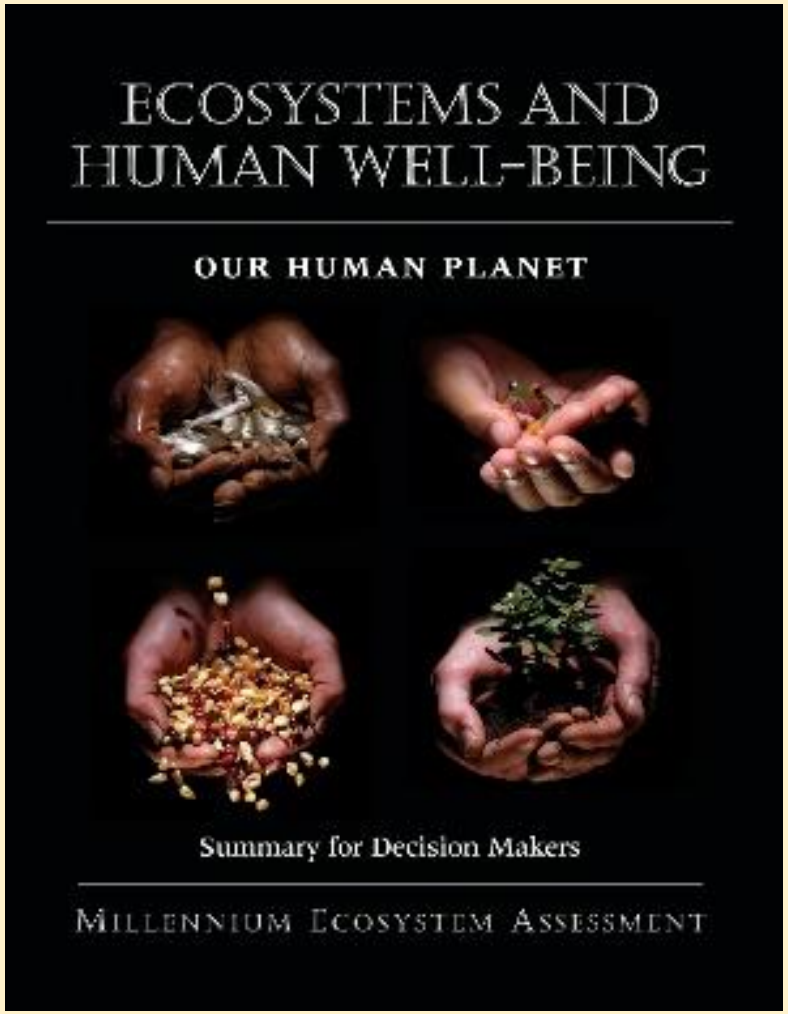

----- Lines of though for risk assessment

- Pre-registration procedures

➢ Representative and sensitive species => ISO norms (annex)

➢ Other relevant endpoints e.g., growth, behavior => life cycle (population dynamics)

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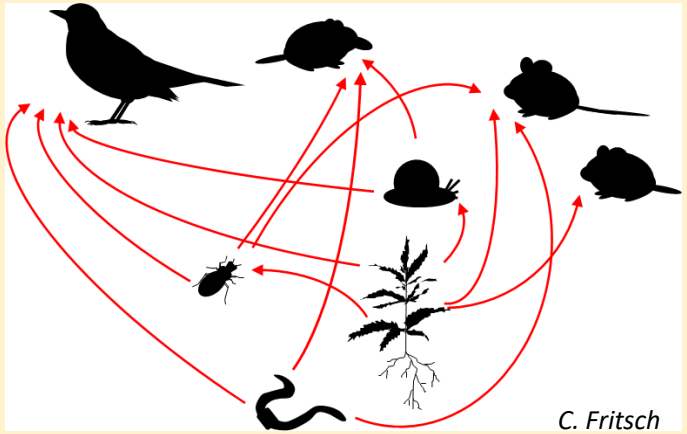
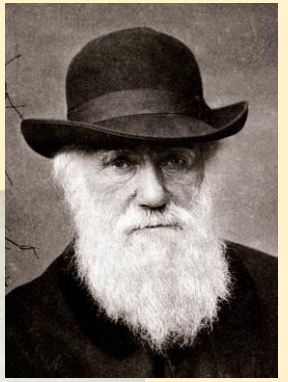
- Post-registration

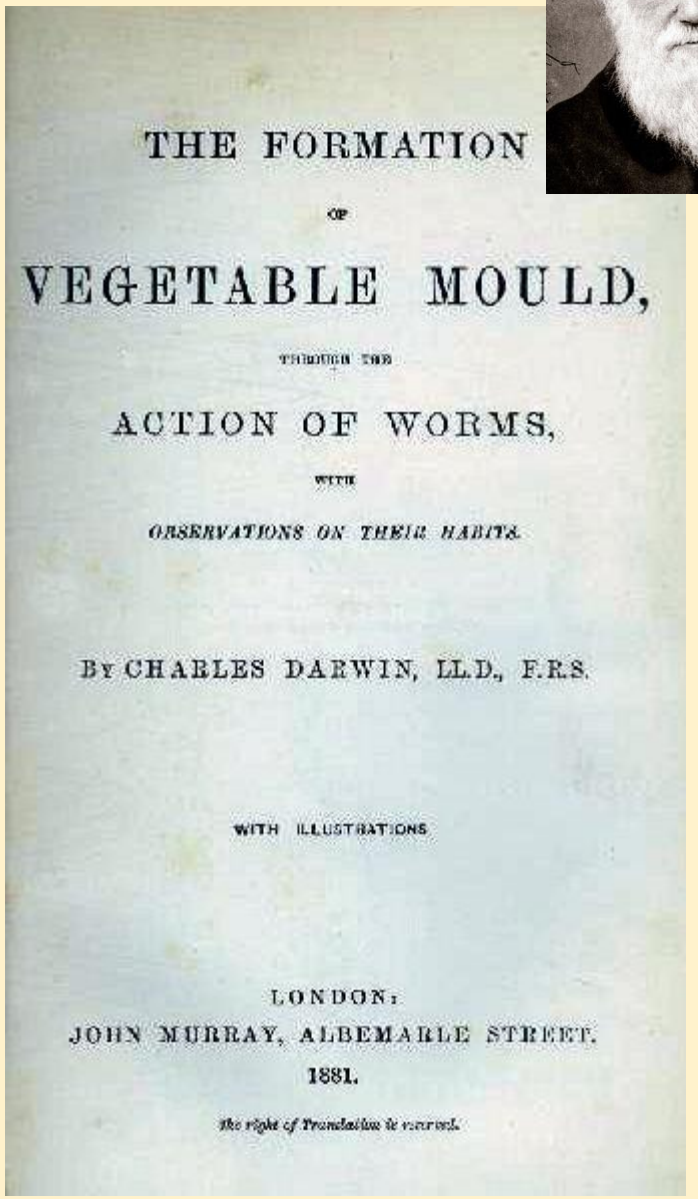
➢ Field studies (confounding factors e.g., agricultural practices)

➢ Exposure of non-target organisms at the landscape scale, effects at higher trophic levels



Thanks for your attention





"Without the work of this humble creature,
who knows nothing of the benefits he confers upon mankind,
agriculture, as we know it, would be very difficult,
if not wholly impossible"

CHARLES DARWIN, 1881

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SCIENCE & IMPACT

40 references (1995 - 2018): glyphosate or AMPA

→ Mortality: do not affect the survival of earthworms (4 studies)
→ Biomass: decrease in biomass (2 studies)
→ Avoidance (2 studies)
→ Viability of cocoons: neutral (1 study) or negative effects (2 studies)
→ Nutrition activity: neutral (1 study) or negative effects (2 studies)

Very few studies under field conditions

Trans-generational effects