

EcoFINDERS

Ecological Function and Biodiversity Indicators in European Soils



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Launch of the Global Soil Biodiversity Atlas in France,
28th November 2016

EU Soil Thematic Strategy

In 2010, EC considered that for establishing Soil Thematic strategy, further knowledge was necessary on:

- soil biodiversity
- functions and resulting ecosystem services supported by this diversity

This requires:

- the development of standardised methods for the characterisation of soil biodiversity
- the establishment of policy-relevant and cost-effective indicators for biological diversity

Finally, convincing policy makers of the relevance of such Strategy also needs:

- the assessment of the economic value of the ecosystem services provided.

➡ **ENV.2010.2.1.4.4 Increasing the understanding of the role of soil biodiversity in ecosystem functioning**

EcoFINDERS

FINAL MEETING
1 - 2 December 2014
INRA Dijon, France

90 - DIJON Place Darcy

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FF d'AGRICULTURE de FRANCE
 AGRICULTURE ■ ALIMENTATION ■ ENVIRONNEMENT

Commission européenne

EcoFINDERS

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General Information

- 23 partners

INRA (F), CEH (UK), AU (DK), ECT (DE), UCO (DE), IT (F), JRC (BE), LU (SE), NIOO (NL), RIVM (NL), SLU (SE), Teagasc (IRL), IMAR (P) UNITO (IT), NUID UCD (IRL), UNIABDN (UK), WU (NL), ALTERRA-DLO (NL), CAU (China), UL (SVN), UNISS (IT), BC3 (ES), SRUC (UK), IFE SAS (SK), UOM (UK)

- 12 European countries: D, DK, F, I, IRL, NL, P, S, SK, SLO, UK, ES

- Non-European country: China

- Total EC contribution: 6 999 930 €

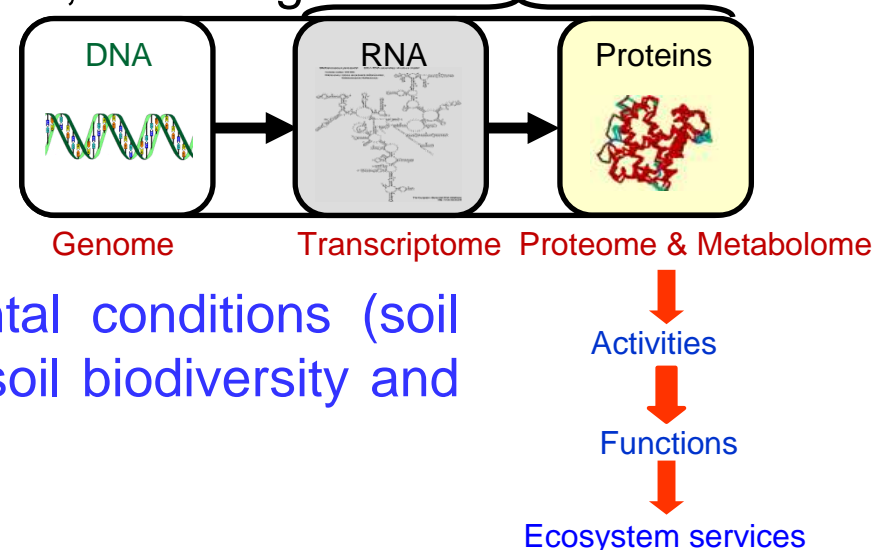
- Period: January 2011 – December 2014



General Aims

- The strategic aim of EcoFINDERS was to provide the European Commission with necessary tools to design and implement soil strategies aimed at ensuring sustainable use of soils, including:
 - Environmental filters
 - Biodiversity
 - Expression of genetic potential

- Deciphering relations between soil biodiversity, activities, functions and ecosystem services



- Assessing the impact of environmental conditions (soil types, climatic zones, land uses) on soil biodiversity and relations biodiversity-activities
- Analysing the interactions between below- and above-ground in food web models and consequences for community and ecosystem stability
- Designing policy-relevant and cost-effective indicators for monitoring soil biodiversity and activity.

Major Achievements

- Development of Standard Operating Procedures (SOPs)
- Characterization of soil biodiversity across Europe
- Deciphering relations between soil biodiversity and functioning
- Identification of bioindicators of soil biodiversity and functioning

Standard Operating Procedures



■ Standardization of soil sampling and storage for microbial analyses

- ✓ Where, when and how to sample, number of replicates, sampling depth, use of composite samples, ...

<https://www.youtube.com/watch?v=k7BEInBXEc>



■ Optimization of DNA extraction

- ✓ allowing extraction of DNA from archaea, bacteria & fungi

OPEN ACCESS Freely available online

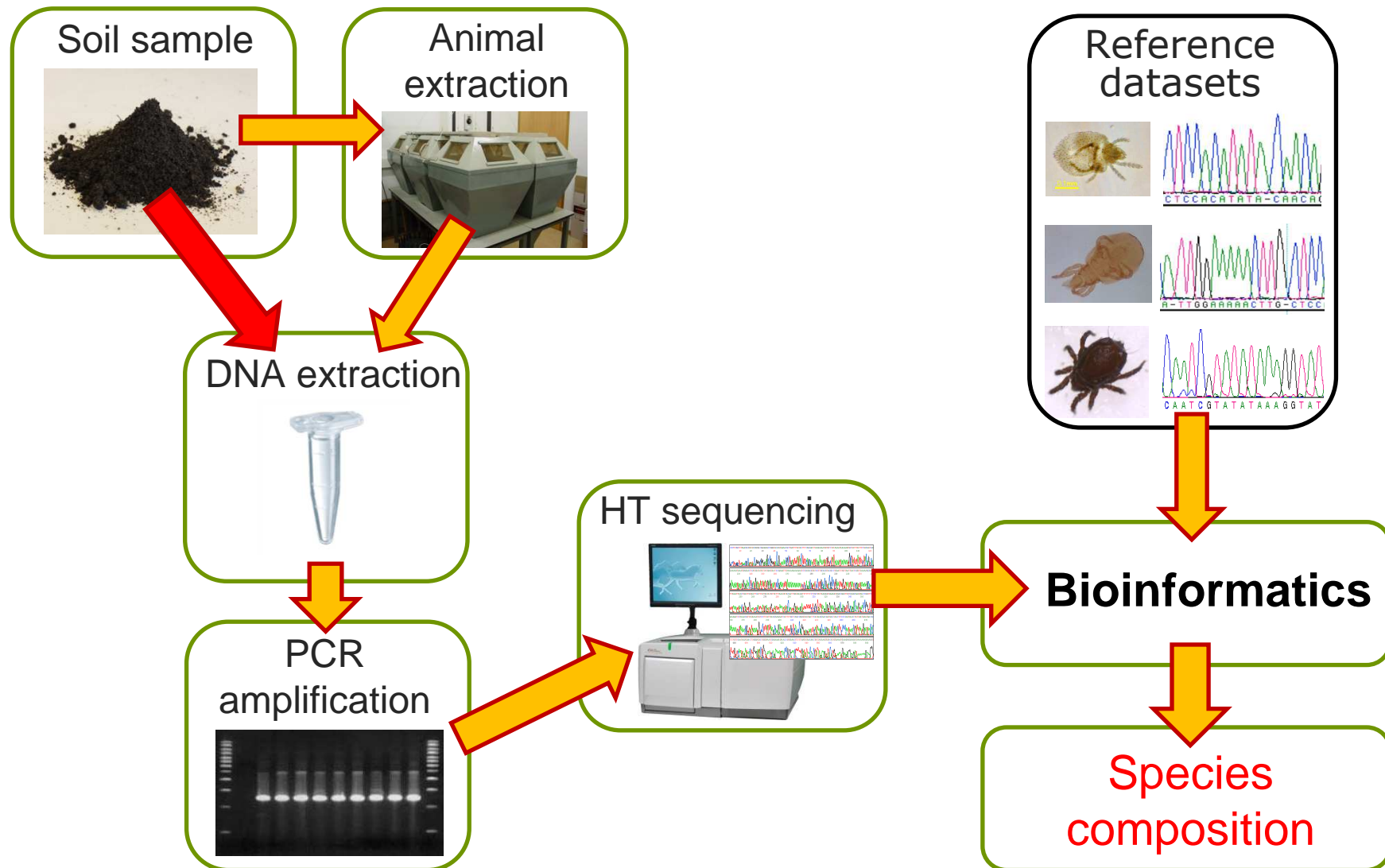
PLOS ONE

Evaluation of the ISO Standard 11063 DNA Extraction Procedure for Assessing Soil Microbial Abundance and Community Structure

Pierre Plassart^{1,2,3}, Sébastien Terrat^{2,3}, Bruce Thomson^{3,4}, Robert Griffiths³, Samuel Dequiedt², Mélanie Lelievre², Tiffanie Regnier², Virginie Nowak^{1,2}, Mark Bailey³, Philippe Lemanceau¹, Antonio Bispo⁴, Abad Chabbi⁵, Pierre-Alain Maron^{1,2}, Christophe Mougel^{1,2}, Lionel Ranjard^{1,2,*}



Progresses in faunal DNA metabarcoding



Courtesy of Arjen De Groot

Soil biodiversity across Europe

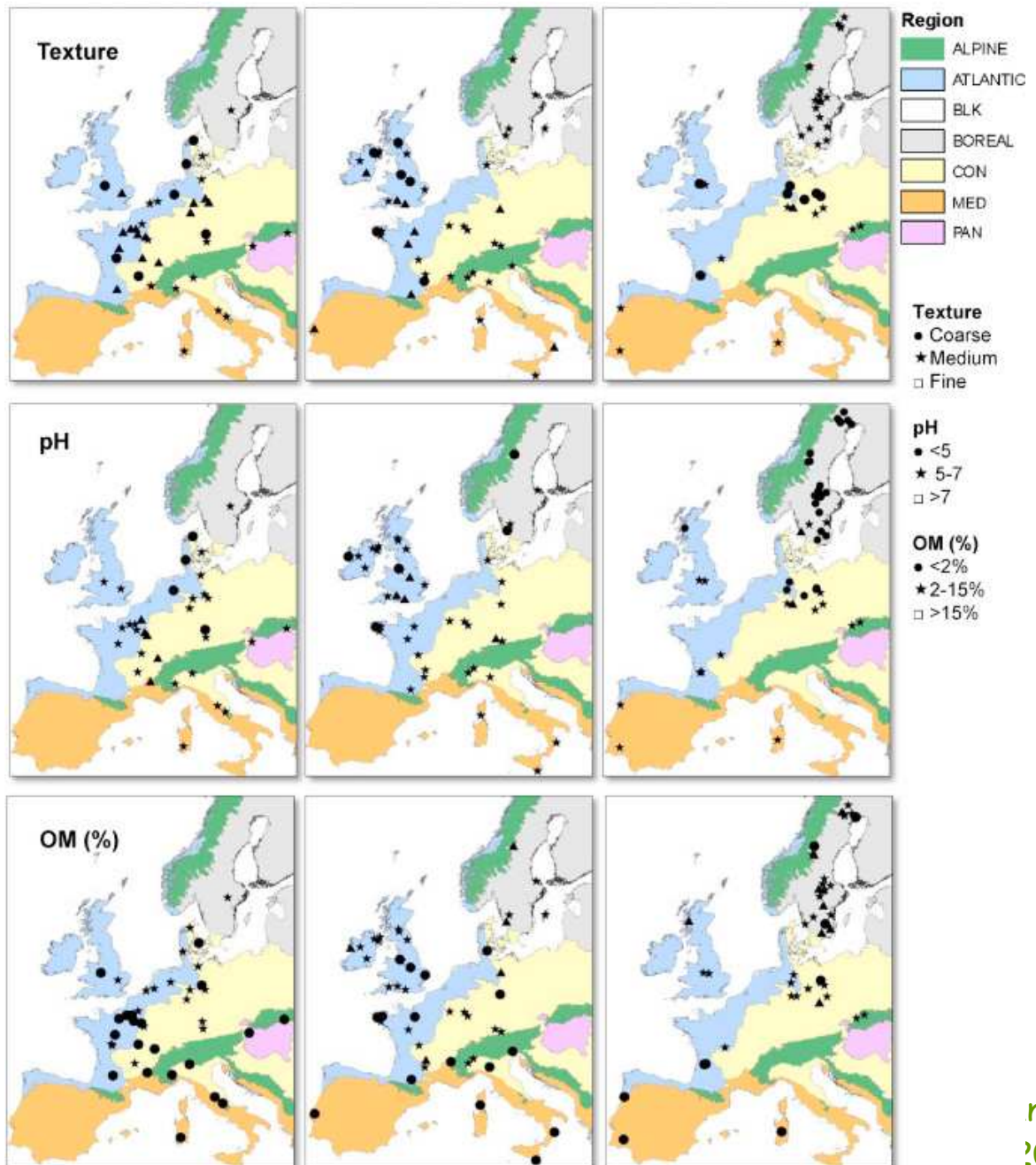
European Transect

Aims at assessing:

- ✓ Range of **biodiversity** variations according to soil types, climatic zones and land uses

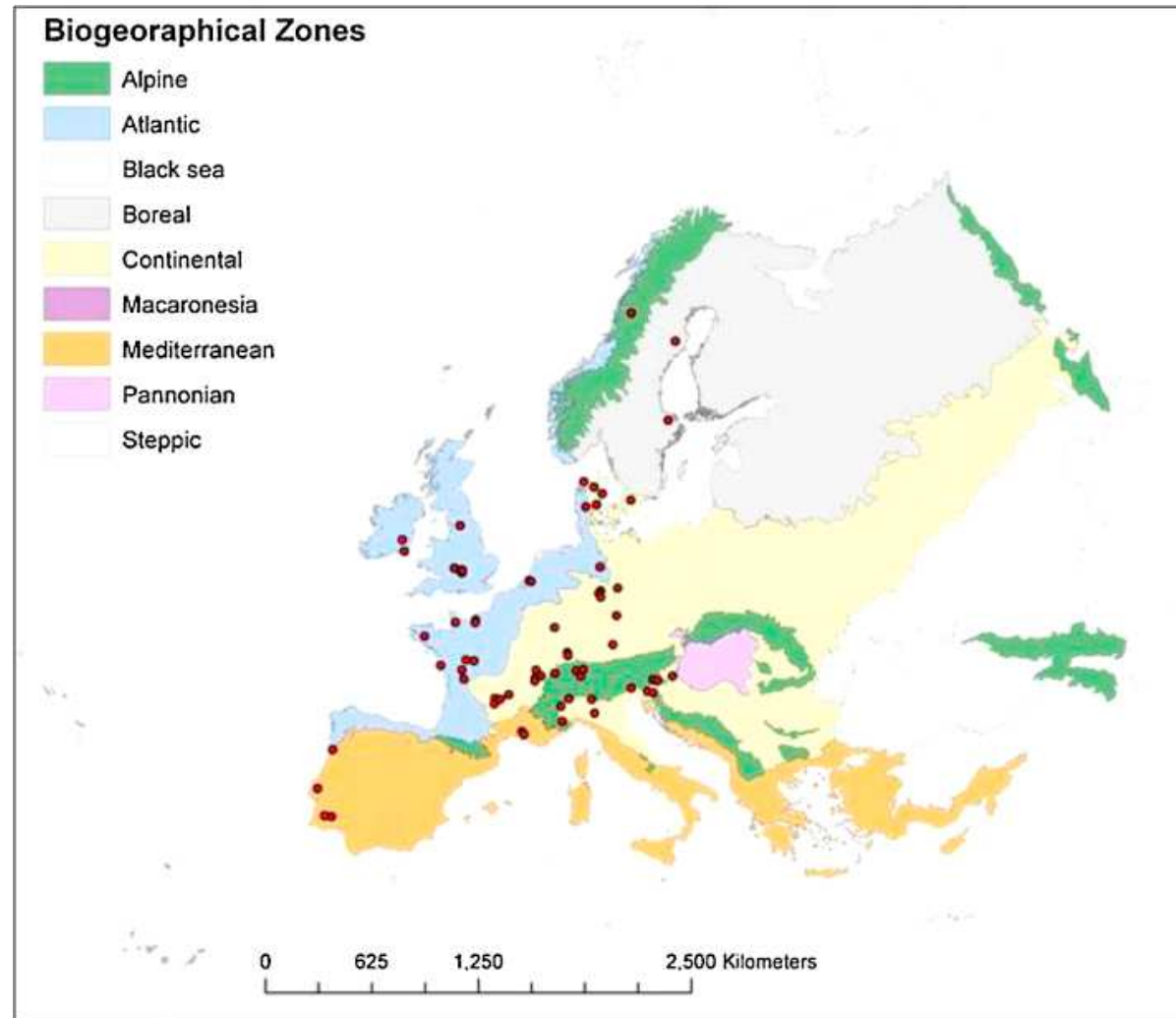
Strategy:

- ✓ Using data derived from the JRC, indicative values for Organic Carbon, Texture, pH
- ✓ Overlaid onto the LUCAS – landcover survey and sites identified as either forest, grass or tillage.
- ✓ Identification of a total of 85 sites across Europe to give a range of the above soil properties



Soil biodiversity across Europe

European Transect



Lemanceau et al.. 2016. Appl. Soil Ecol. 97:1-2.

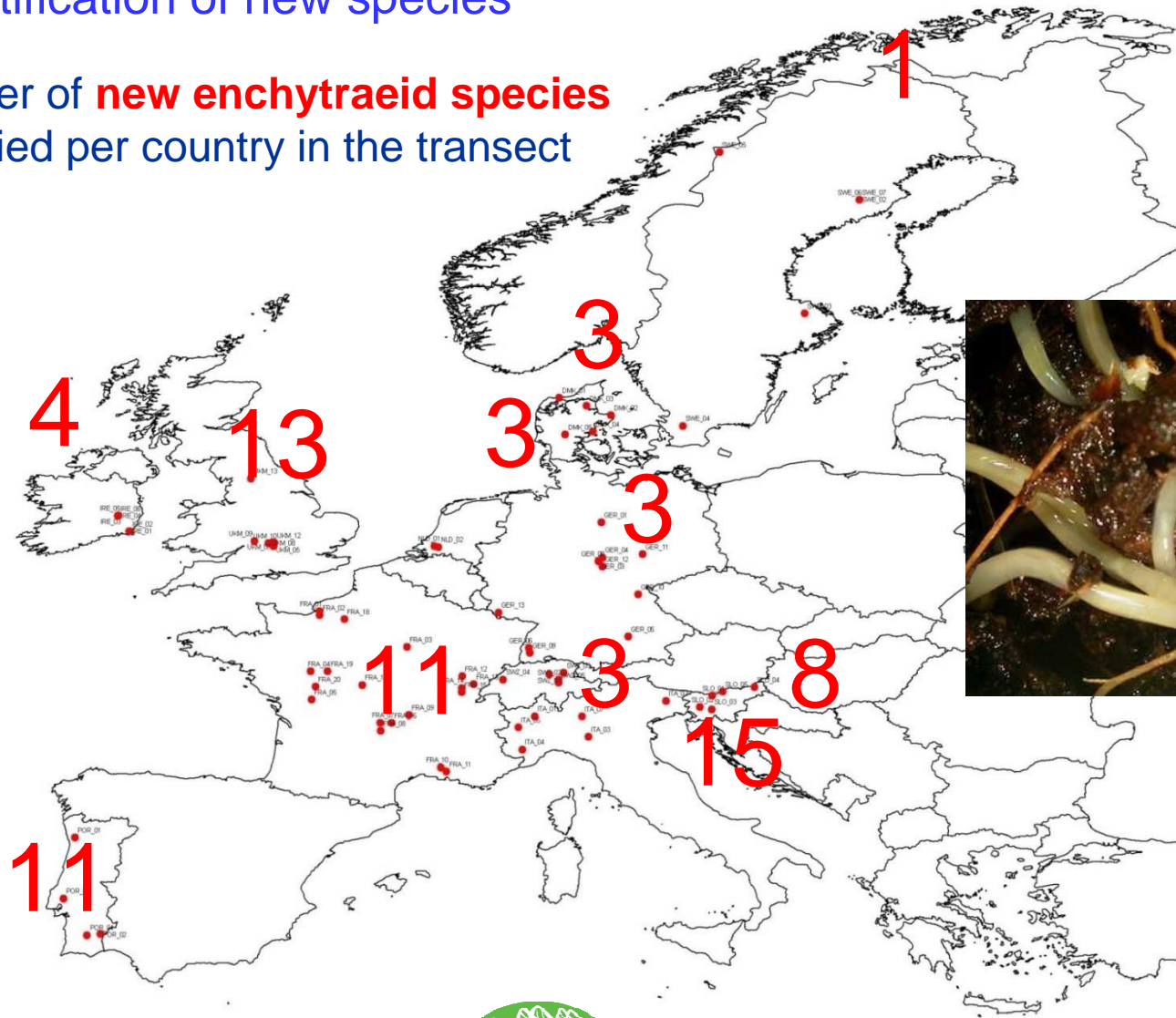
Stone et al. 2016. Appl. Soil Ecol. 97:3-11.

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Soil biodiversity across Europe

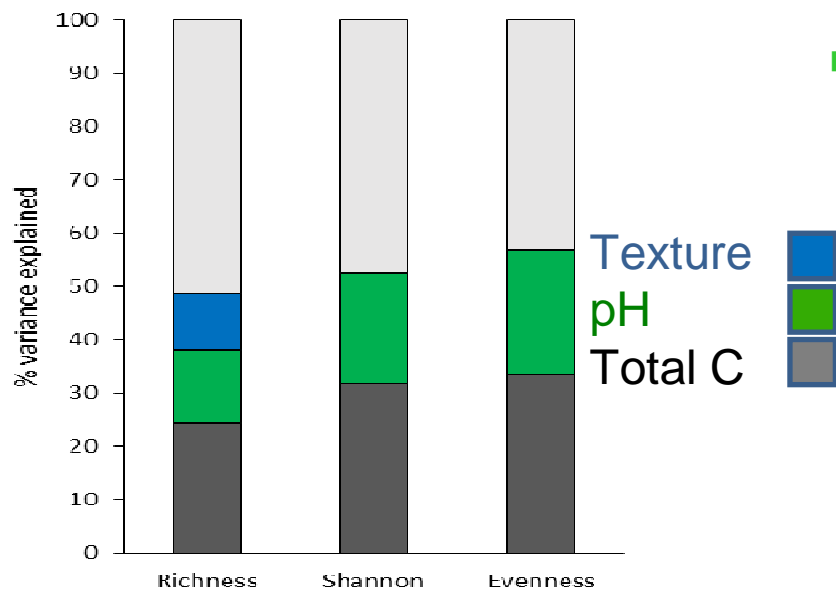
■ Identification of new species

Number of **new enchytraeid species** identified per country in the transect

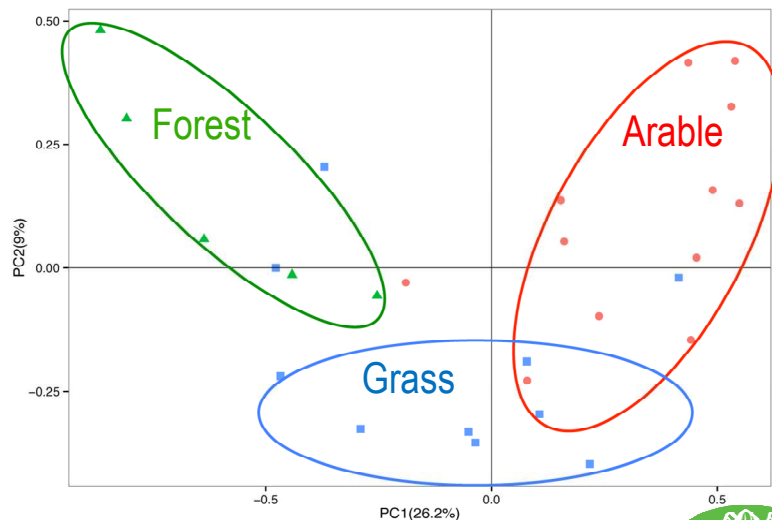


<http://bioinformatics.ua.pt/enchybase/>

Soil biodiversity across Europe



- Variations of bacterial diversity and structure across Europe mostly explained by the soil physical-chemical properties (total C, pH and texture).



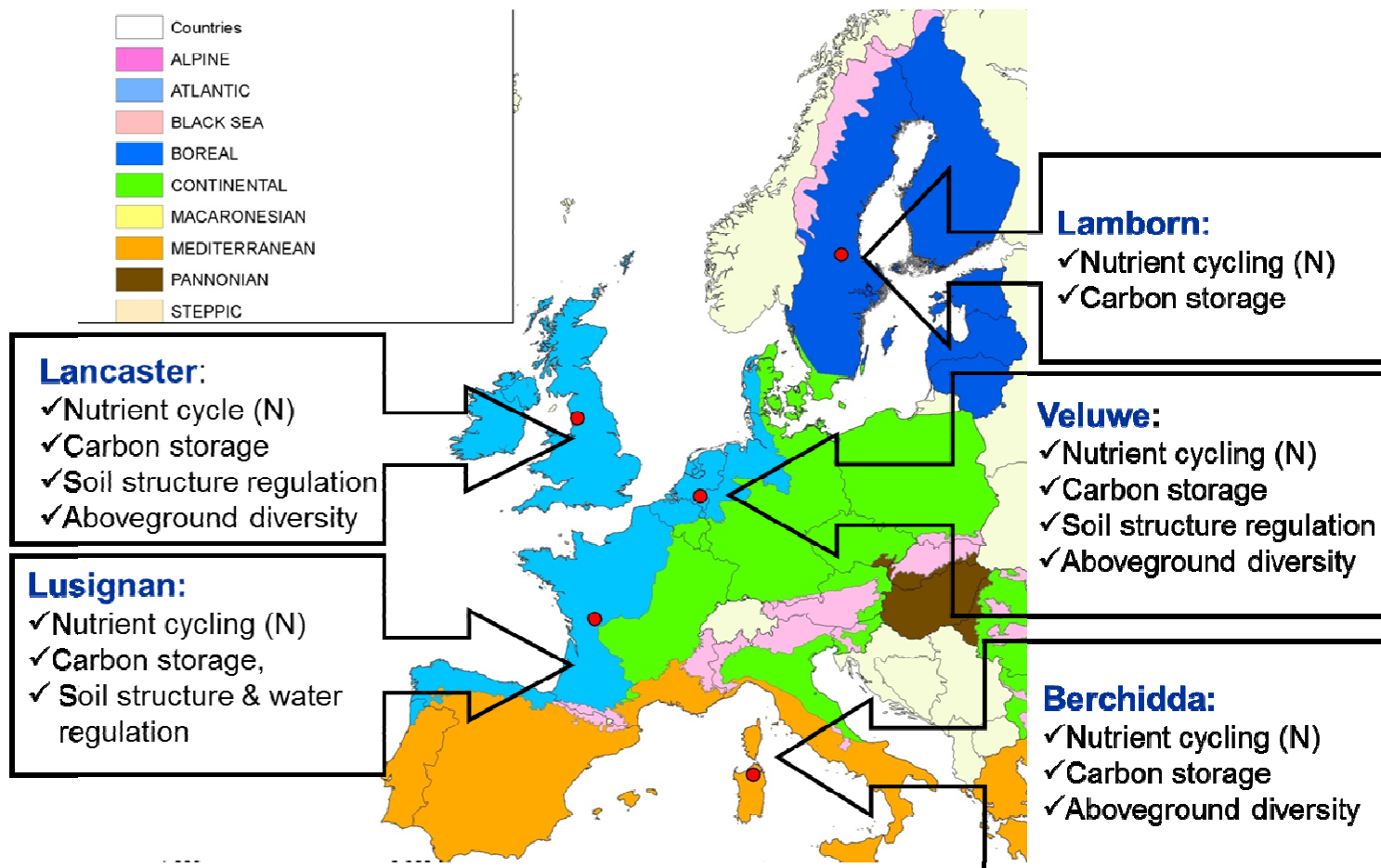
- However, in similar soil conditions bacterial communities differ according to the land use.

Plassart et al. submitted for publication

Relation biodiversity/functioning

Connecting soil biodiversity, functions and ecosystem services

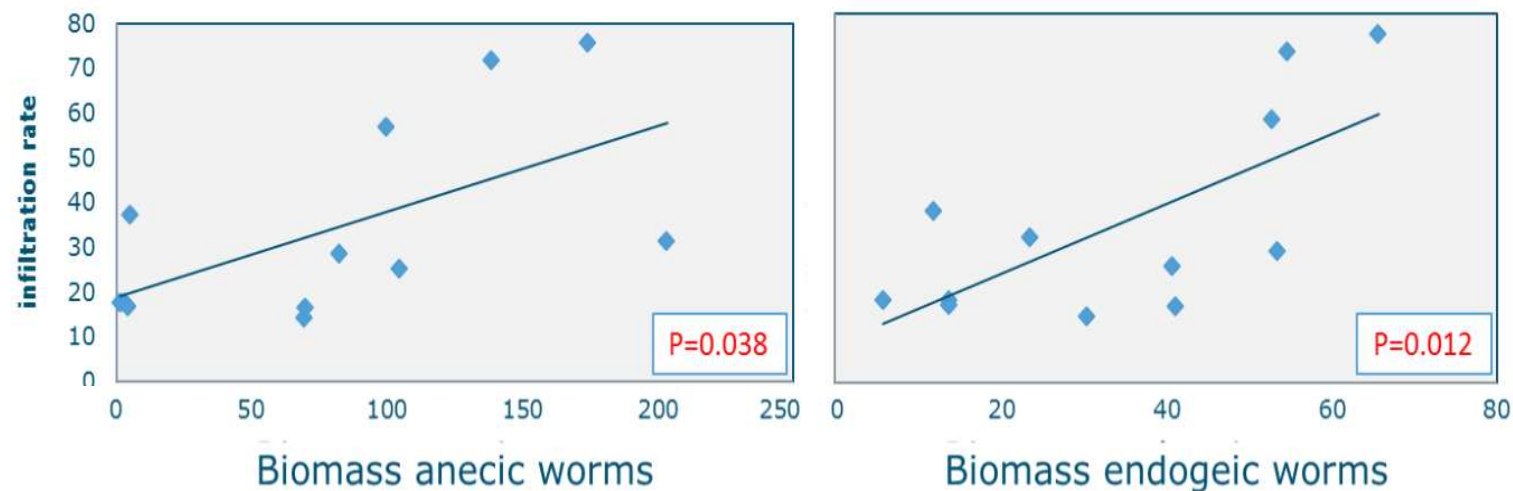
■ Five Long Term Observatories



- Different land uses: grasslands, tillage, forests
- For each LTO: three levels of intensification

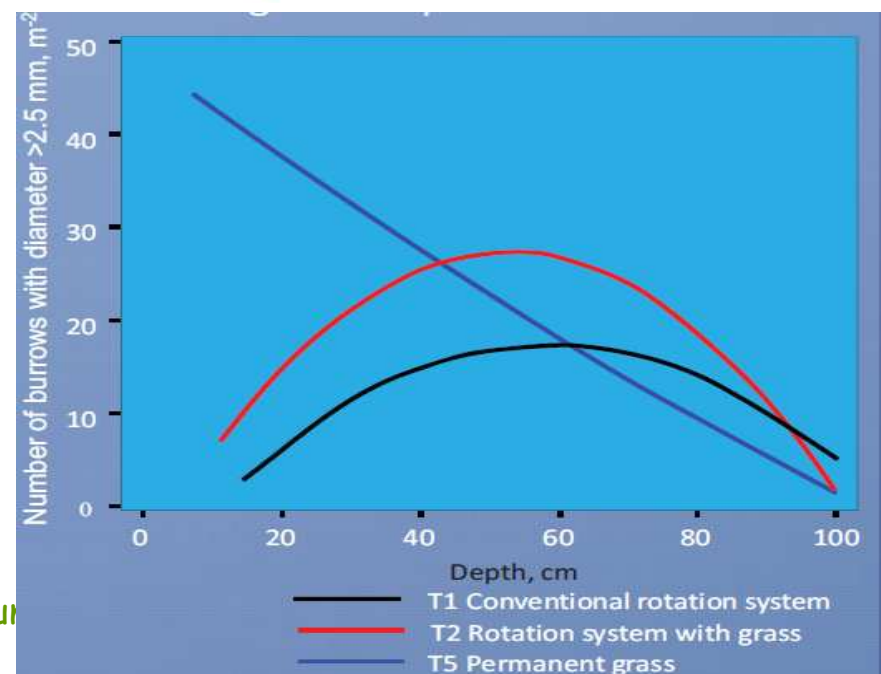
Relation biodiversity/functioning

■ Relation between earthworms' biodiversity and water regulation



■ Impact of the level of intensification

Courtesy of Jack Faber



Relation biodiversity/functioning



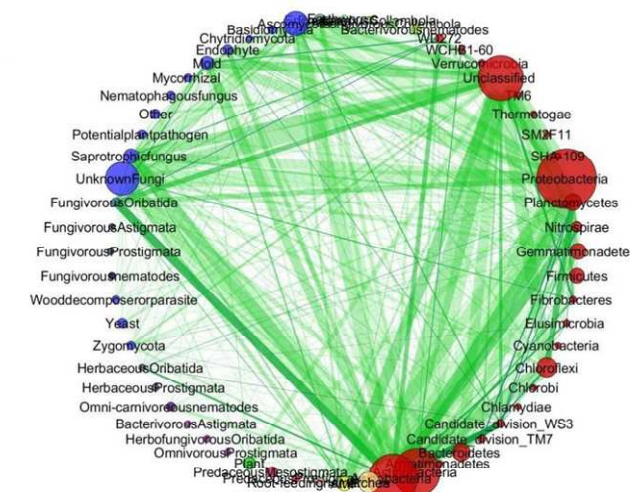
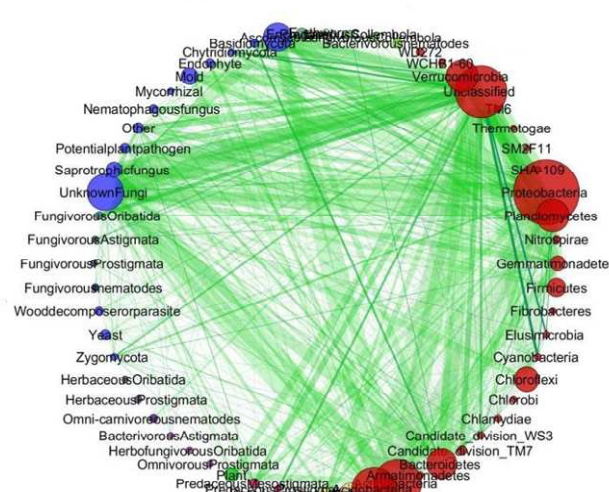
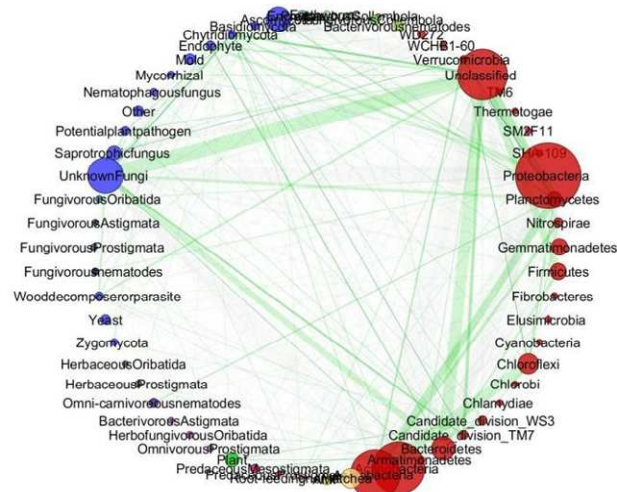
Recent



Mid-term



Long-term



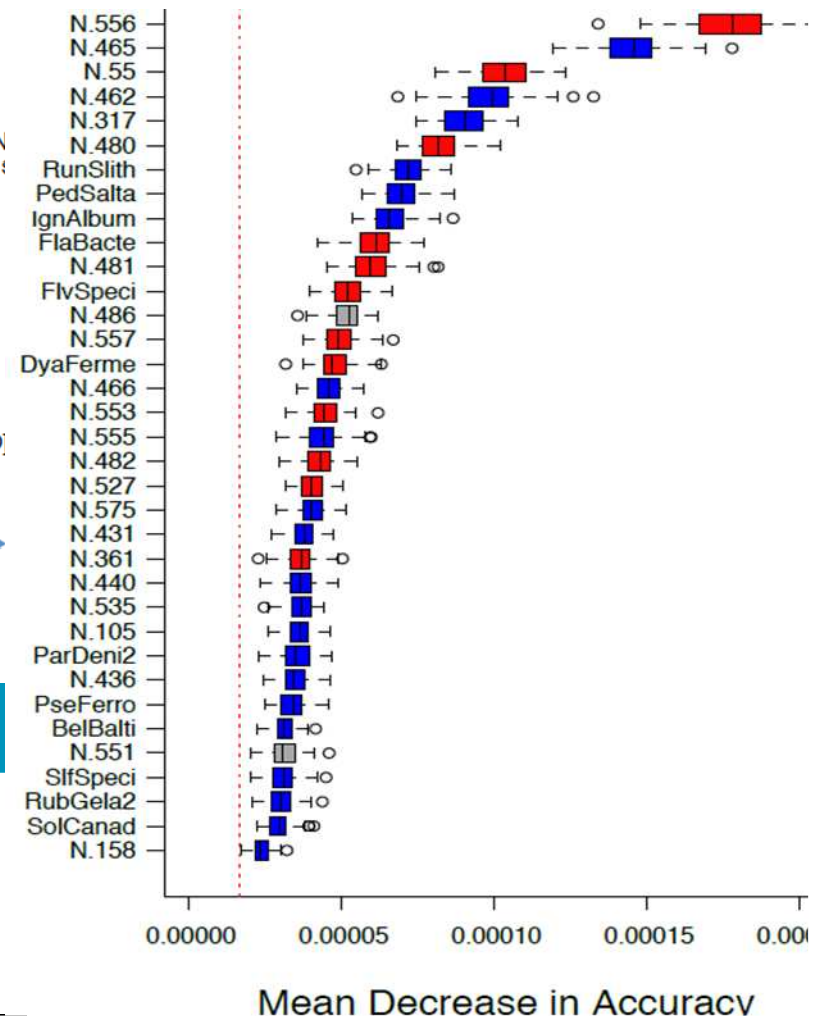
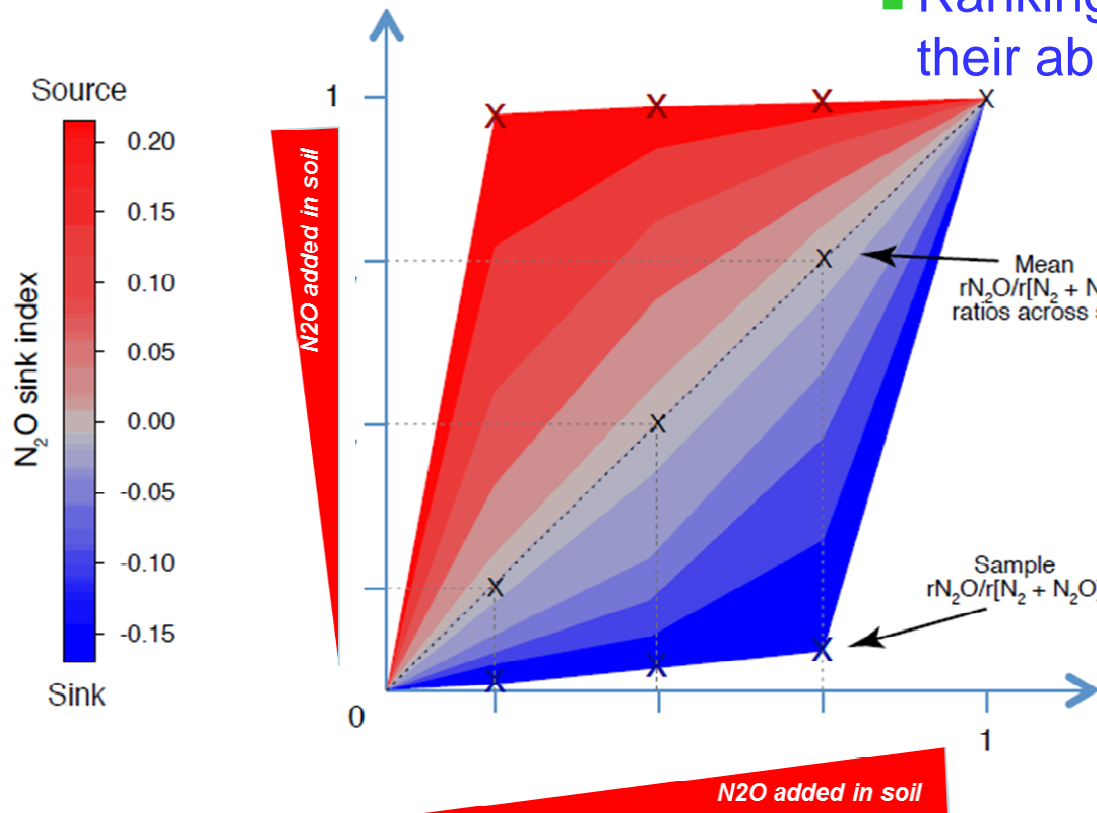
- During land restoration, belowground networks are getting more tight and efficiency of carbon uptake is increased, with a shift in fungal composition and activity without an increase in fungal to bacterial biomass ratio.

Morriën, Hannula, Snoek, & EcoFinders (in press) - Courtesy of Wim van der Putten

Relation biodiversity/functioning

- Soils may act as a source or a sink of N_2O

- Ranking of *nosZ* groups according to their ability to predict the N_2O sink index



nature
climate change

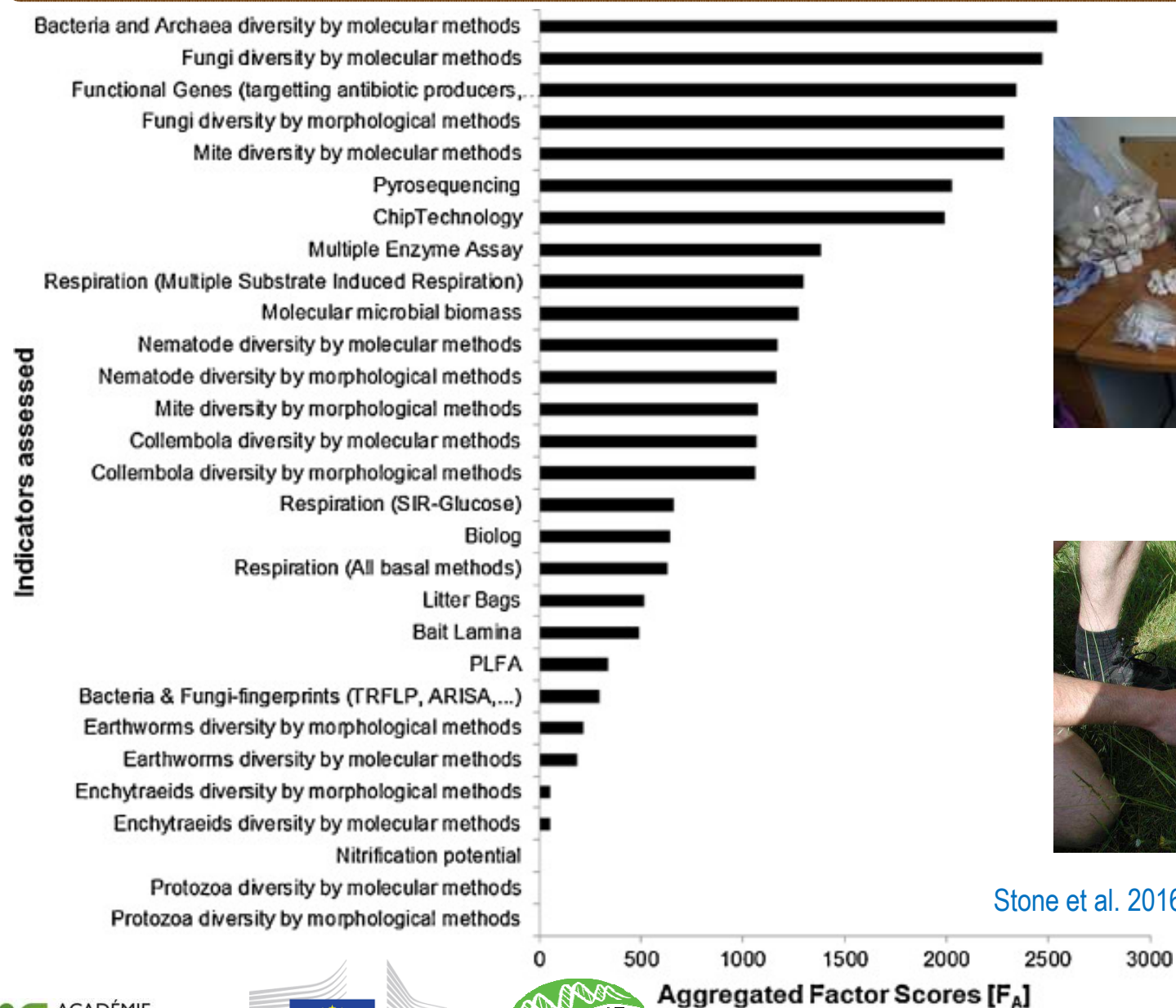
LETTERS

PUBLISHED ONLINE: 13 JULY 2014 | DOI: 10.1038/NCLIMATE2301

Recently identified microbial guild mediates soil N_2O sink capacity

Christopher M. Jones^{1,2†}, Ayme Spor^{1†}, Fiona P. Brennan^{1,3,4}, Marie-Christine Breuil¹, David Bru¹, Philippe Lemanceau¹, Bryan Griffiths^{3,5}, Sara Hallin^{2*} and Laurent Philippot¹

Identification of bioindicators



Stone et al. 2016. Appl. Soil Ecol. 97:12-22

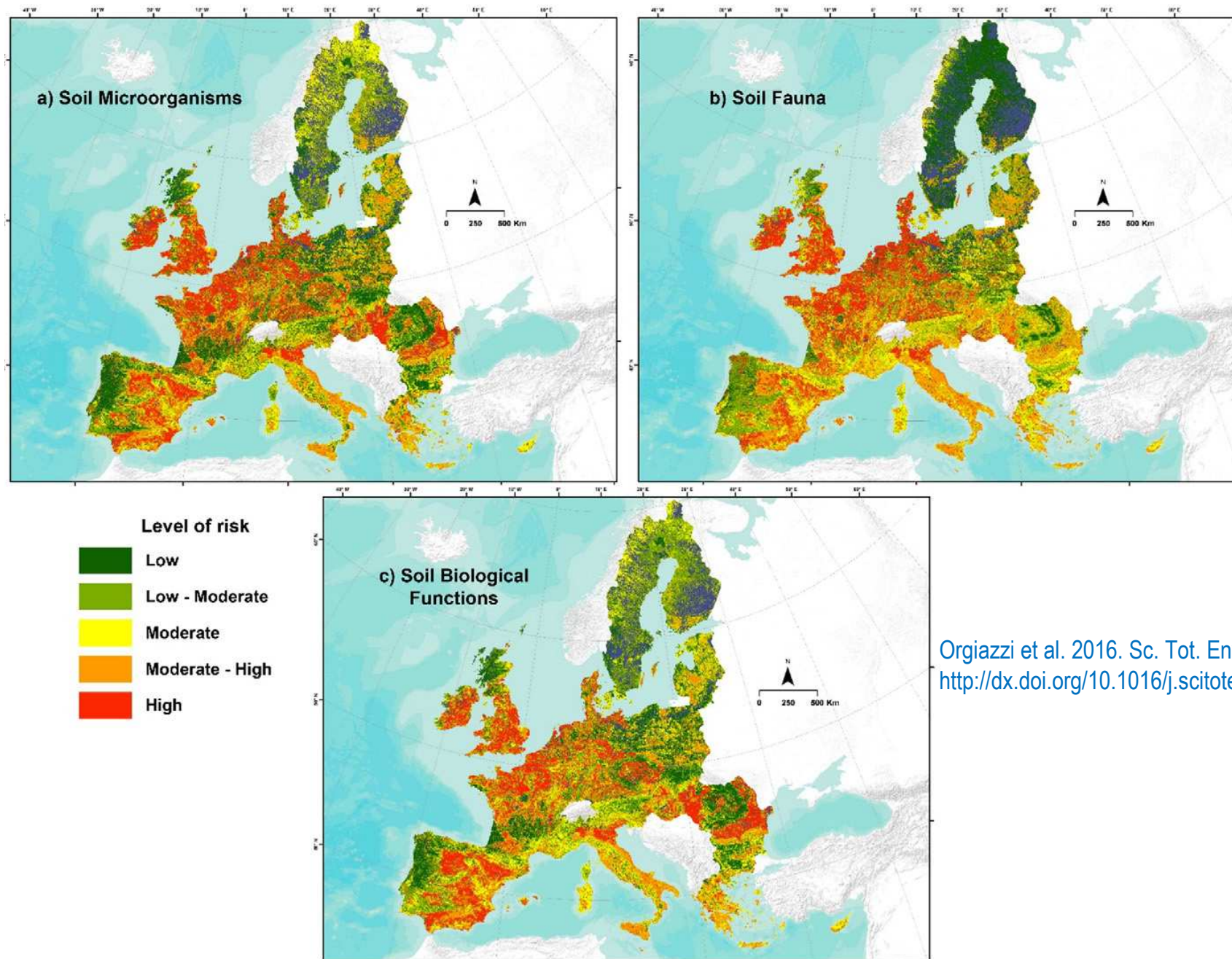
Identification of bioindicators

- Indicator species of Arbuscular Mycorrhizal Fungi for different environment categories across Europe.

Categories	Indicator species	Specificity	Sensitivity
pH			
<5	<i>Acaulospora brasiliensis</i>	0.99	0.67
	<i>Acaulospora alpina</i>	0.96	0.33
	<i>Archaeosporaceae</i> sp.	0.83	0.67
	<i>Rhizophagus</i> sp.	0.76	0.67
>5	<i>Septoglomus constrictum</i>	0.99	0.88
	<i>Funneliformis caledonium</i>	0.99	0.87
	<i>Funneliformis mosseae</i>	1	0.81
>7	<i>Claroideoglossum</i> sp.1	0.93	0.91
Land use			
Meadow	<i>Claroideoglossum</i> sp.3	0.65	1
Forestry and Meadow	<i>Acaulospora brasiliensis</i>	0.99	0.38
All except forest	<i>Funneliformis caledonium</i>	0.99	0.9
	<i>Funneliformis mosseae</i>	0.96	0.85
	<i>Glomeraceae</i> sp.3	0.99	0.81
Organic carbon			
>15%	<i>Paraglossum</i> sp.	0.97	0.5
<2%	<i>Diversispora celata</i>	0.98	0.33

Bouffaud et al. 2016. Soil Biol. Biochem. 103:464-470

Mapping possible threats to soil biodiversity



Orgiazzi et al. 2016. Sc. Tot. Environ.
<http://dx.doi.org/10.1016/j.scitotenv.2015.12.092>

Valuation of soil biodiversity and ecosystem services

How to value soil biodiversity?

On the value of soil biodiversity and ecosystem services

PAYMENTS

PRODUCERS

- Adopt farming practices that increase soil fertility, water retention, biodiversity and enhance carbon sequestration or any other ecosystem service.
- Estimate the ecosystem services you are able to provide and engage with potential buyers of these services through a PES/RPE scheme.
- Share knowledge with other producers' organizations and help each other in implementing PES schemes.

CONSUMERS

- Encourage the involvement of local and national governments in PES/RPE programmes.
- Convince your community to initiate PES/RPE schemes.
- Choose, where possible, food products coming from producers involved in PES/RPE schemes.

HOW CAN YOU HELP?

FOOD INDUSTRY

- Engage in PES/RPE schemes, discussing with providers the payment of specific ecosystem services, supporting involved producers or buying their products.
- Ask your suppliers to enhance ecosystems services on their farms.
- Label your products as part of PES/RPE programmes.

POLICY MAKERS

- Create economic incentives that encourage PES/RPE schemes, including environmental taxes and subsidies, transferable discharge permits and environmental labeling.
- Develop specific PES/RPE projects with farmers, foresters and/or fisher folks in their region, or their watershed.
- Provide incentives for the private sector to engage in PES/RPE schemes.

EcoFINDERS - Outputs

- **Scientific papers:** 71 published in magazines ranked outstanding (10), or excellent (41).
- **Preparation** of 28 PhD theses
- **Major technologic developments:** SOPs for biodiversity characterization, bioindicators of soil quality and functioning, referential allowing interpretation of biodiversity measurement ⇒ soil diagnosis
- **Unprecedented data base on European soil biodiversity** which will be hosted and implemented by JRC at Ispra.
- **Communications to scientists:** First Global Soil Biodiversity Conference « Assessing Soil Biodiversity and Role for Ecosystem Services » organized together with GSBI in Dijon (750 participants from 56 countries with all continents represented).
- **Communications to public:** showroom, public release, Jazz festival, schools,...

General Conclusions & Prospects

- Soil biodiversity and translation in ES strongly impacted by soil types.
 - For a given soil type, soil biodiversity is impacted by land use and intensification.
 - Translation of soil biodiversity in ES is related to environmental conditions and land use.
 - ES provision not only relies on soil biodiversity but also on interactions within soil communities and interactions between below- and above-ground.
 - Provision of ES may be at least partly predicted by soil biodiversity
- **Major need to continue the effort of characterization of soil biodiversity at the European level at a more tight grid, in the context of the MAES**
- **Major need to capitalize information on physical-chemical and biological soil properties**
- **Connect these efforts with national and world initiatives**