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Effects of earthworm activity on bulk density - a meta-analysis

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Senckenberg Museum of Natural History Görlitz



BonaRes

Soil as a sustainable resource for the bio-economy

- Preserve and improve productivity and fertility of soils in the long term
- Soil is a limited resource, the functionality cannot be replaced once lost



→ Sustainable soil use and management

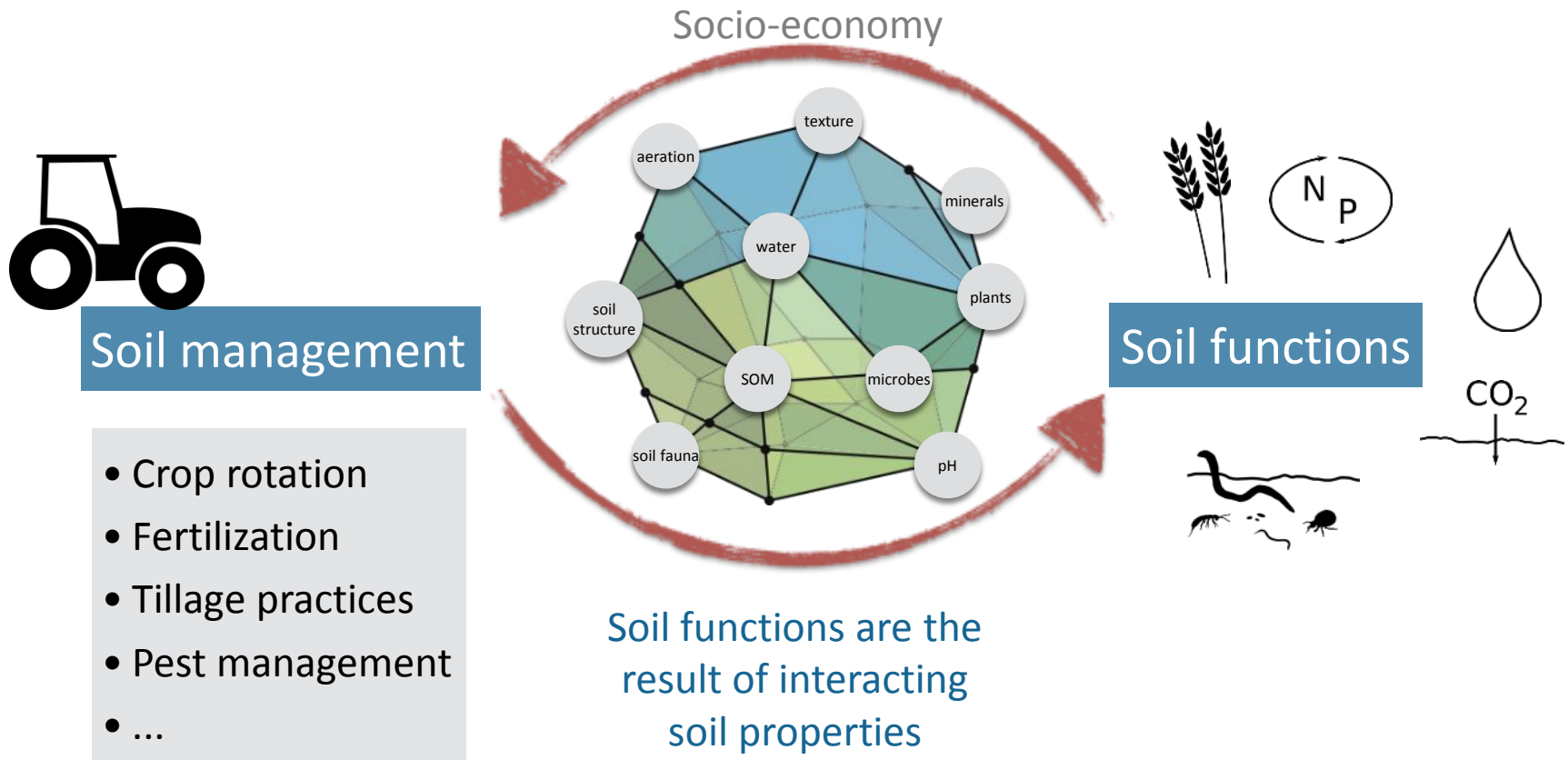


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All photos: B. Lang

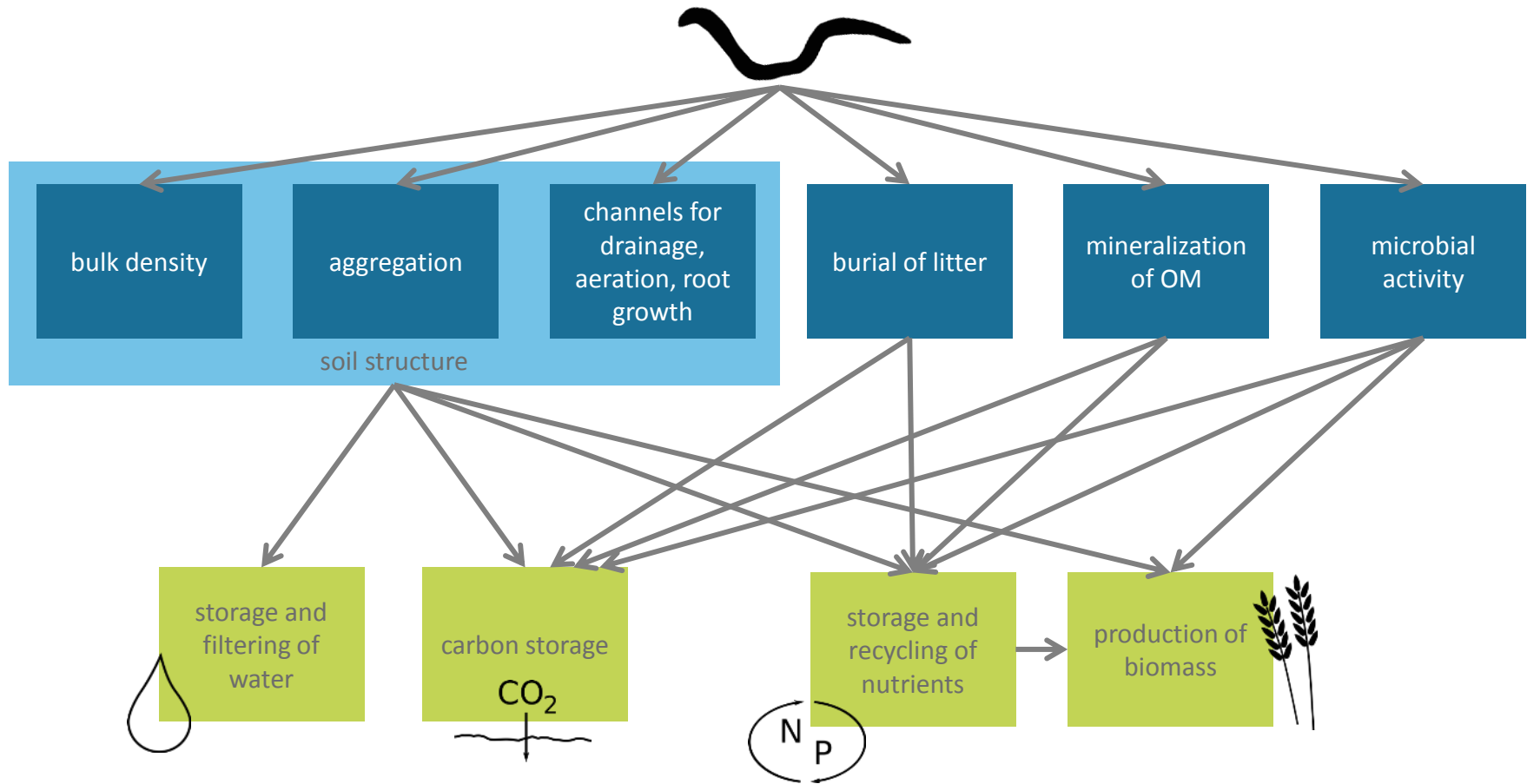
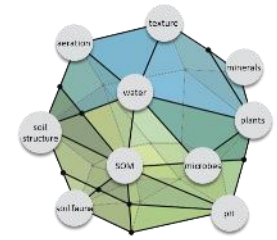
Science-based model: Predict the impact of soil management on soil functions



Pictograms (tractor, soil functions): B. Lang



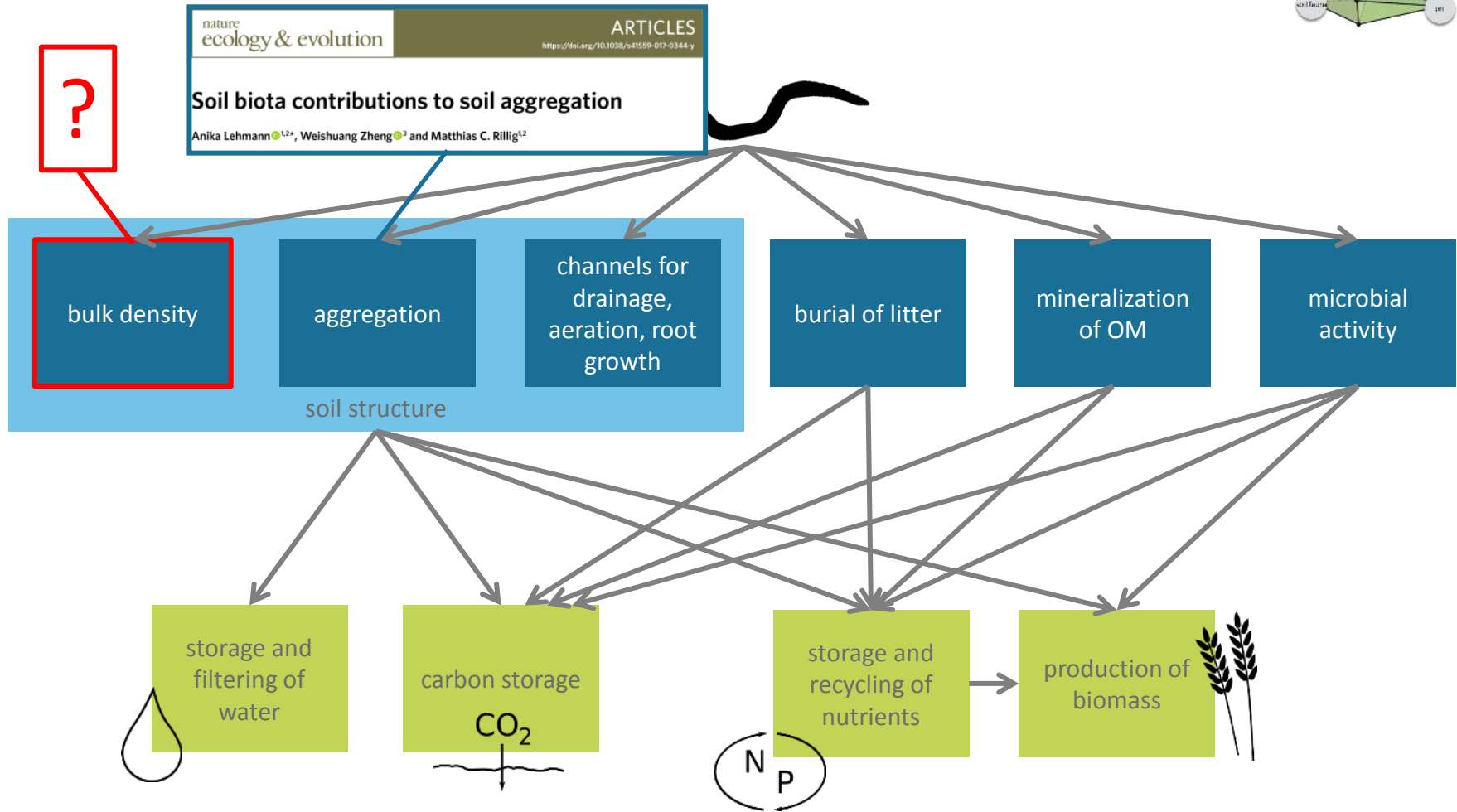
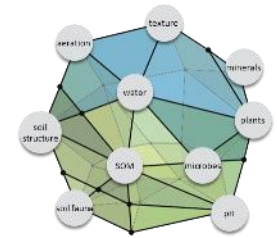
Soil fauna and functions



Pictograms (earthworm, soil functions): B. Lang



Soil fauna and functions

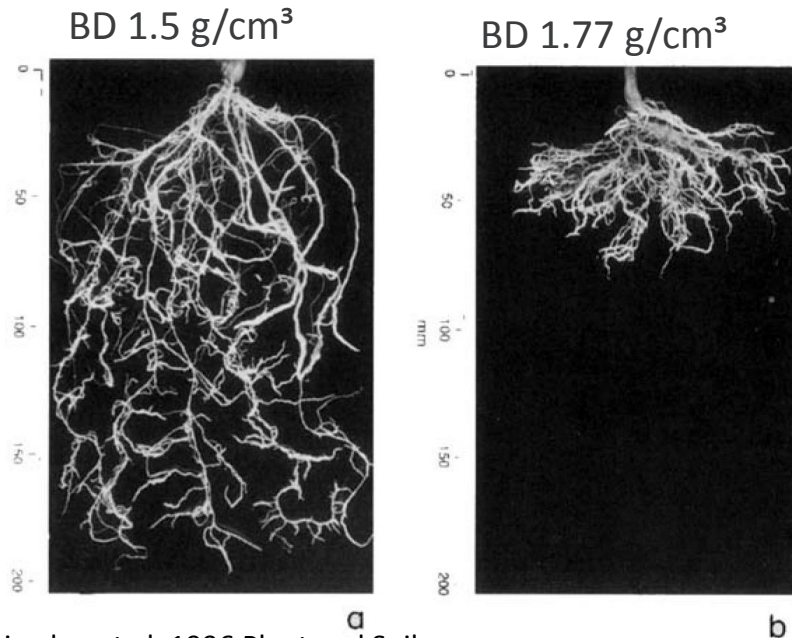


Pictograms (earthworm, soil functions): B. Lang



How does soil fauna affect bulk density?

- Indicator of soil structure and soil compaction
- Important for water dynamics and root growth



Stirzaker et al. 1996 Plant and Soil

Quantitative synthesis of soil faunal effects lacking

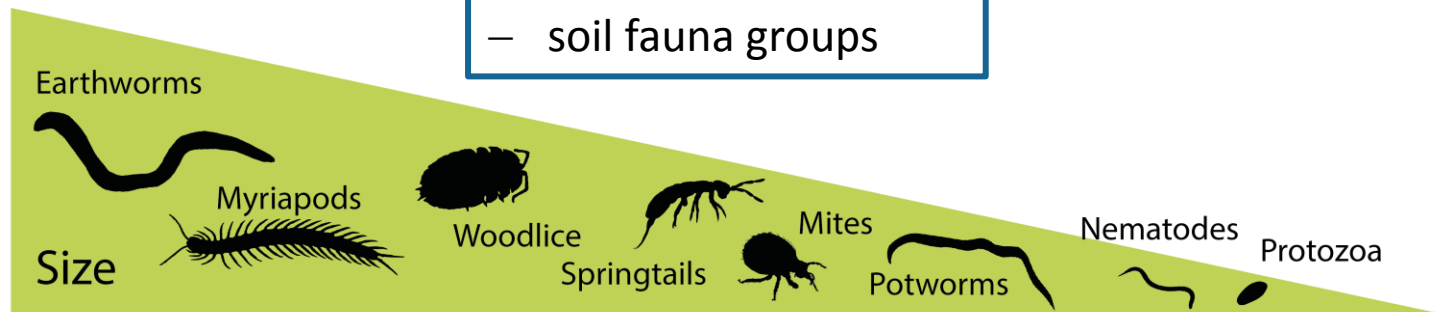
Potential for counteracting compaction?

How do earthworms affect bulk density?

Data collection

Systematic
search

- bulk density
 - porosity
 - pore volume
- AND
- soil fauna groups



Pictograms: Myriapoda by Yan Wong , all others by Birgit
Lang. Available at phylopic.org

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How do earthworms affect bulk density?

Data collection



Requirements

- control vs. EW treatment (same exp. conditions)

Effect size: $\ln(BD_{EW}/BD_C)$
Mixed effects models (random factor: study ID)

Excluded

- cast vs. bulk soil
- before-after investigations



Collection of additional information

Basic site information, e.g.

- Geography
- Climate
- Habitat and **land use**
- Soil description (soil type, **texture**, pH, **initial bulk density** ...)

Experimental information, e.g.

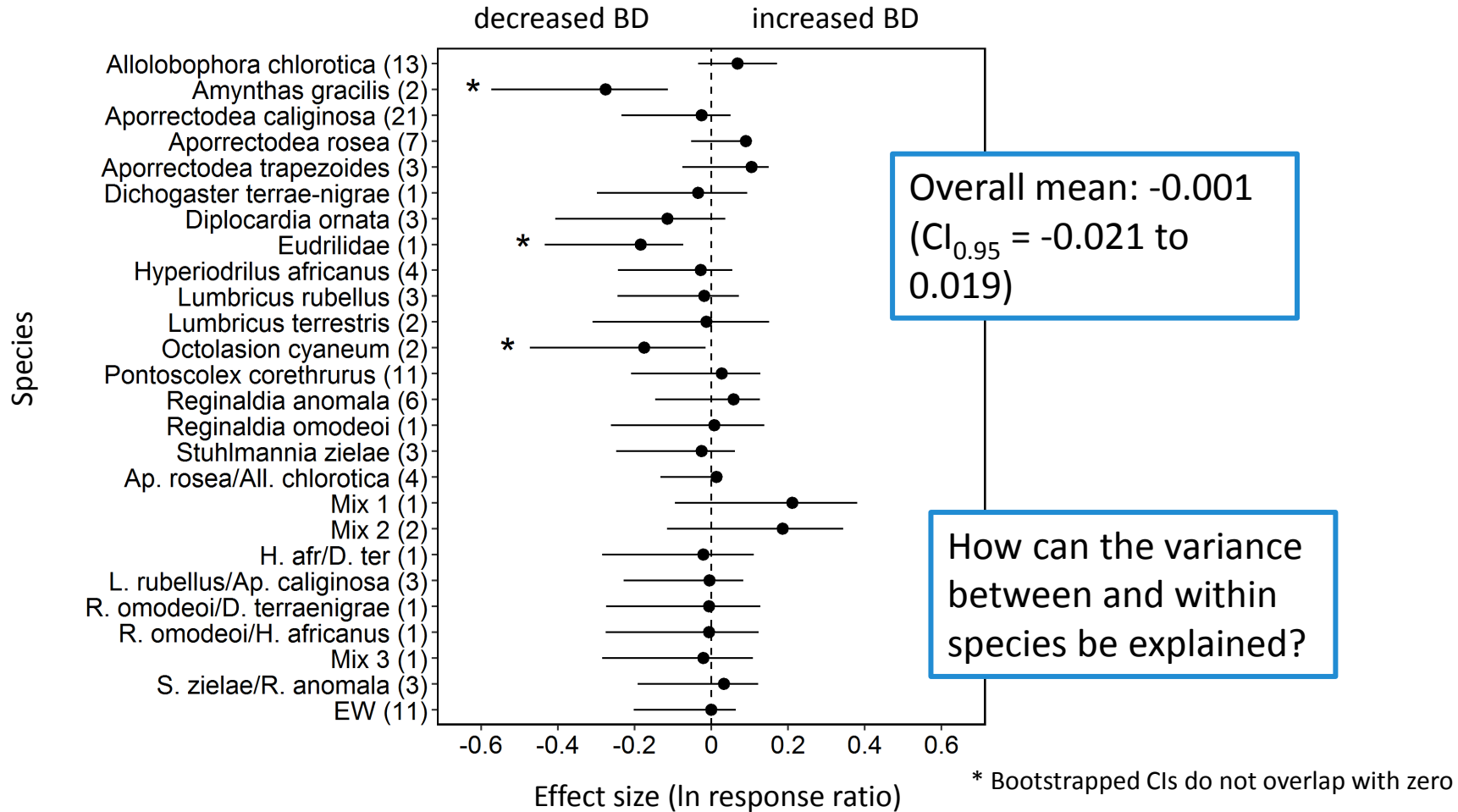
- Lab/field experiment
- Repacked/undisturbed soil
- Duration
- Treatments and replication

Taxonomic details , e.g.

- **Species**
- **Ecological group**
- Biomass, **abundance**, **size**



Do earthworms affect bulk density?



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How can the variance between and within species be explained?

- Effects of ecological group + texture + land use + experimental duration?

→ These factors do not explain the large variation

**Not enough data for
interactive effects!**

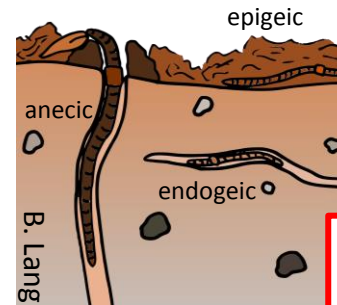
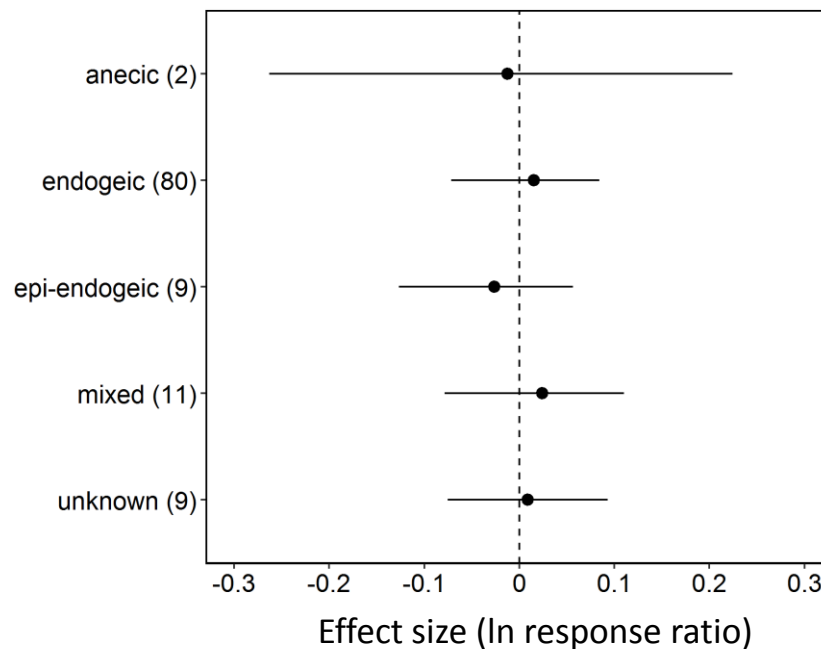


How can the variance between and within species be explained?

- Effects of ecological group + texture + land use + experimental duration?

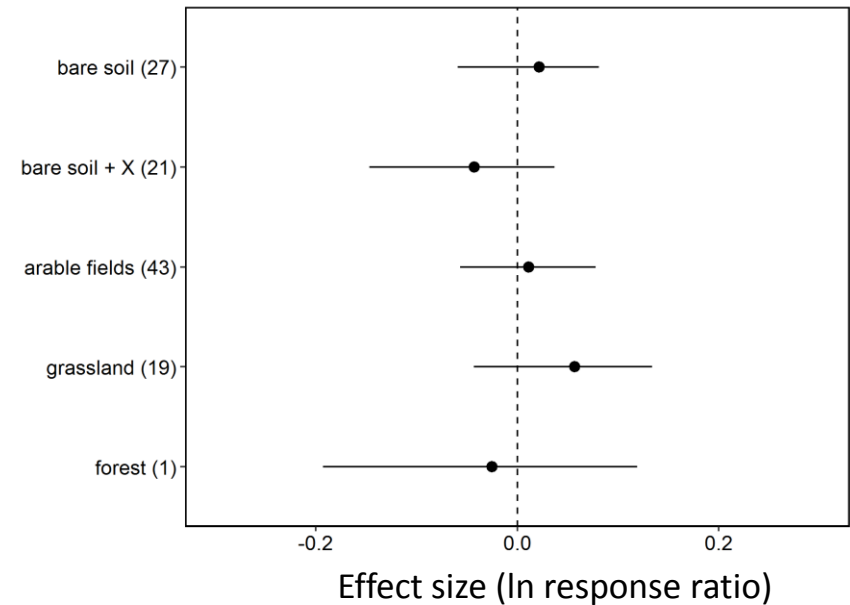
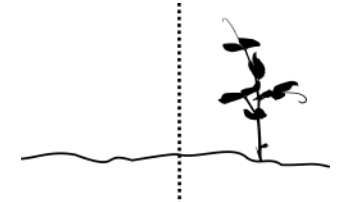
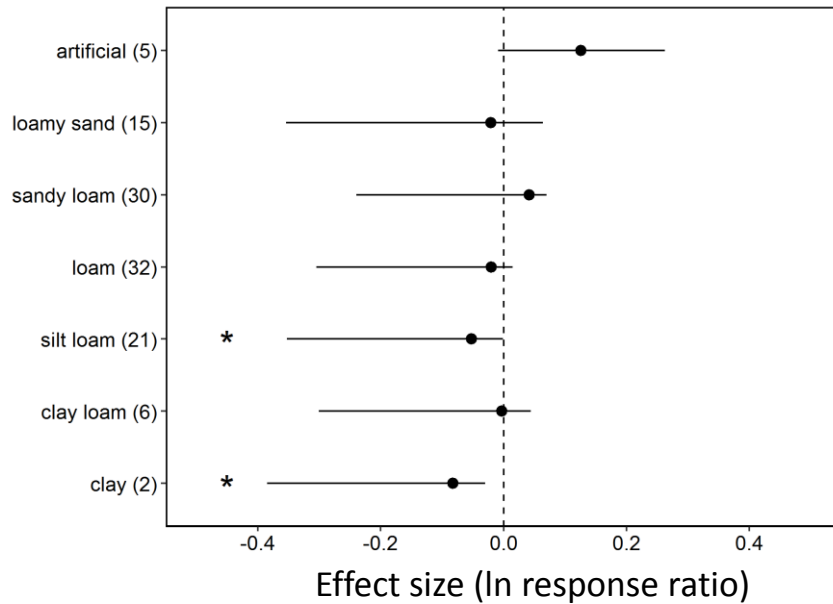
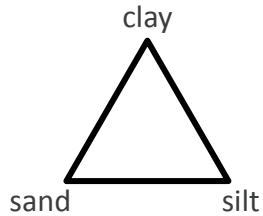
→ These factors do not explain the large variation

**Not enough data for
interactive effects!**



Knowledge gap!
Data missing for most
groups

Influence of texture or land use on effect size?



Knowledge gap!
Data missing for some textures

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How can the variance between and within species be explained?

- Effects of ecological group + texture + land use + experimental duration?

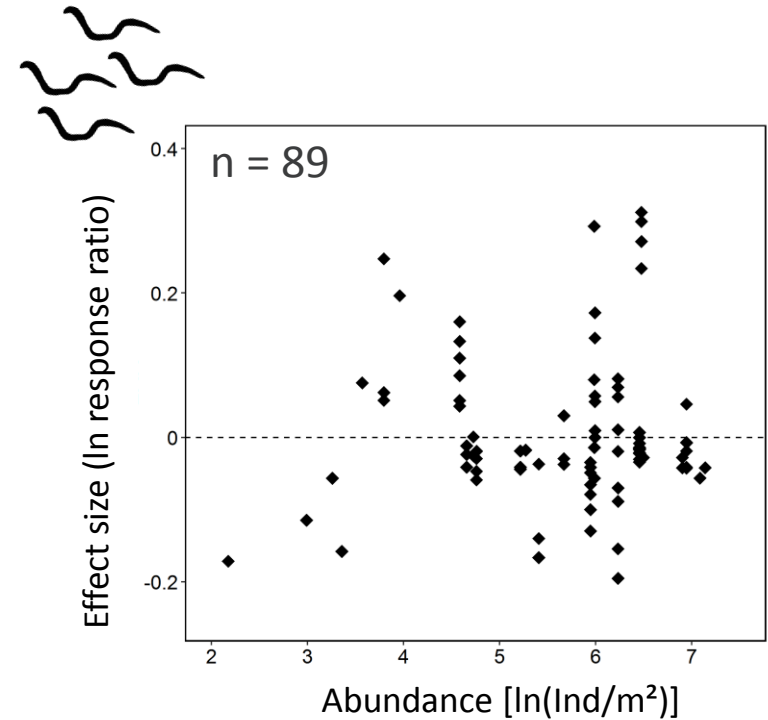
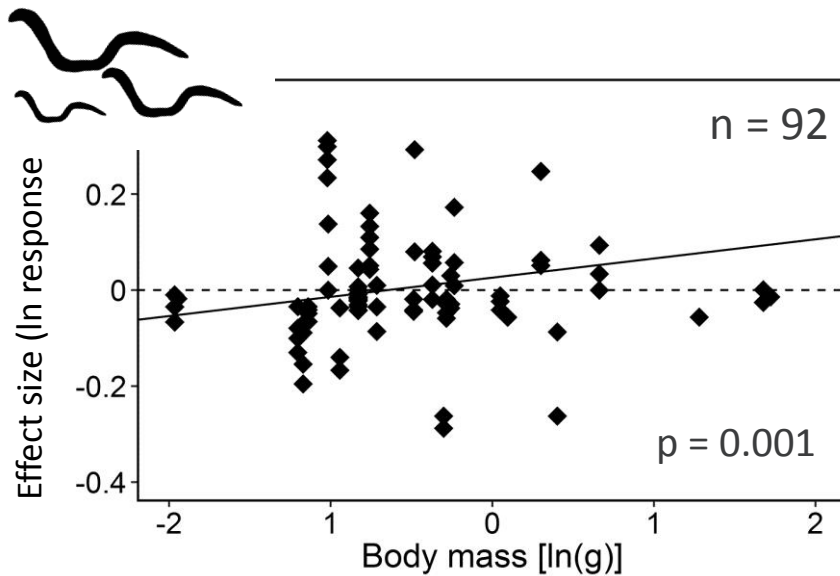
→ These factors do not explain the large variation

**Not enough data for
interactive effects!**

- Abundance model (subset, 89 datapoints)
- Body mass model (subset, 92 datapoints)
- Bulk density model (subset, 65 datapoints)



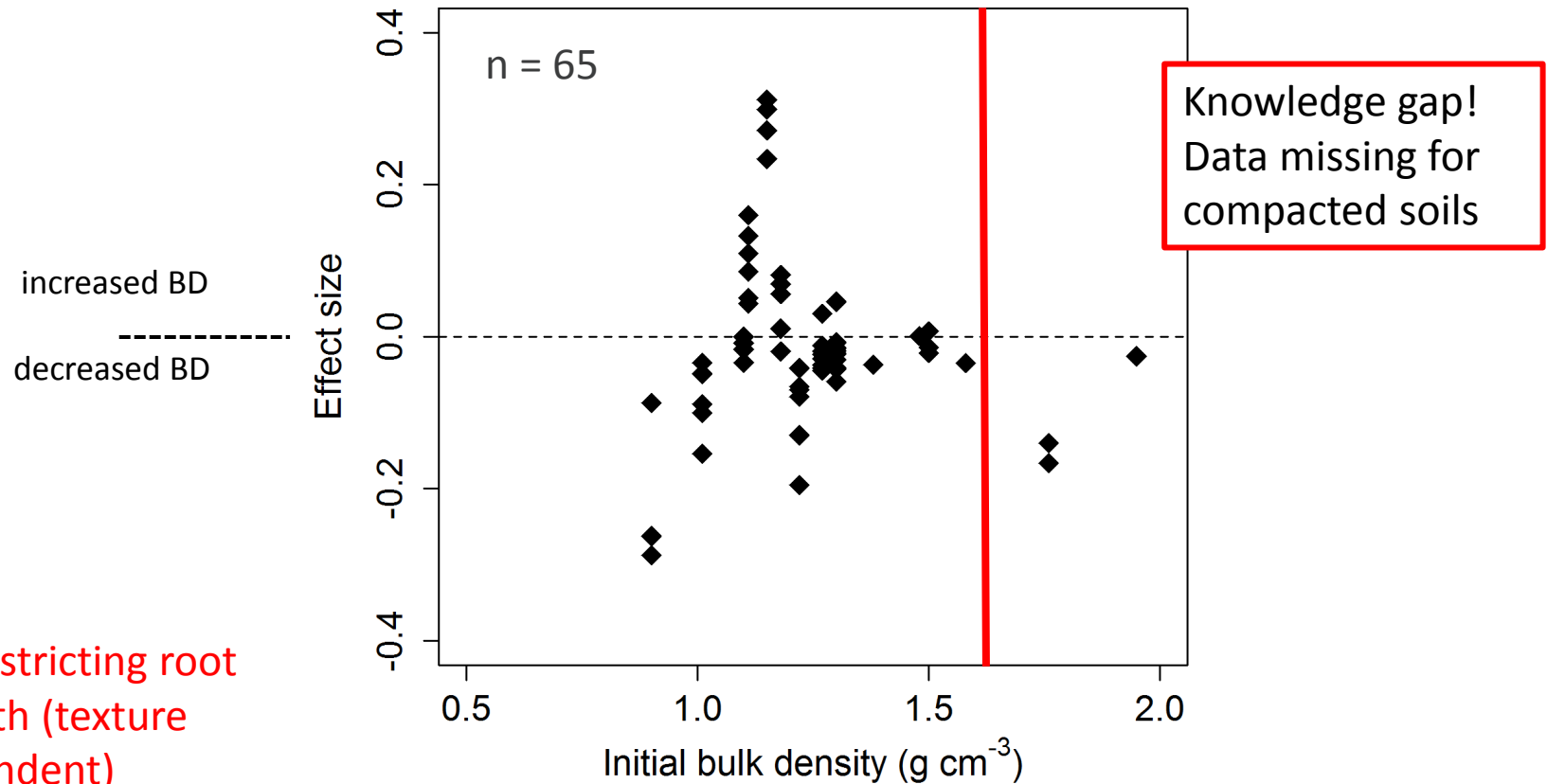
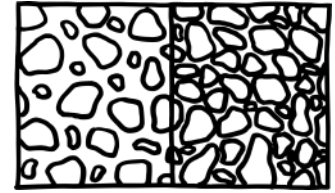
Do effect sizes depend on body mass or abundance?



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Do earthworms loosen soil after compaction?




BD restricting root
growth (texture
dependent)

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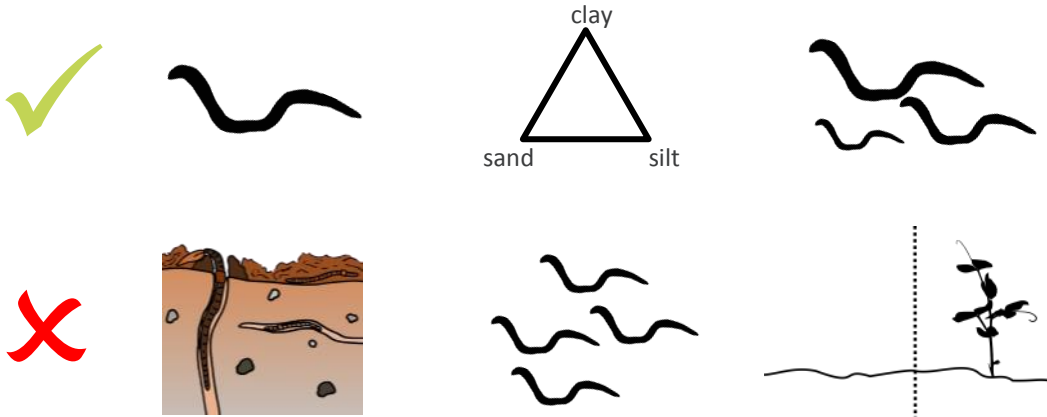


Conclusions

Effects of earthworms on bulk density: A meta-analysis

Birgit Lang  | David J. Russell

- High variability



- Potential to loosen compacted soils



- Knowledge gaps!
- Interactive effects?!

All pictograms: B. Lang



Thank you for your attention!

Photo: B. Lang



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