August 18th, 2025 Karaganda

Terrestrial isopods as model organisms to understand soil fauna distribution in a changing world

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Haplphthalmus danicus
Picture: Spinicornis - Gert Arijs

Content

Porcellio monticola © Spinicornis – Gert Arijs

- Why terrestrial isopods and short introduction
- Citizen Science: A Belgian terrestrial isopod group “Spinicornis”
- Species distribution modelling to predict species distribution
- Species traits to understand distribution and ecosystem functioning
- Species abundance modelling to assess ecosystem functioning?


Why terrestrial isopods ?

Androniscus dentiger (© Spinicoprnis - Gert Arijs)

Merulanella sp. “Phoenix” © Benedikt Kästle

A) “Cubaris” sp. ‘Rubber Ducky’ (Thailand), B) Armadillidae gen. sp. ‘Shiny Gator’ (Thailand), C) Laureola sp. ‘Durian’ (Vietnam), D) “Merulanella” sp. ‘Lava’ (Vietnam), E) Pseudarmadillo spinosus (Cuba), F) Armadillidium ruffoi (Italy), G) Porcellio bolivari (Spain), H) Porcellio werneri (Greece). © A, B, C, D, F, G, H Benedikt Kästle and E Carlos Michaelsen. Plate from De Smedt et al. (under review in Conservation Biology)


Back to the ocean…

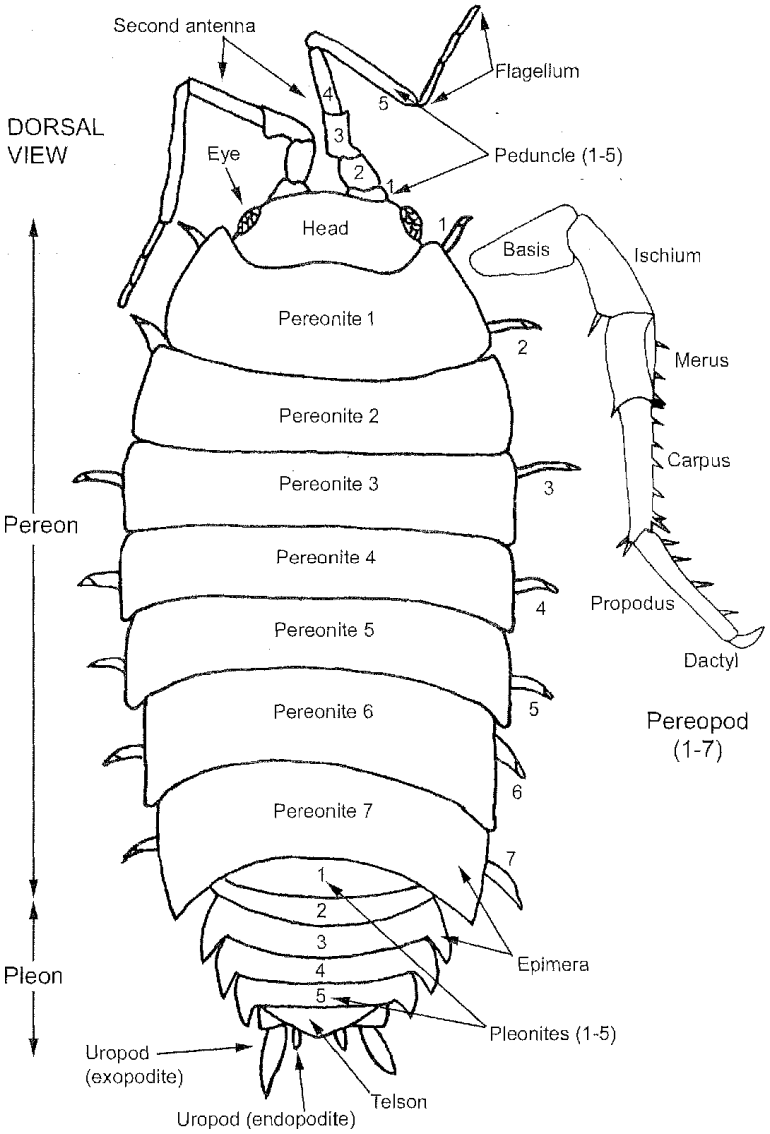
Freaks of nature!

Eluma caelata (© Spinicoprnis - Gert Arijs)

From sea to land

Adaptations to live on land:

- Body shape
- Legs for walking
- Chewing mandibles
- Internal fertilization
- …

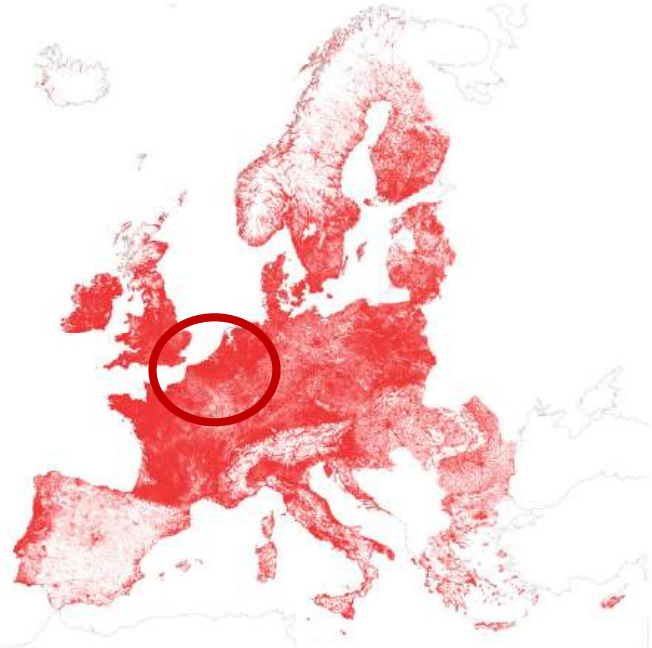


Ecologically important detritivores

- Direct
  - Consume dead organic material
  - Litter decomposition, nutrient cycling, carbon storage etc.
- Indirect
  - Important grazers of biofilm
  - Spread of fungal spores

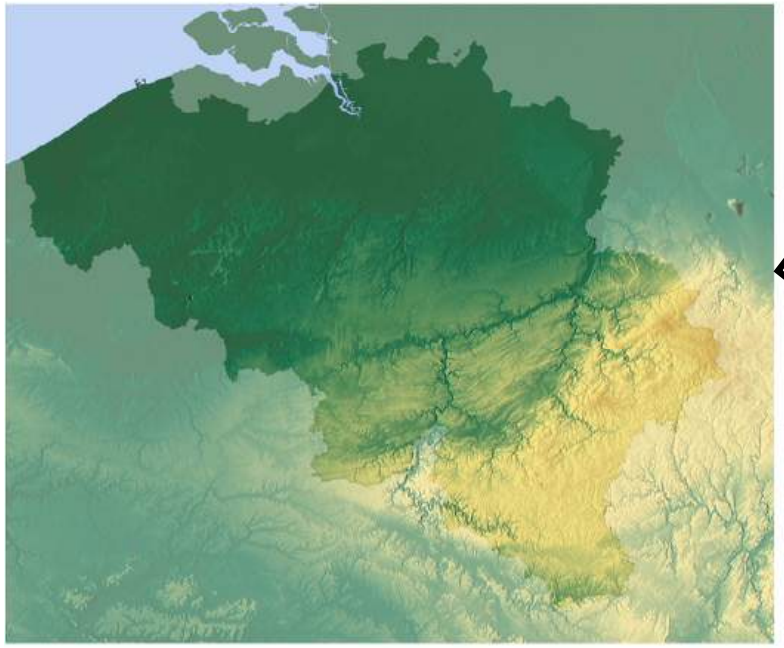
Belgium

- Small country in Western Europe (30.500 km²)
- High population density (385/km²)
- Very fragmented



Belgium

Geologically diverse country



Poor knowledge!

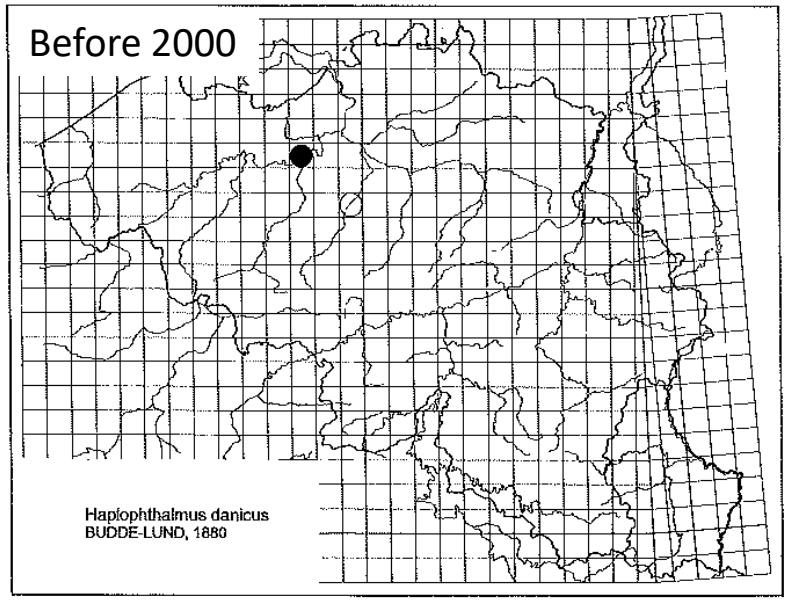
BULLETIN DE L'INSTITUT ROYAL DES SCIENCES NATURELLES DE BELGIQUE, BIOLOGIE, **70**: 193-205, 2000
BULLETIN VAN HET KONINKLIJK BELGISCH INSTITUUT VOOR NATUURWETENSCHAPPEN, BIOLOGIE, **70**: 193-205, 2000

Distribution and bibliography of the terrestrial Isopoda (Crustacea) of Belgium

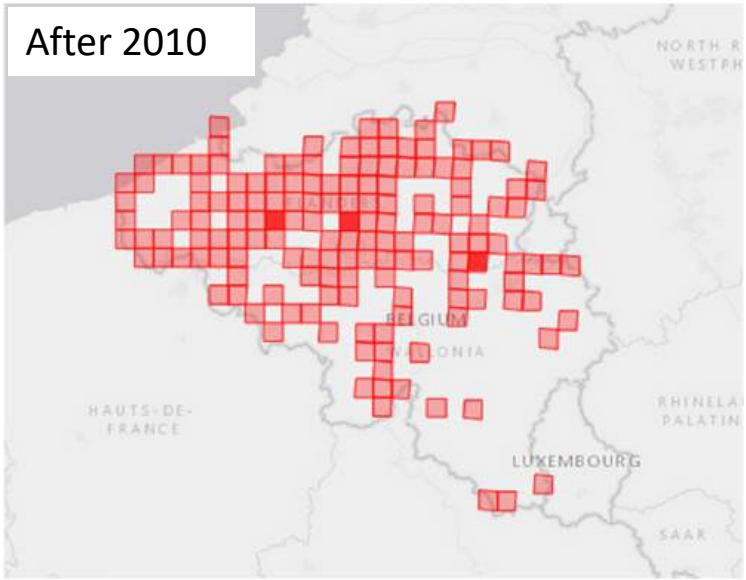
by K. WOUTERS, J.M. TAVERNIER & L. MEURISSE

After 2010 => recorded from 153 squares!

Strong need for new knowledge!



Haplphthalmus danicus © Spinicornis - Gert Arijs



Citizen Science: A Belgian terrestrial isopod group "Spinicornis"

Terrestrial isopod interest group:

- Founded by four former members of the youth movement for nature and environment (JNM) in 2014
- Citizen science project
- Goal: Publication of a distribution atlas for Belgium covering the <u>complete</u> Belgian territory by 2020.

Spinicornis landpissebedden van België

A citizen science project to make a statewide inventory

Step 1: Historical data

ZooKeys 801: 265–304 (2018)
doi: 10.3897/zookeys.801.21894
http://zookeys.pensoft.net

CHECKLIST

A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Woodlice of Belgium: an annotated checklist and bibliography (Isopoda, Oniscidea)

Pallieter De Smedt[1,2], Pepijn Boeraeve[2], Gert Arijs[2], Stijn Segers[2]

Step 2: Complete distribution atlas

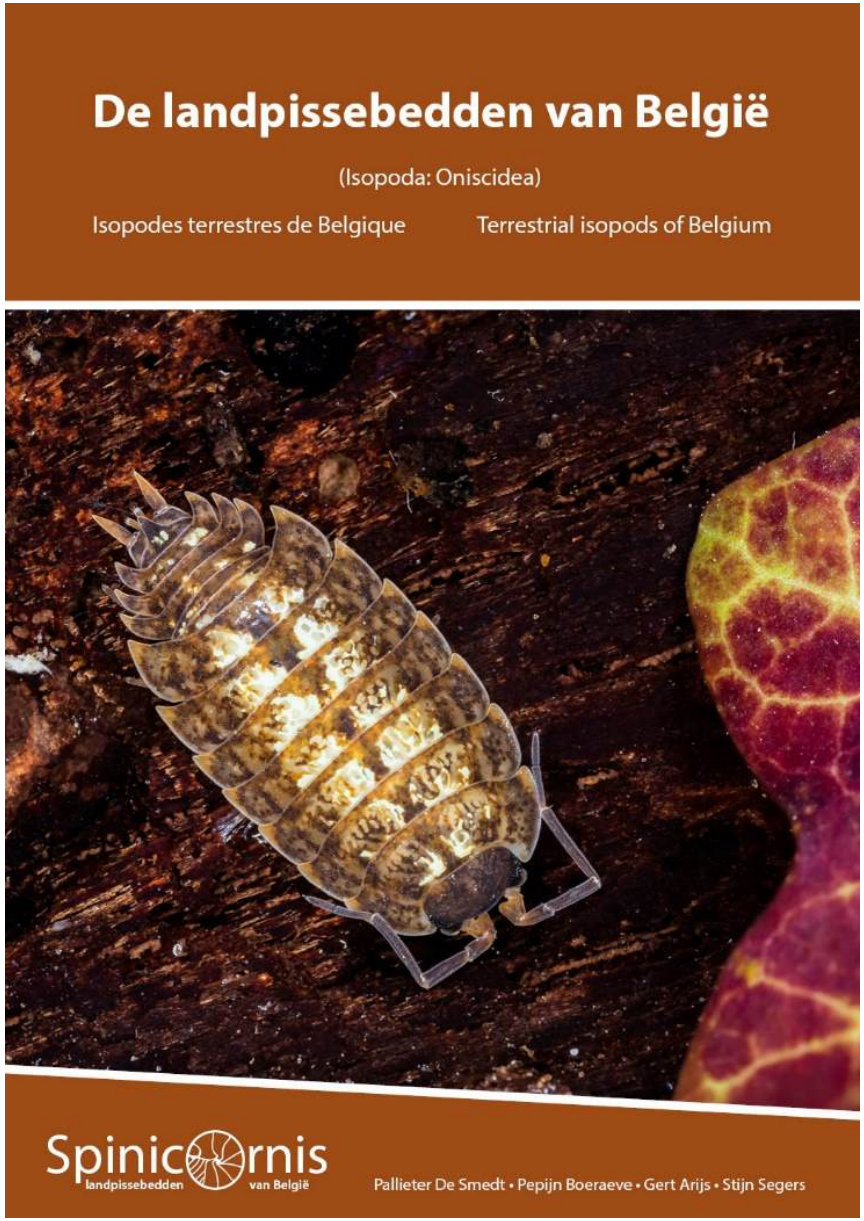
373 squares in Belgium (10 x 10 km)
Monthly excursions and weekends
3 types of landscapes

Forest

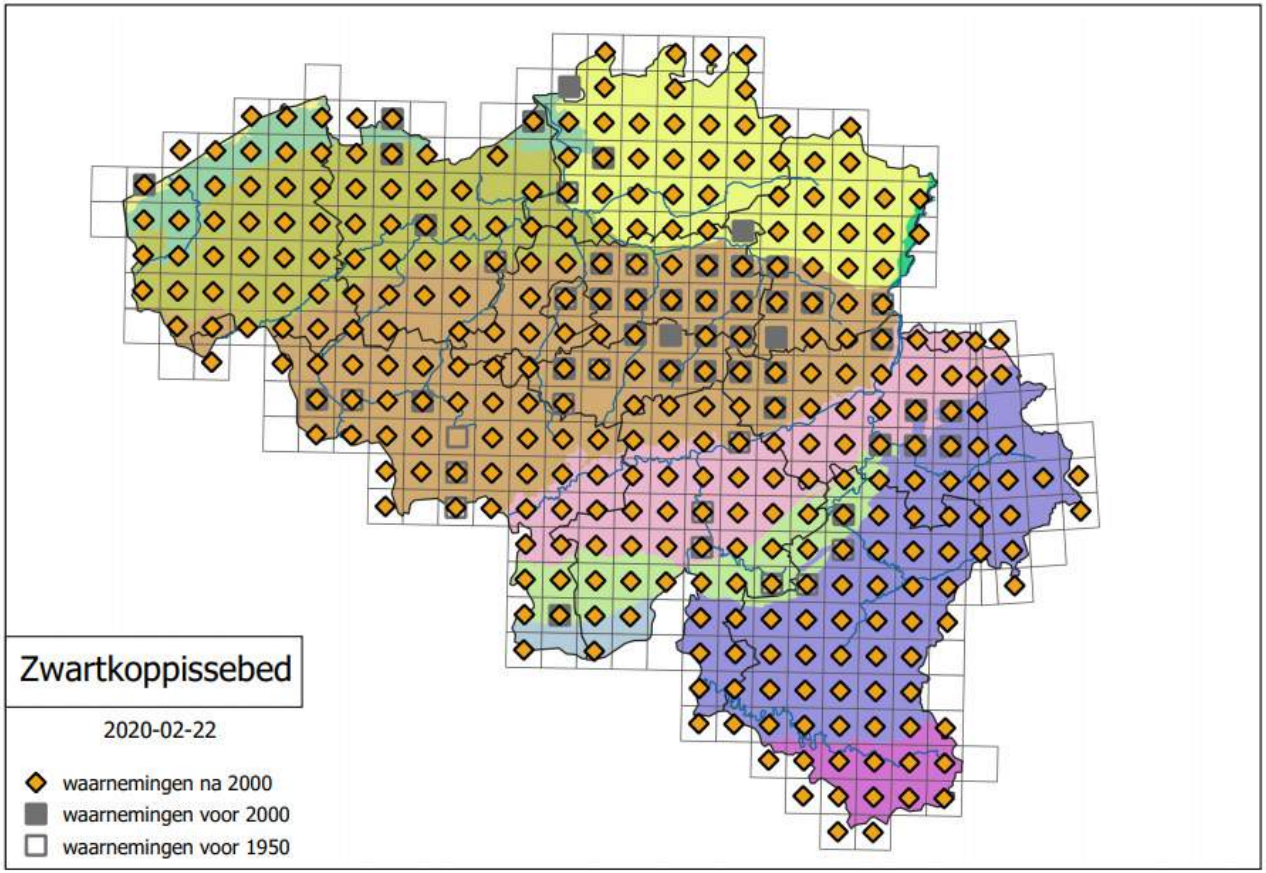
Rivers edges, wetlands, etc..

Anthropogenic habitat

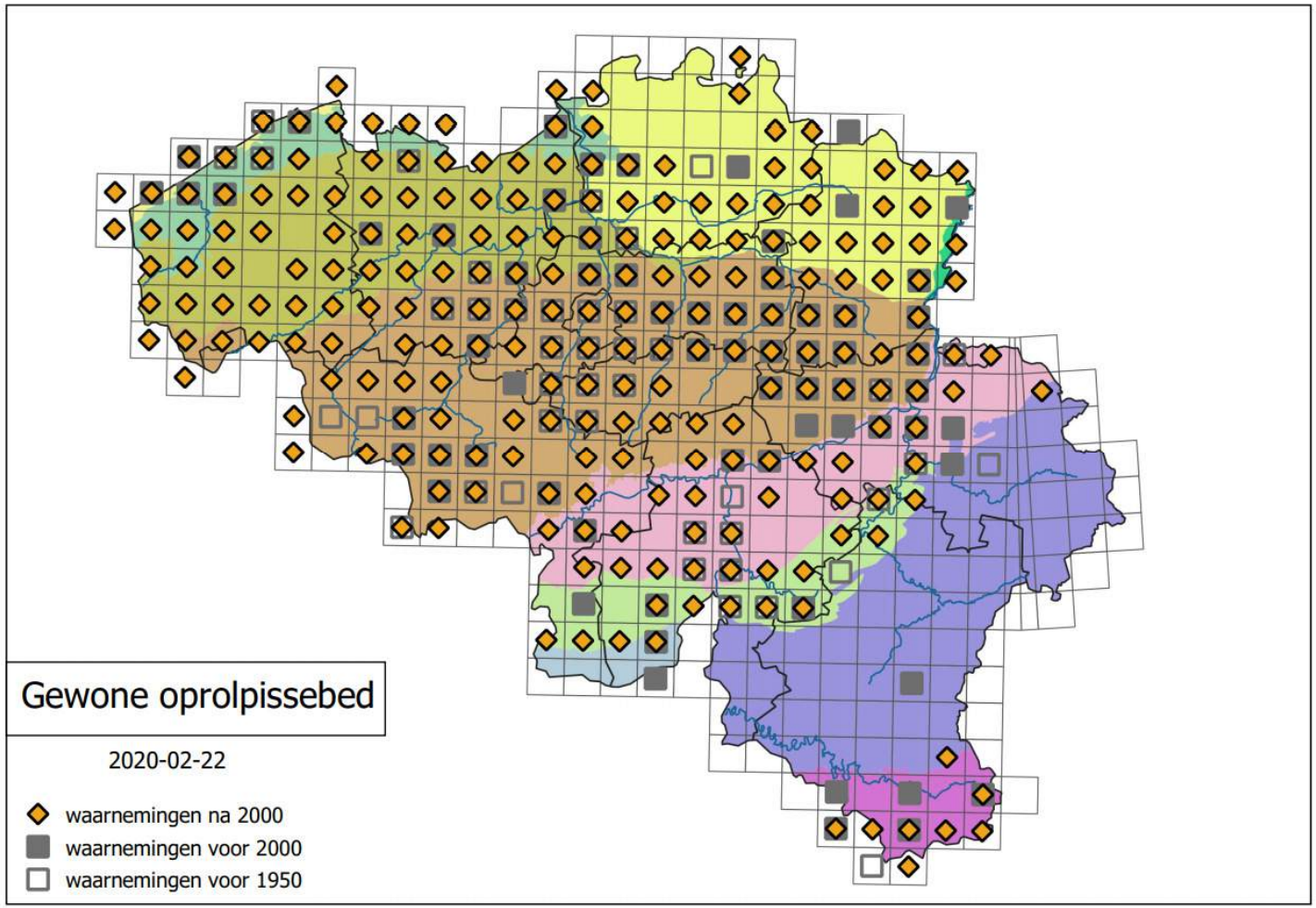
The terrestrial isopods of Belgium



Porcellio spinicornis



Armadillidium vulgare



Step 3: Publishing data

Via GBIF

ZooKeys 1101: 57–69 (2022)
doi: 10.3897/zookeys.1101.65810
https://zookeys.pensoft.net

DATA PAPER

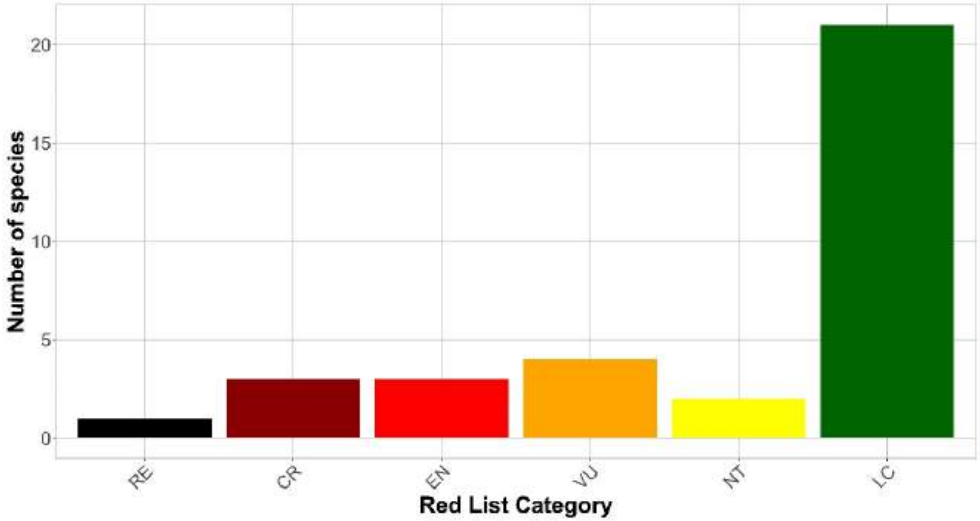
A peer-reviewed open-access journal
ZooKeys
Launched to accelerate biodiversity research

Inventory of the terrestrial isopods in Belgium (2011–2020)

Pepijn Boeraeve[1], Gert Arijs[1], Stijn Segers[1], Dimitri Brosens[2,3], Peter Desmet[2], Kristijn Swinnen[4], Jorg Lambrechts[4], Pallieter De Smedt[1,5]

Step 4: Red List Flanders

11/34 species endangered



Journal of Insect Conservation
https://doi.org/10.1007/s10841-022-00390-7

ORIGINAL PAPER

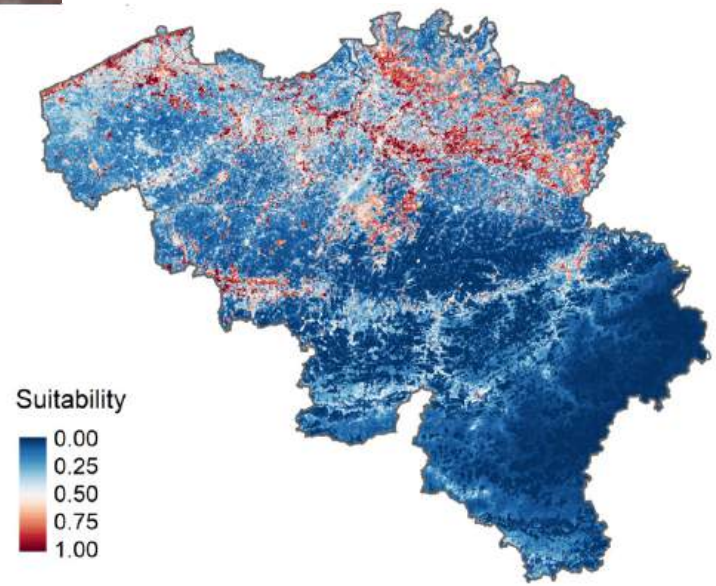
Check for updates

A Red List of terrestrial isopods (Isopoda: Oniscidea) in Flanders (northern Belgium) and its implications for conservation

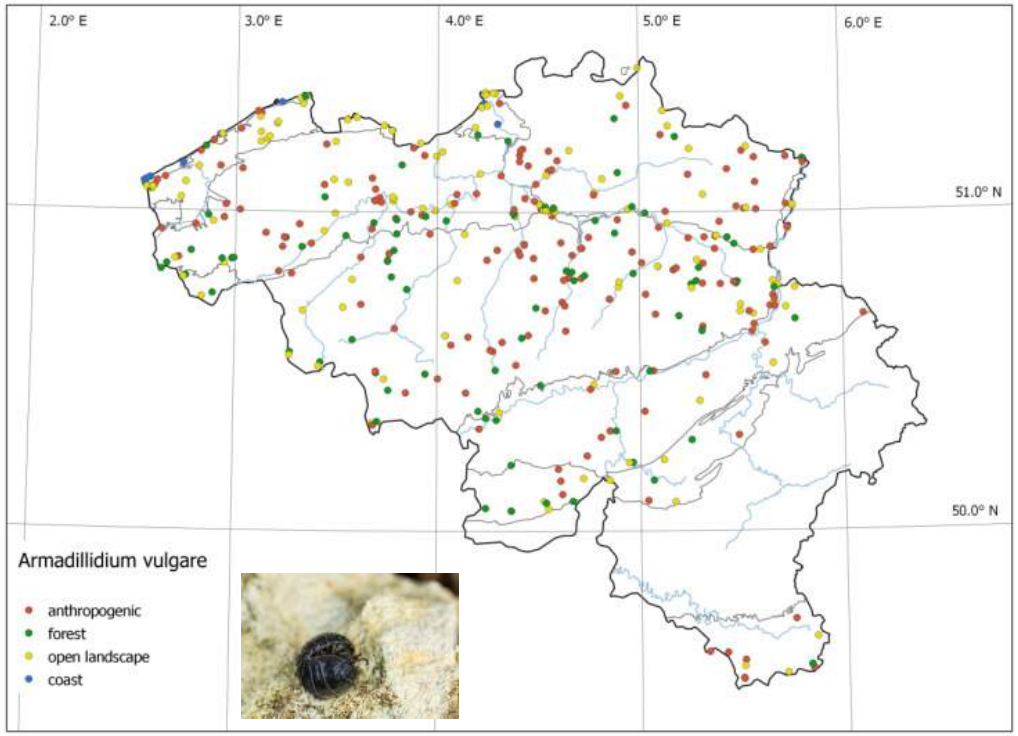
Pallieter De Smedt[1,2] · Pepijn Boeraeve[2] · Gert Arijs[2] · Stijn Segers[2] · Jorg Lambrechts[3] · Dirk Maes[4,5]

Next steps:
This is where the modelling starts…

Haplphthalmus danicus © Spinicornis - Gert Arijs



Species distribution modelling to predict species distribution



Distribution of *Armadillidium vulgare* per habitat type in Belgium. From Boeraeve et al. 2021 BJE: 1-95

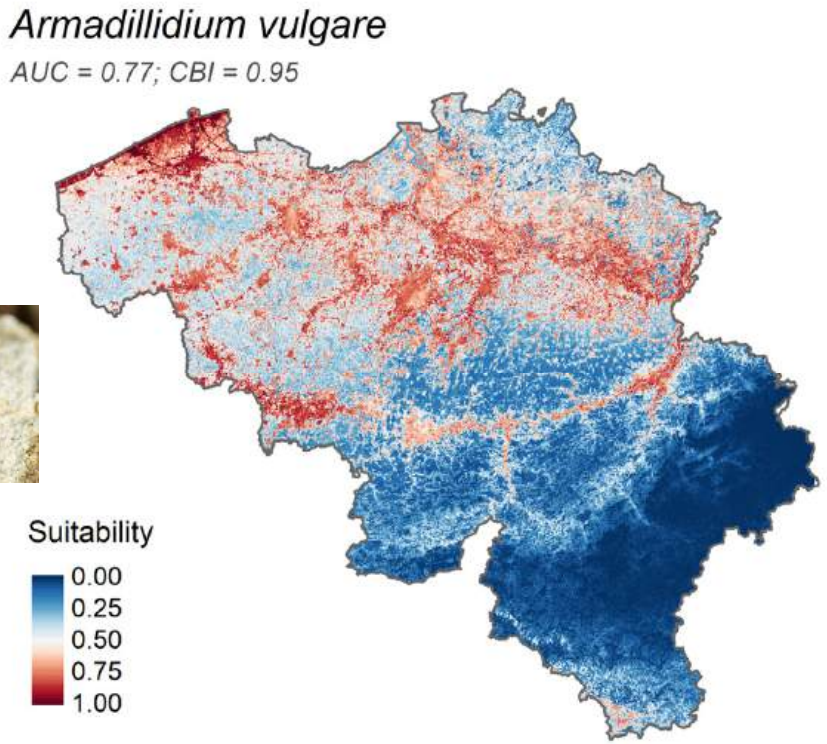
Modelling based on relevant environmental variables from global databases:

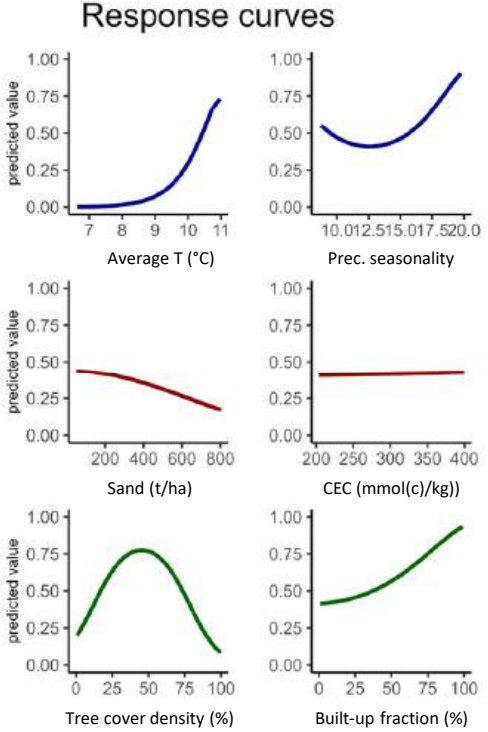
- Macroclimate via CHELSA version 2.1
- Edaphic variables from SoilGrids database
- Land cover variables from Copernicus Global Land Cover Layers

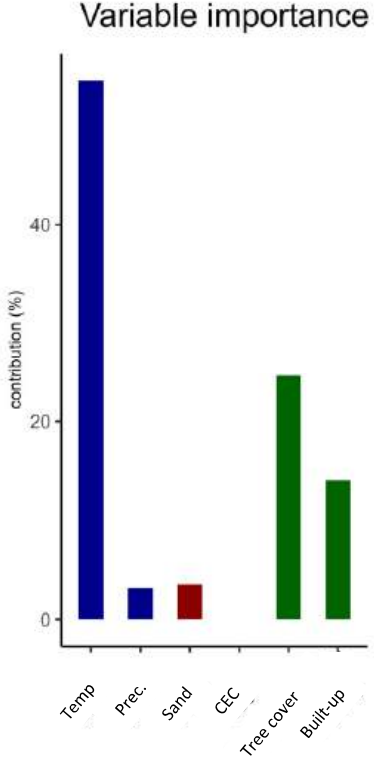
Selection of most relevant variables to capture the variation in Belgium via PCA-axes

Species distribution models

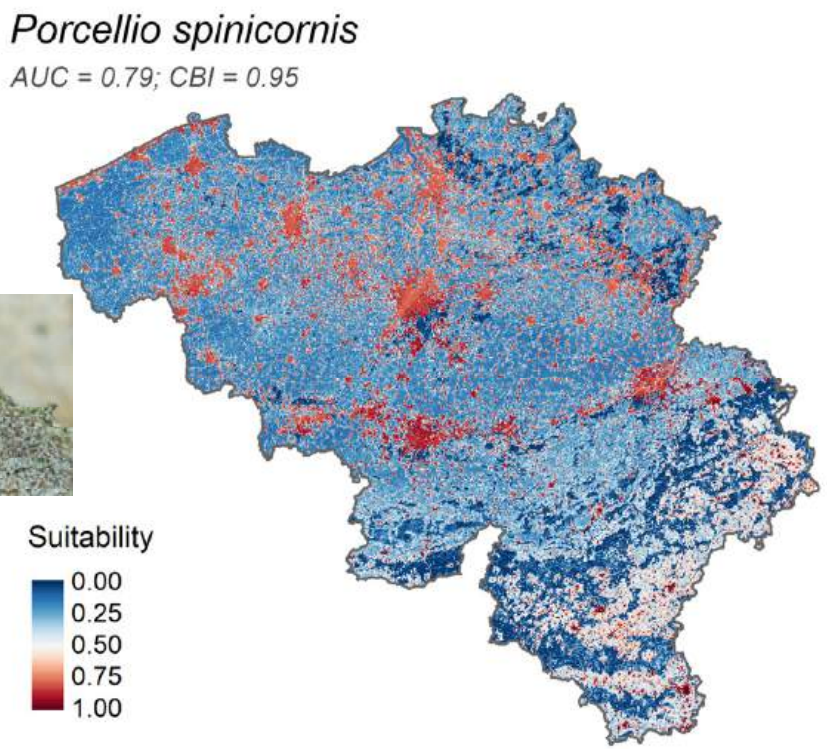
Dr. Pieter Sanczuk

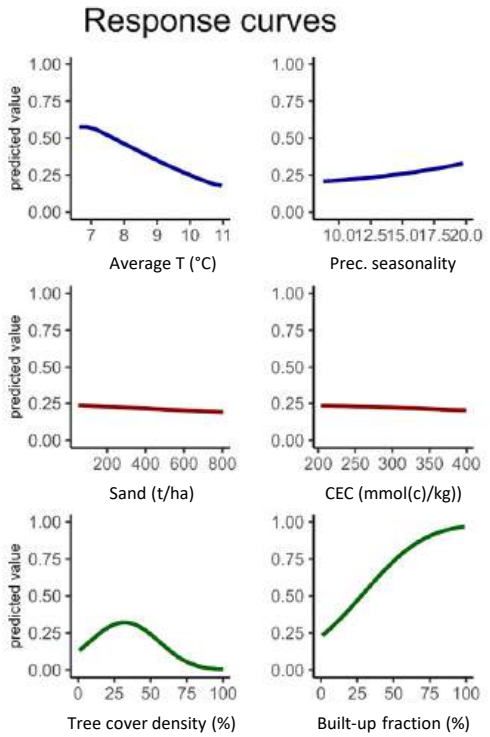


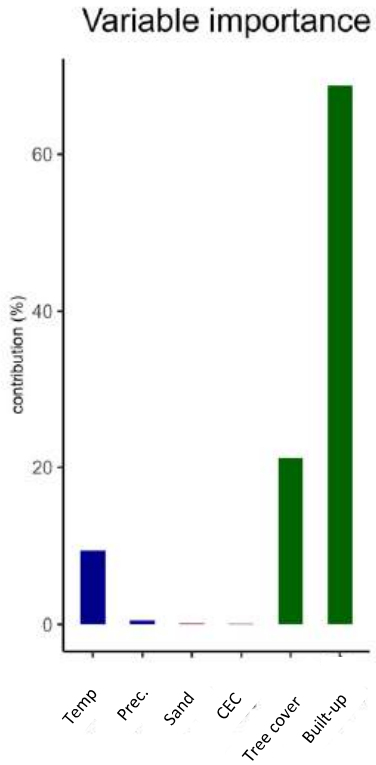




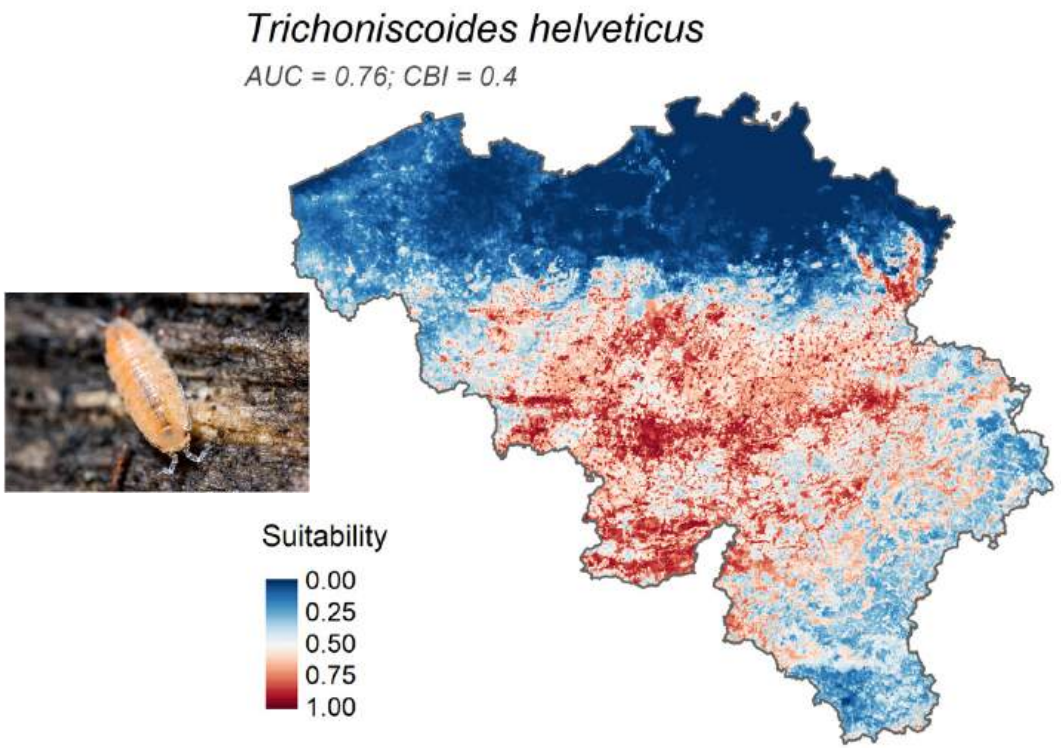
Species distribution models

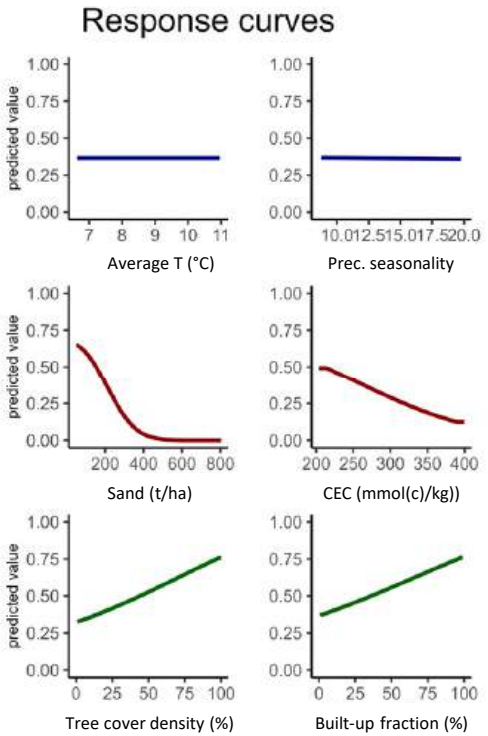


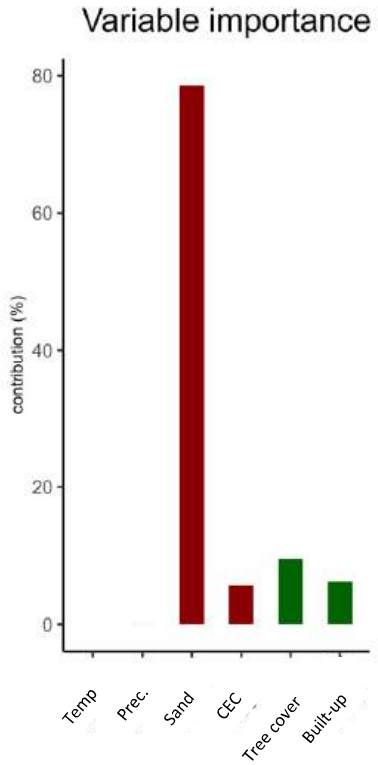




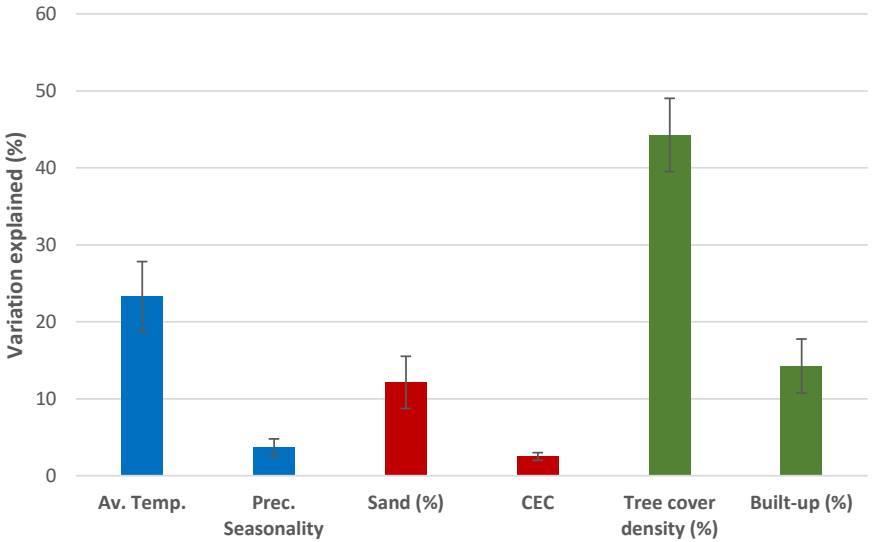
Species distribution models



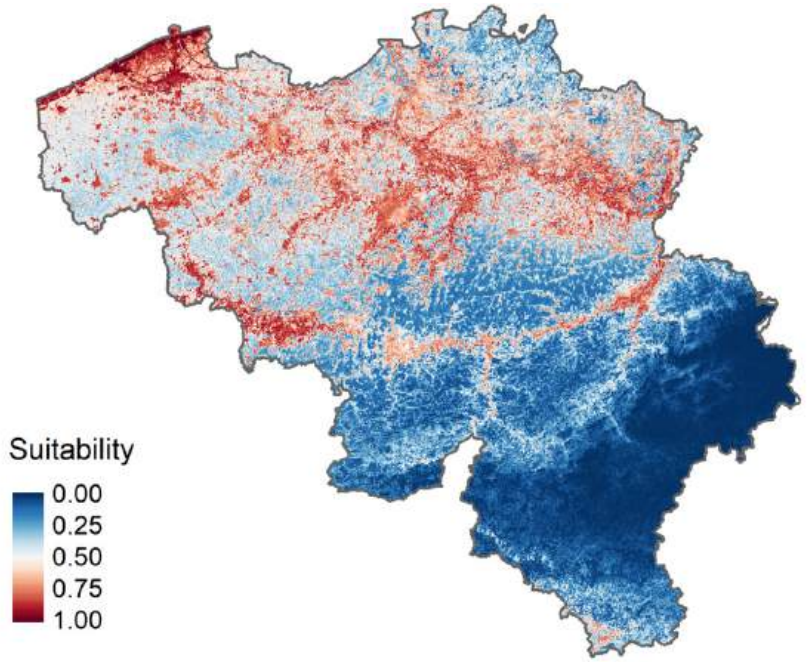




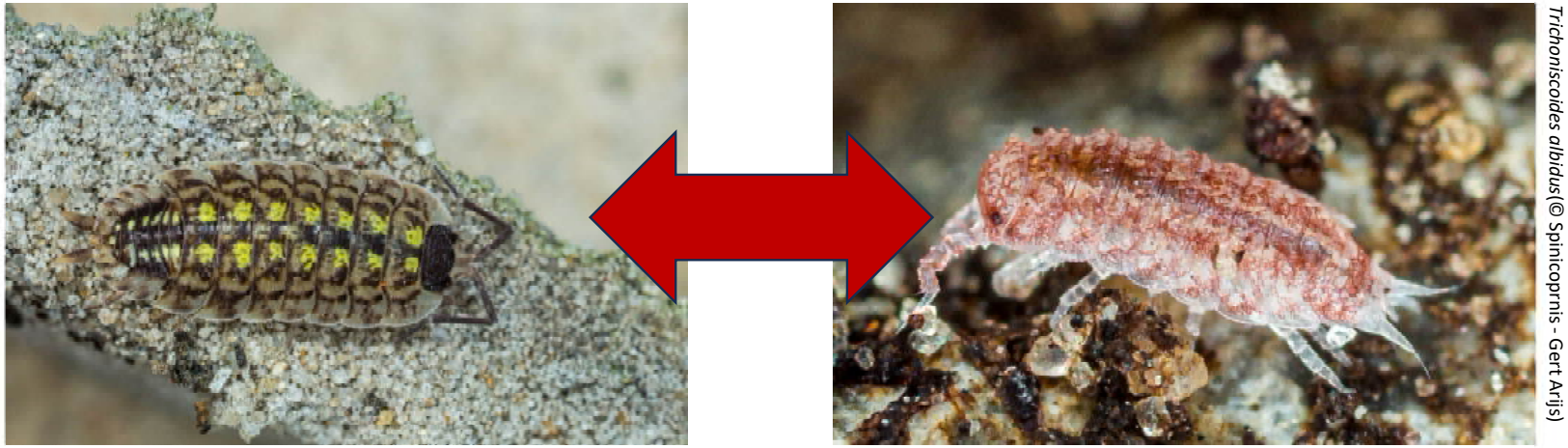
Variable importance across woodlouse species



Average explained variation (± SE) of the SDM's of the 26 most common (> 10 observations) species in Belgium



Species traits to understand distribution and ecosystem functioning: The need to measure traits

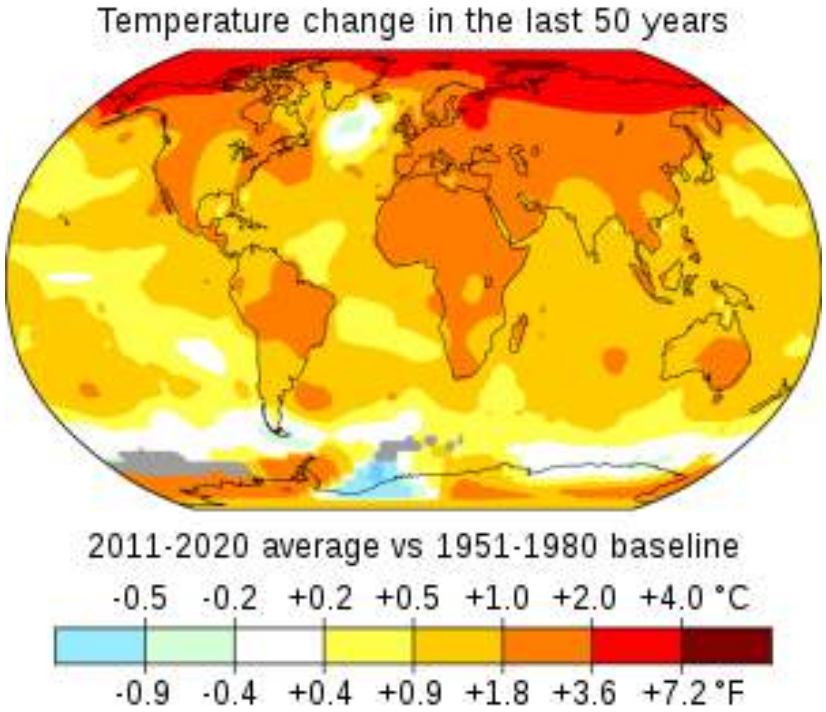


Porcellio spinicornis(© Spinicoprnis - Gert Arijs)

Trichoniscoides albidus(© Spinicoprnis - Gert Arijs)

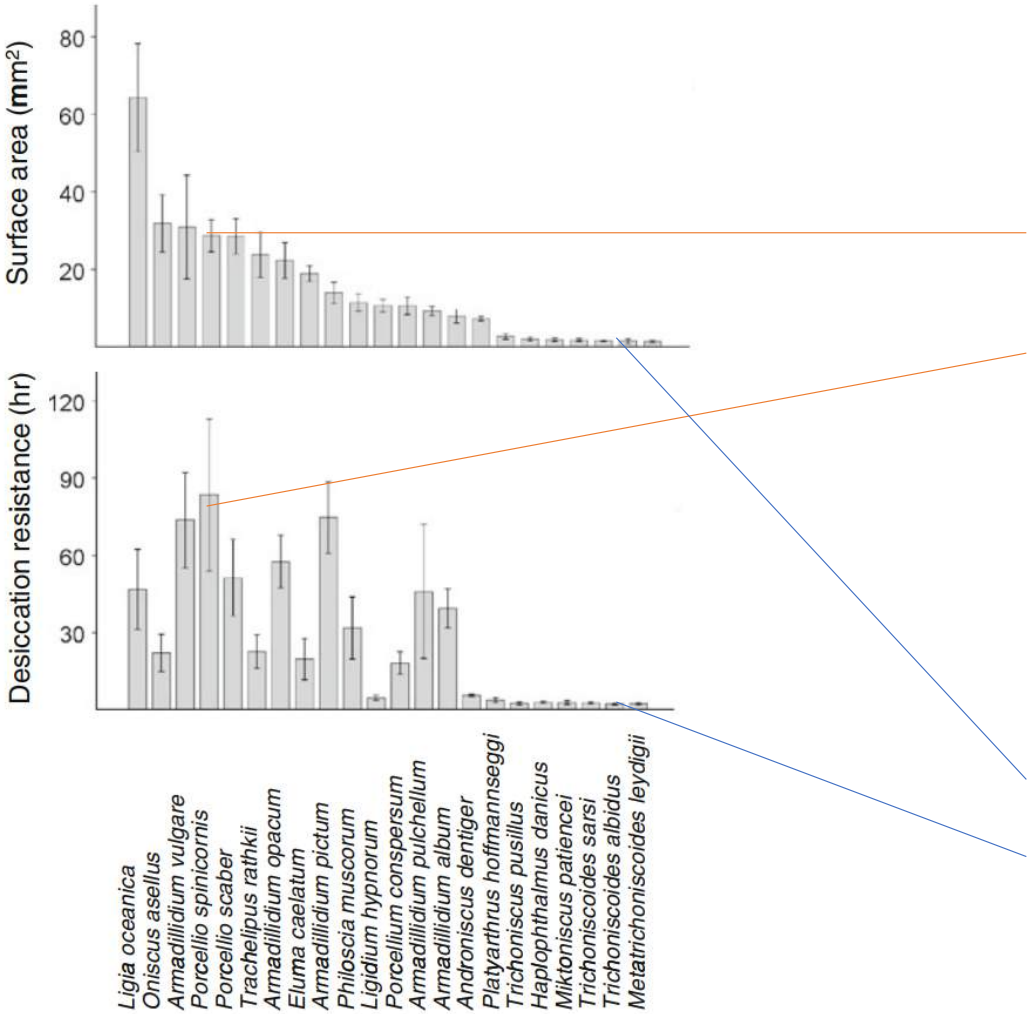
Collect species traits to predict how distribution will change in changing ecosystems

Prof. Matty Berg, VU Amsterdam



Measuring desiccation resistance

Large variation in drought resistance between species



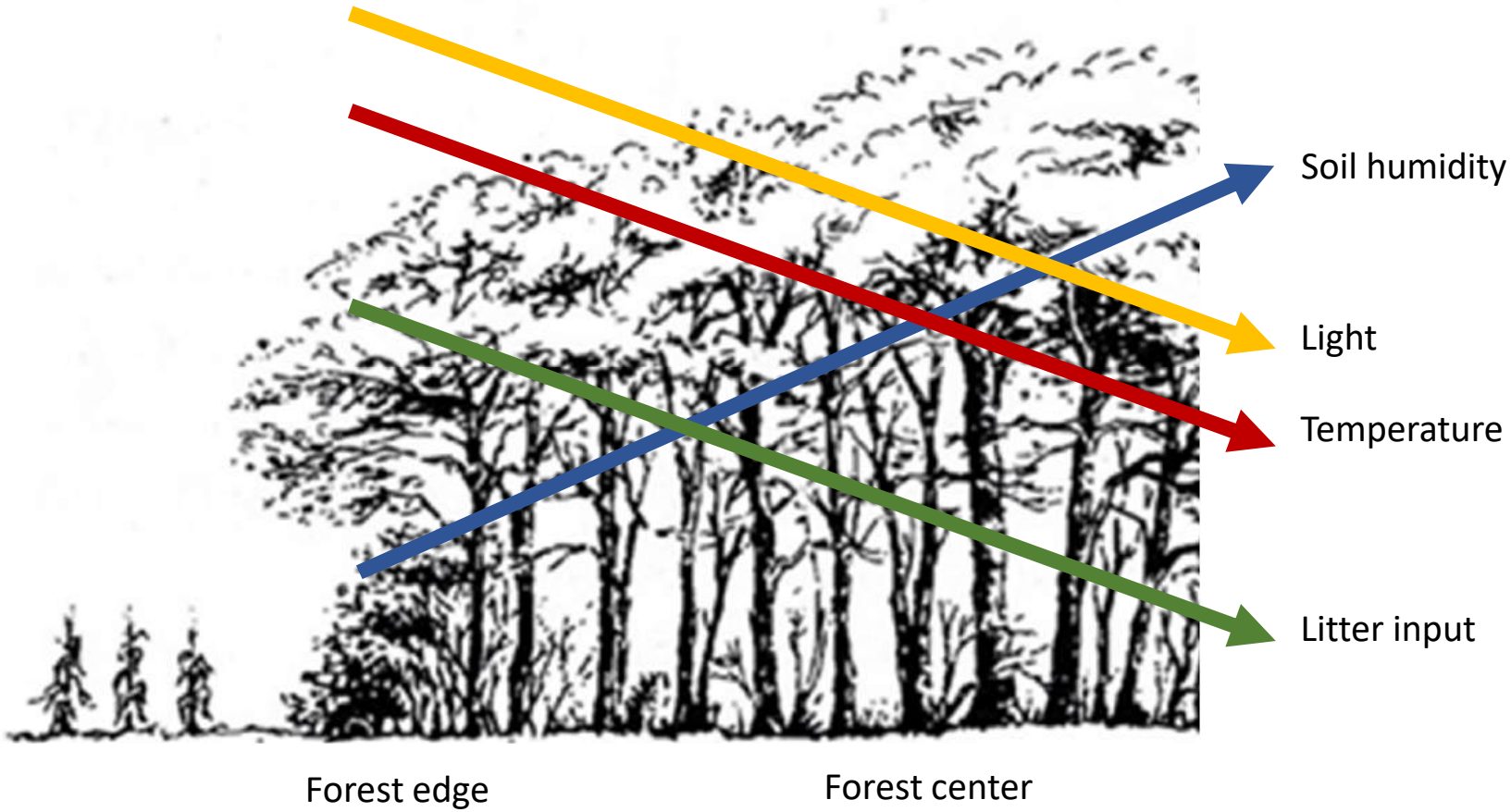
Dias et al. 2013, Oecologia 172: 667-677

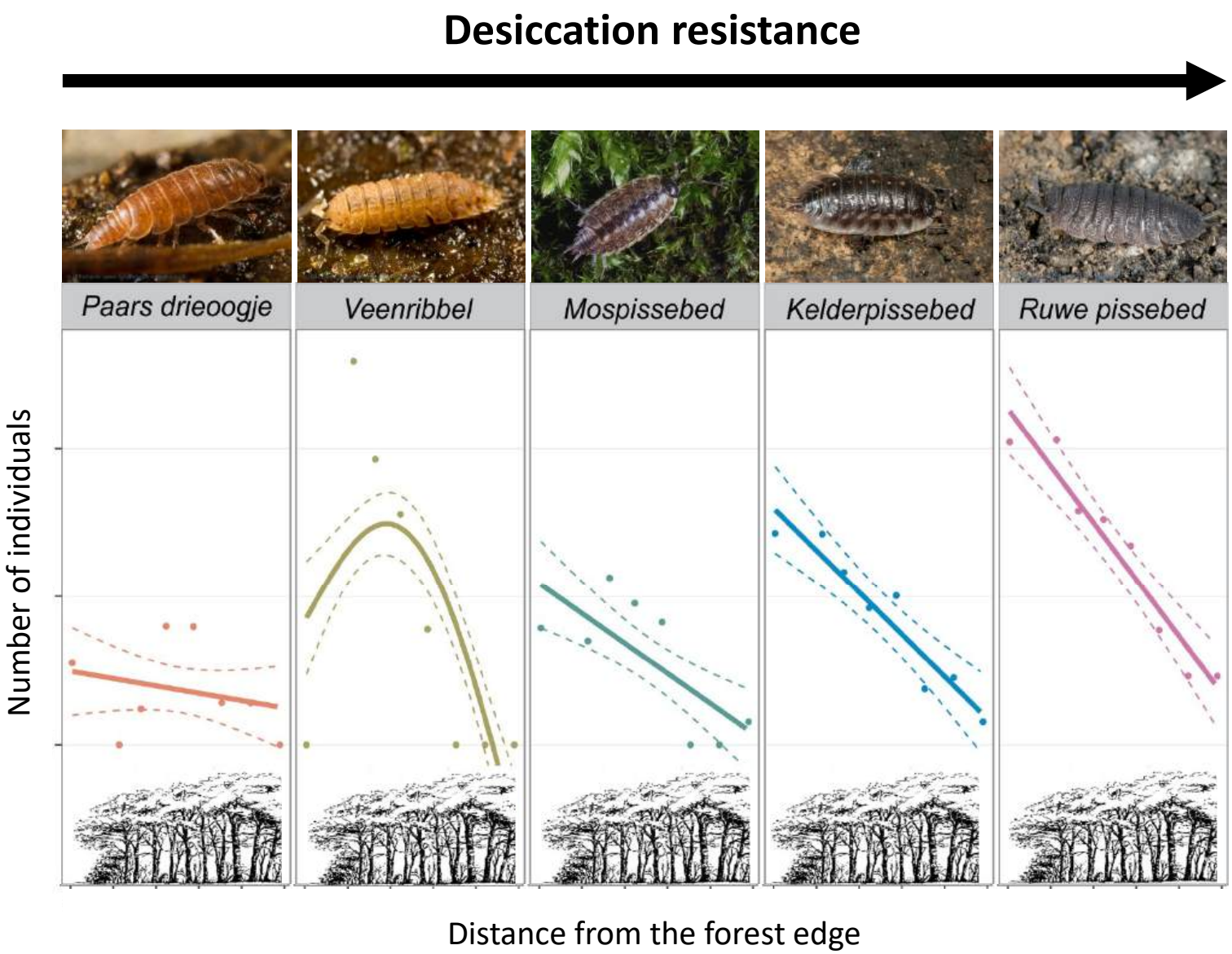
Porcellio spinicornis(© Spinicoprnis - Gert Arijs)

Trichoniscoides albidus(© Spinicoprnis - Gert Arijs)

As an example:

Desiccation resistance determines soil fauna responses to forest edges

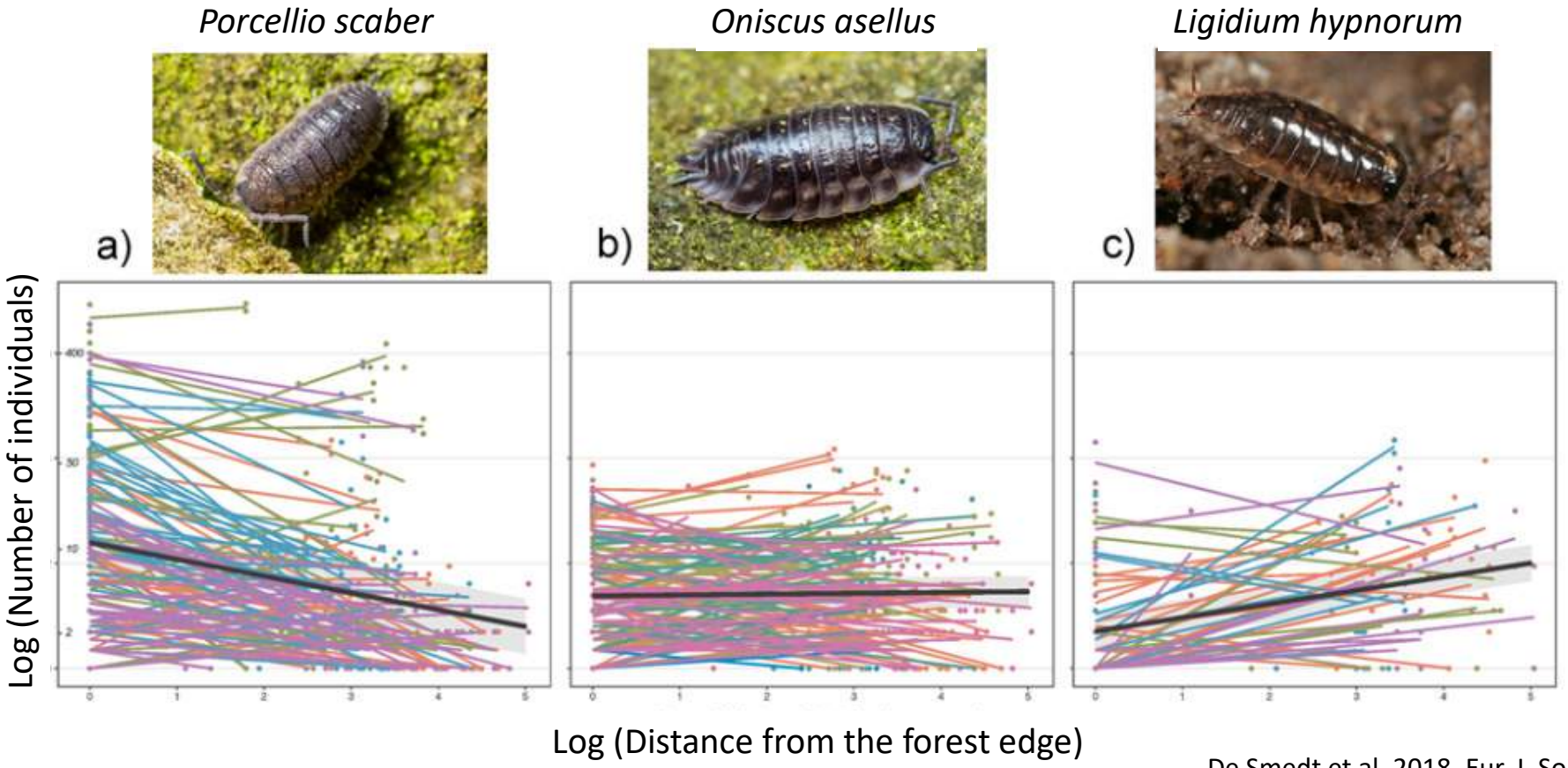




Forest edges

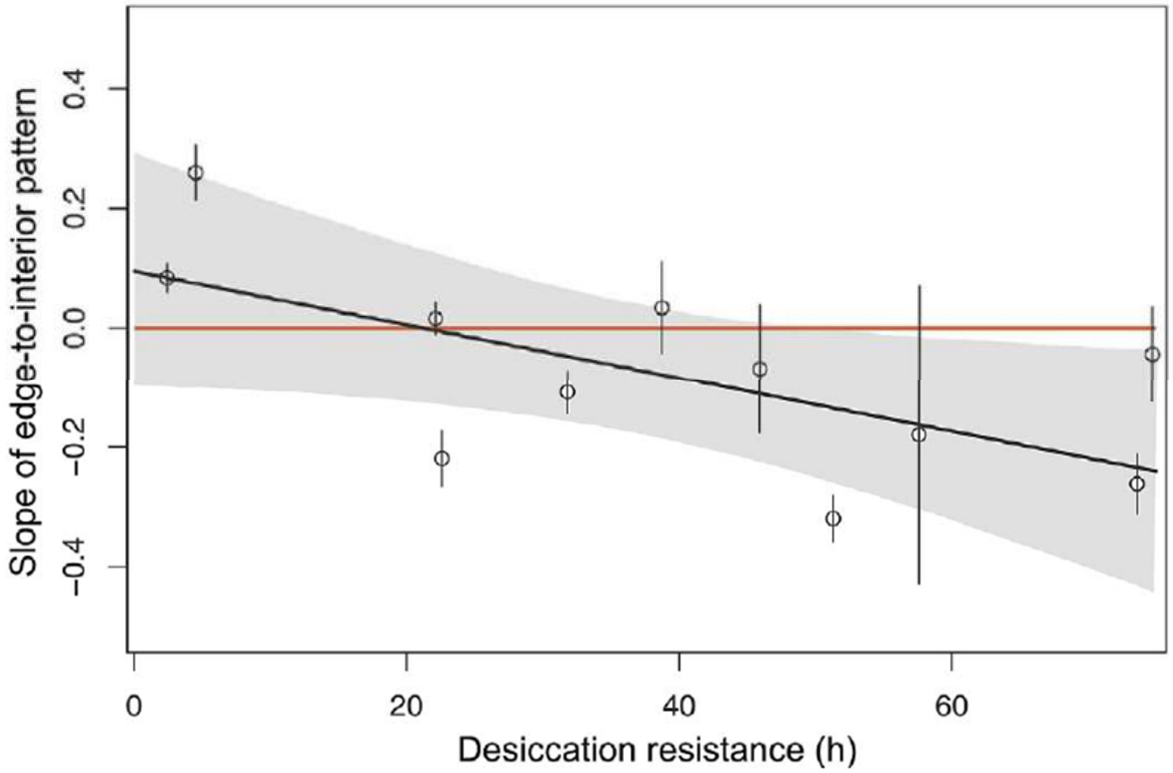
De Smedt et al. 2016, ICDIV 9: 456-469

Forest edges across Europe

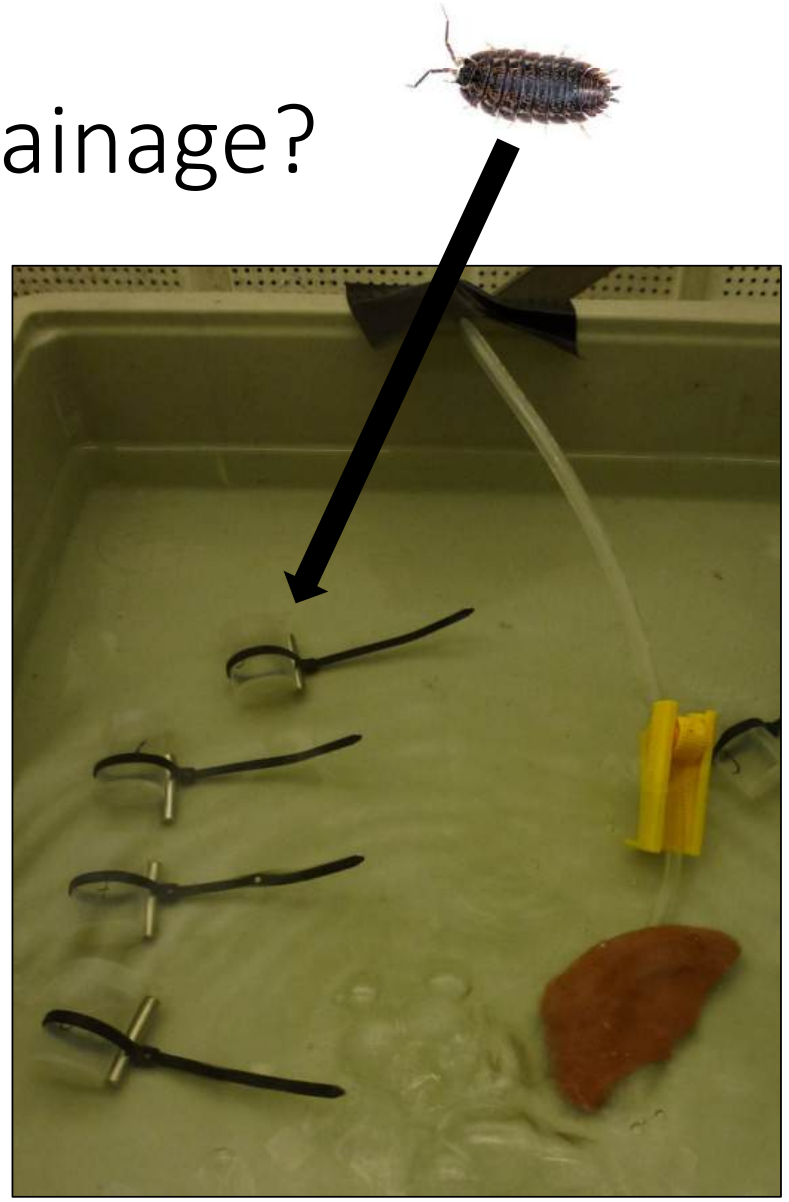


De Smedt et al. 2018, Eur. J. Soil .Biol. 85: 1-3

One trait to predict small scale distribution!



Predict the effect of floods or drainage?



Inundation resistance

1.	Forest specialist	*Armadillidium pictum*	19h
2.	Coastal species	*Armadillidium album*	87h
3.	Soil species from ant nests	*Platyarthrus hoffmannseggii*	290h = 12 days
4.	River edge species	*Hyloniscus riparius*	424h = 18 days

1

2

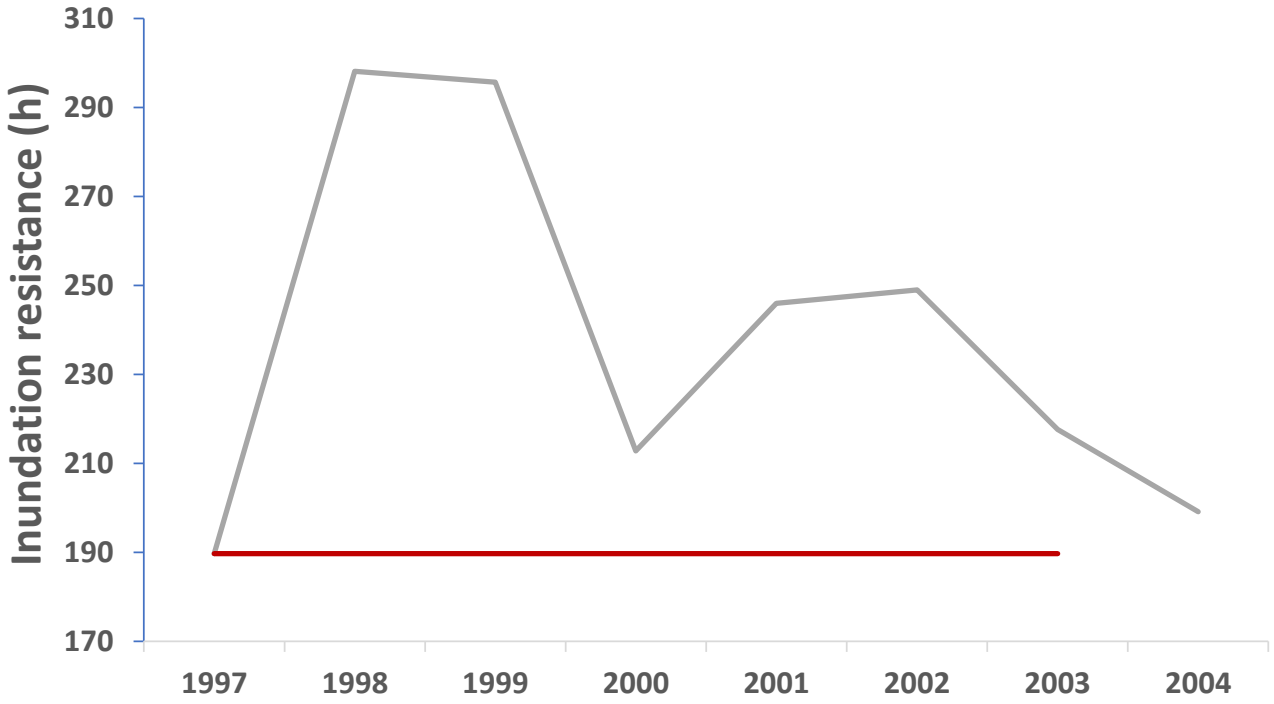
3

4

Inundation resistance to predict soil fauna recovery after floods

Hyloniscus riparius (© Spinicoprnis - Gert Arijs)

Community weighted mean inundation resistance of terrestrial isopods after an exceptional summer flood in 1998 in a river valley in the Czech Republic



Community data from Tuf et al. 2008 *Peckiana* 5: 65-75.

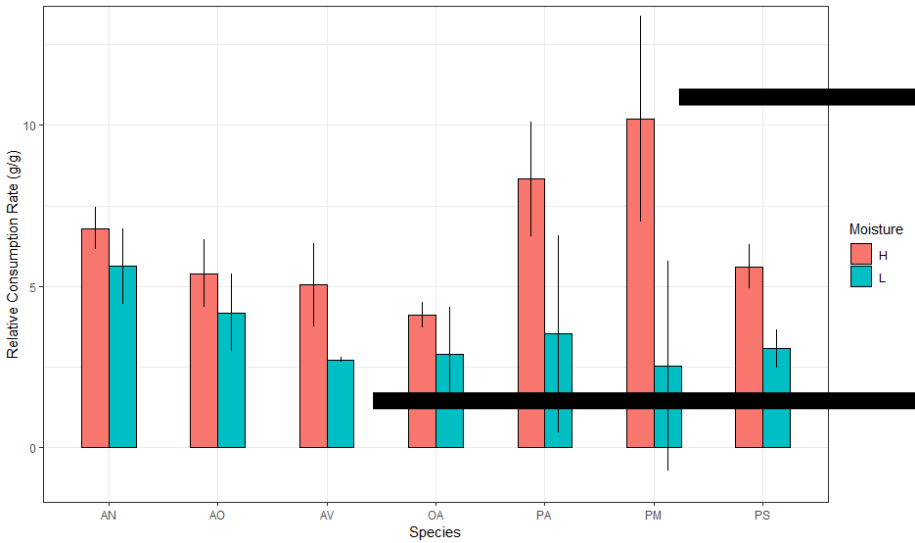
Coupling of response traits to effect traits

- Response traits: Species response to environmental gradients
- Effect traits: Species traits that actually affect ecosystem functioning

Example effect traits:
Differences in species consumption

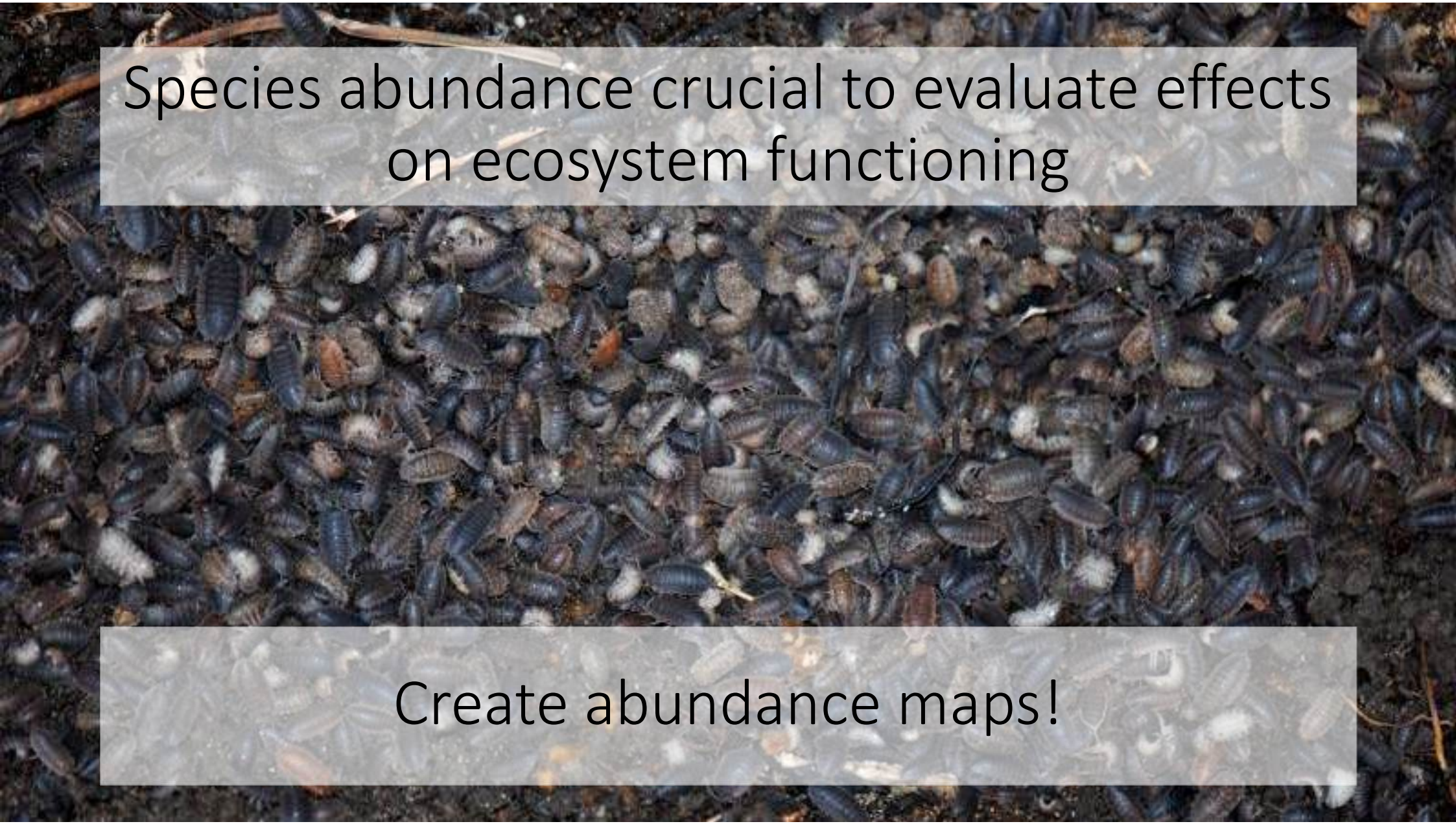
Test consumption of species under controlled lab conditions.

Relative consumption rate per species



Philoscia muscorum (© Spinicoprnis - Gert Arijs)

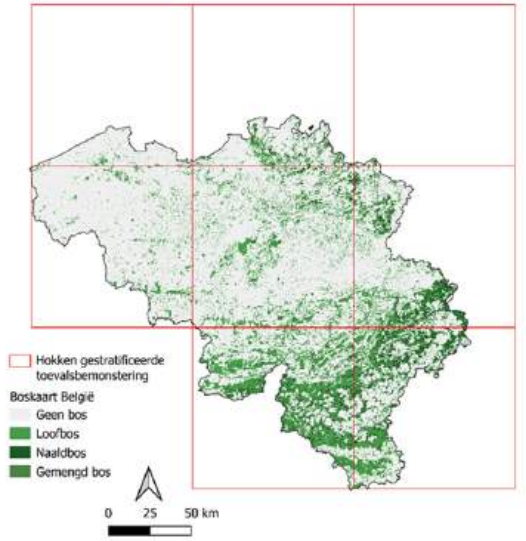
Armadillidium vulgare (© Spinicoprnis - Gert Arijs)


Species abundance crucial to evaluate effects on ecosystem functioning
Create abundance maps!

Species abundance modelling to assess ecosystem functioning?

MSc. Fien Dauwe

- Sampling in forests
- Stratified random sampling in 120 locations



Abundance modelling in Belgium: Methods

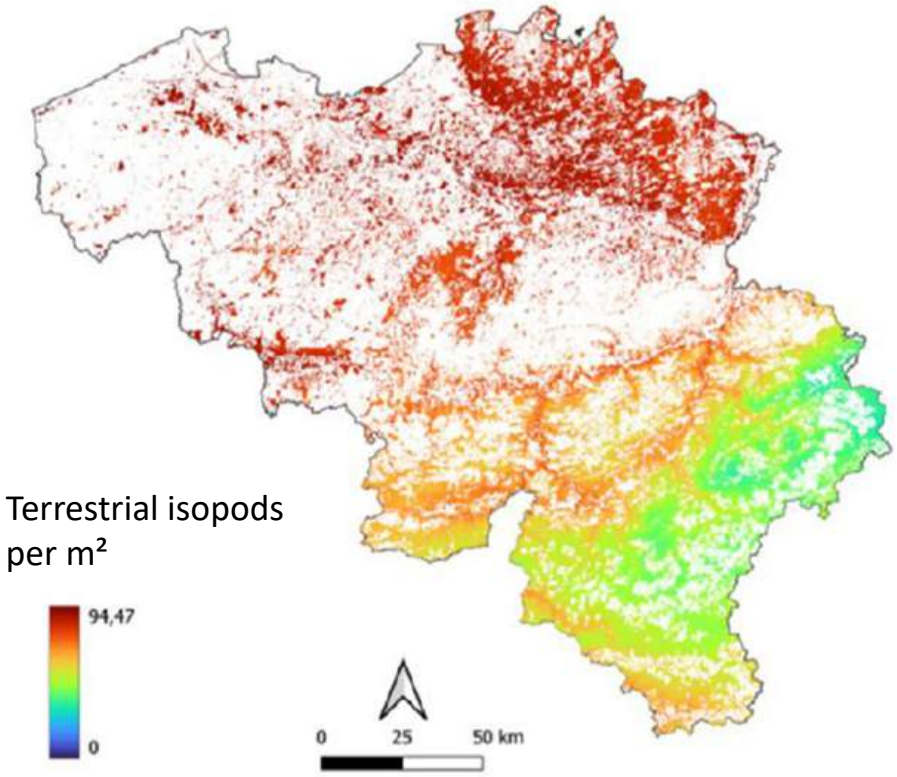
Abundance terrestrial of isopods in forests in Belgium

Local driving variables:

➔ pH, thickness litter layer, litter quality, distance from forest edge

Macro-scale:

➔ Temperature and soil properties



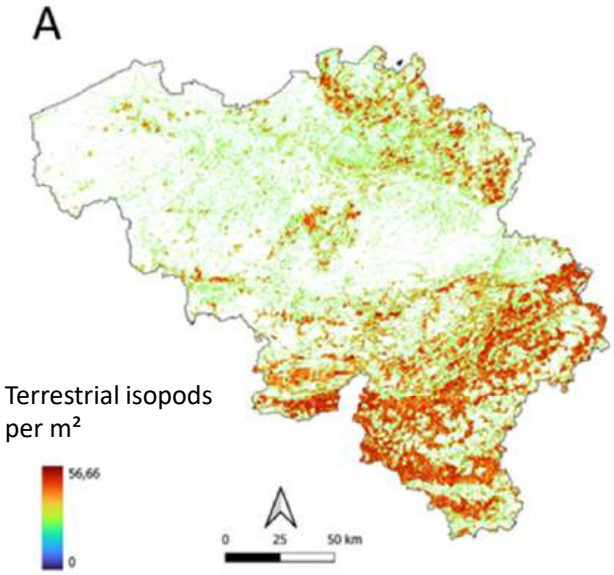
Species-specific patterns

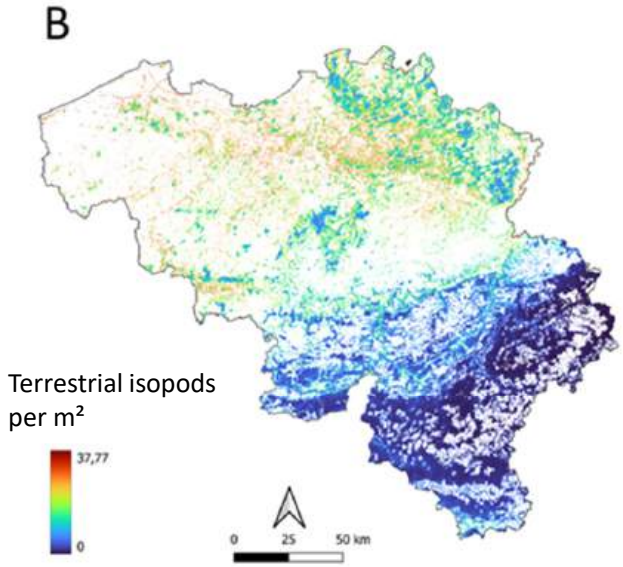
A. Trichoniscus pusillus

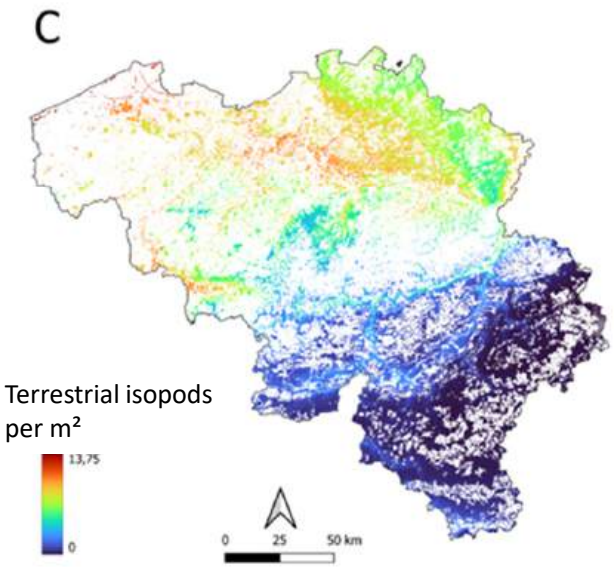
B. *Philoscia muscorum*

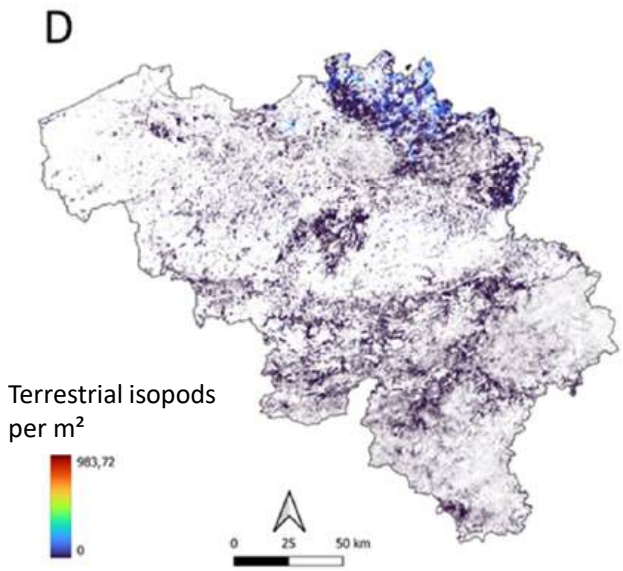
C. *Oniscus asellus*

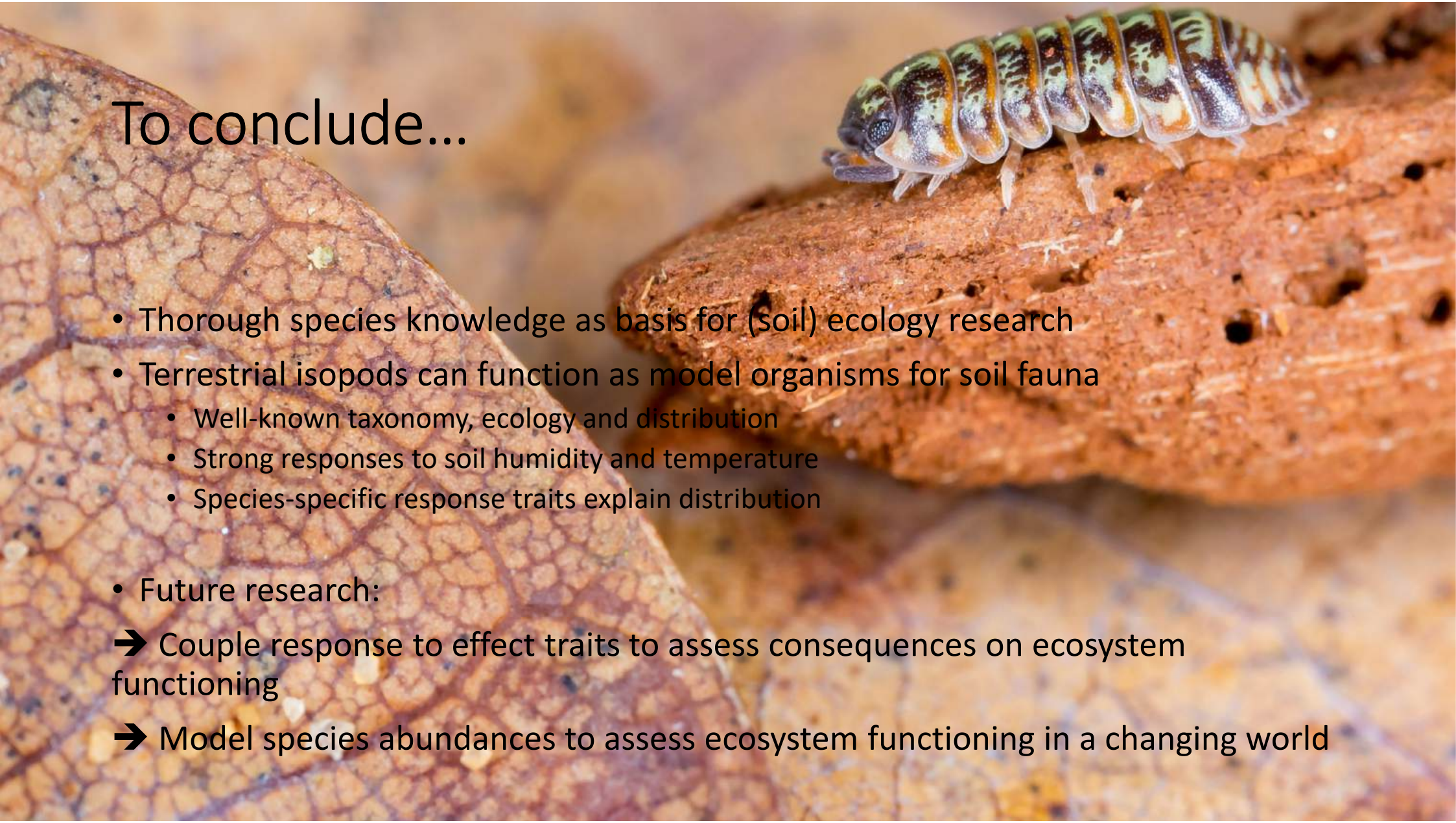
D. *Porcellio scaber*











To conclude…

- Thorough species knowledge as basis for (soil) ecology research
- Terrestrial isopods can function as model organisms for soil fauna
  - Well-known taxonomy, ecology and distribution
  - Strong responses to soil humidity and temperature
  - Species-specific response traits explain distribution

- Future research:

➔ Couple response to effect traits to assess consequences on ecosystem functioning

➔ Model species abundances to assess ecosystem functioning in a changing world

Acknowledgements

Spinicornis

Prof. Kris Verheyen

Prof. Lander Baeten

Prof. Matty P. Berg

Dr. Pieter Sanczuk

MSc. Fien Dauwe

OniscidBase

Global Woodlice Database

A global database to boost terrestrial isopod research

Oniscidbase.com (Under construction)

Call paper: Gongalsky, De Smedt et al. (in press) *Soil Organisms*

Goal:

1. Create a platform for literature and checklists both regional and worldwide
2. Collect presence/absence data to create large scale distribution maps of species presence and diversity
3. Collect biomass data to assess the importance of terrestrial isopods worldwide

OniscidBase
Global Woodlice Database

Looking for regional/country-level experts

Please let us know if you want to contribute to the initiative

- Digitizing data
- Producing a country-level checklist
- Data curation
- …

Contact:

- Konstantin Gongalsky (Gongalsky@gmail.com)
- Pallieter De Smedt (Pallieter.desmedt@ugent.be)

OniscidBase
Global Woodlice Database

Questions?

Contact:
Pallieter De Smedt
Pallieter.desmedt@ugent.be

Veenribbel (*Haplphthalmus danicus*)
Picture: Spinicornis - Gert Arijs

UNIVERSITEIT GENT
ForNa Lab
Spinicornis landpissebedden van België