Chemical pollution and microbiomes responses

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Chemical pollution and microbiomes responses

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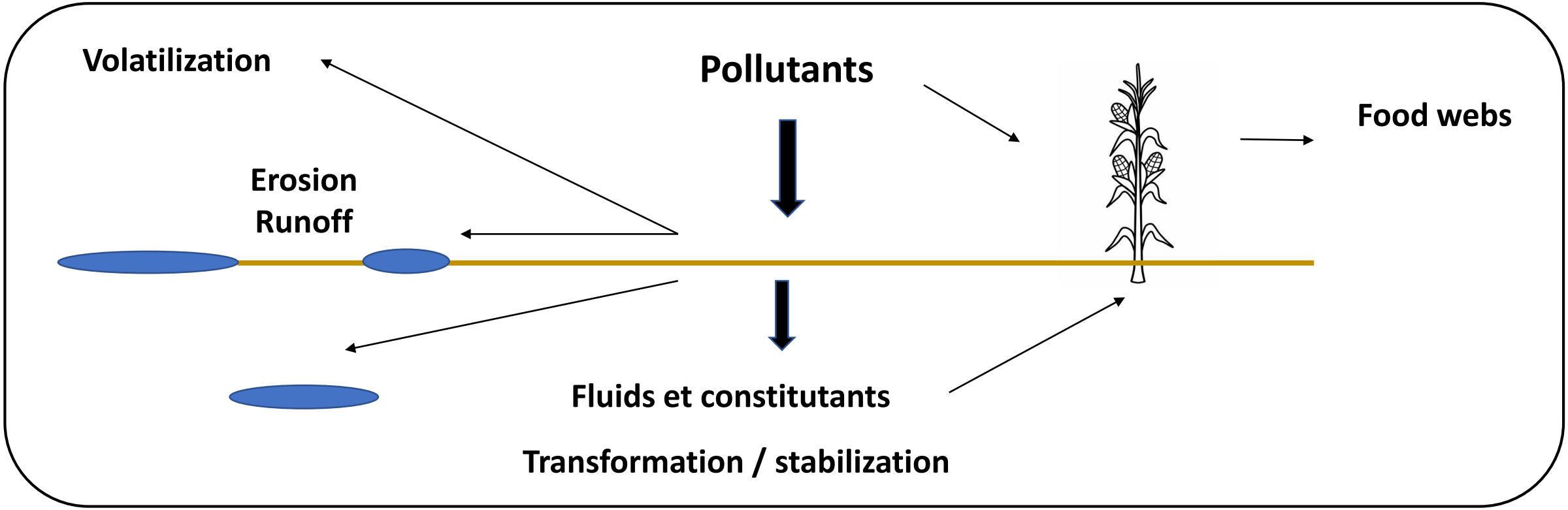
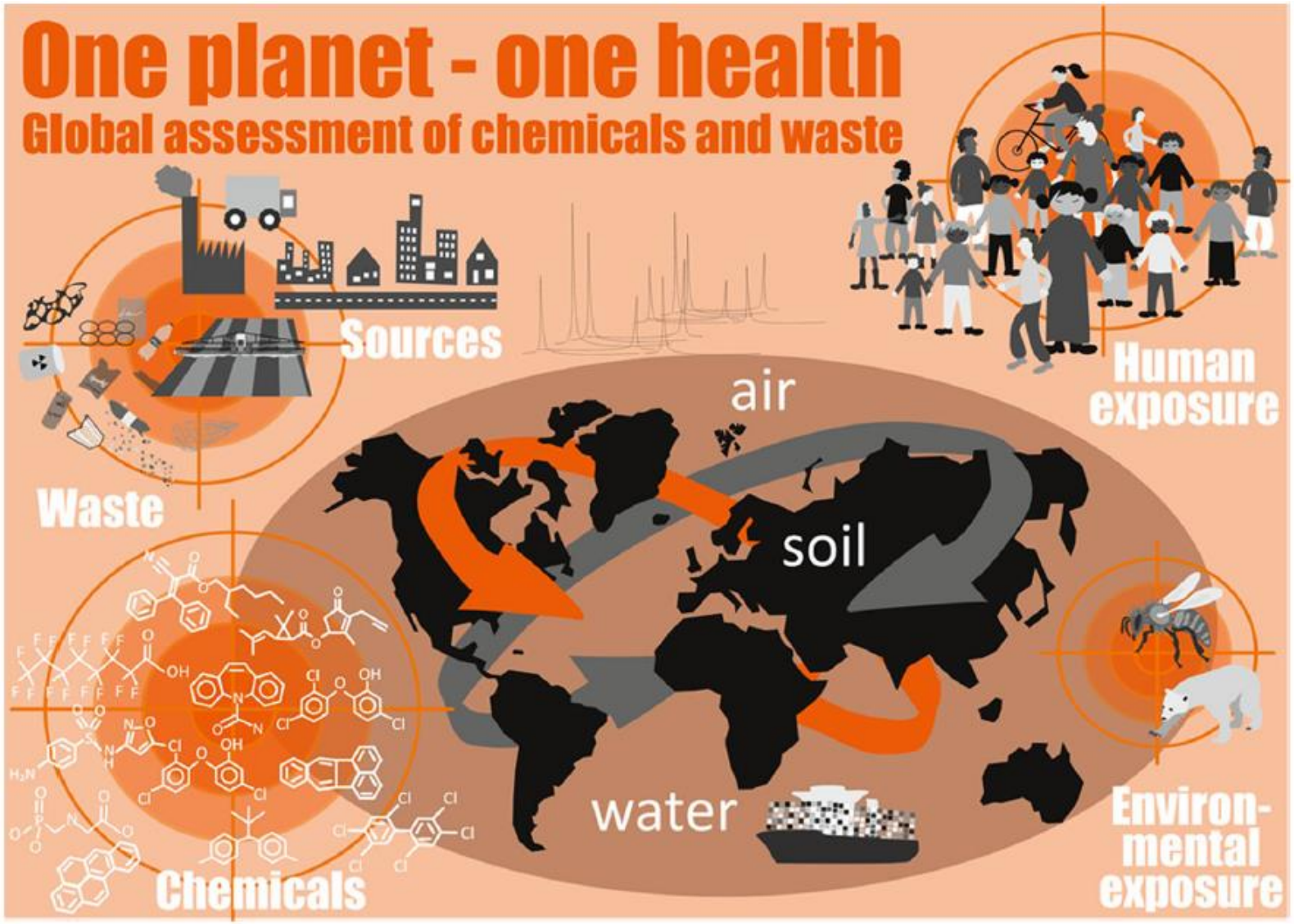
Bioconnect day – April 13, 2023

Fate and effects of pollutants



Ecotoxicological and health risks > One Health



Brack et al. Environmental Sciences Europe (2022) 34:21
https://doi.org/10.1186/s12302-022-00602-6

Environmental Sciences Europe

POLICY BRIEF Open Access

One planet: one health. A call to support the initiative on a global science–policy body on chemicals and waste

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Abstract

The chemical pollution crisis severely threatens human and environmental health globally. To tackle this challenge the establishment of an overarching international science–policy body has recently been suggested. We strongly support this initiative based on the awareness that humanity has already likely left the safe operating space within planetary boundaries for novel entities including chemical pollution. Immediate action is essential and needs to be informed by sound scientific knowledge and data compiled and critically evaluated by an overarching science–policy interface body. Major challenges for such a body are (i) to foster global knowledge production on exposure, impacts and governance going beyond data-rich regions (e.g., Europe and North America), (ii) to cover the entirety of hazardous chemicals, mixtures and wastes, (iii) to follow a one-health perspective considering the risks posed by chemicals and waste on ecosystem and human health, and (iv) to strive for solution-oriented assessments based on systems thinking. Based on multiple evidence on urgent action on a global scale, we call scientists and practitioners to mobilize their scientific networks and to intensify science–policy interaction with national governments to support the negotiations on the establishment of an intergovernmental body based on scientific knowledge explaining the anticipated benefit for human and environmental health.

Keywords: Chemical pollution, Science–policy body on chemicals, Planetary boundaries, One-health perspective, Systems thinking

A call to action

Climate change and biodiversity loss are well known to pose a threat to humankind and the global environment and are rightly in the focus of global policies and the public. However, a third major challenge on a global level of the same significance is the chemical pollution crisis that severely threatens human and environmental health

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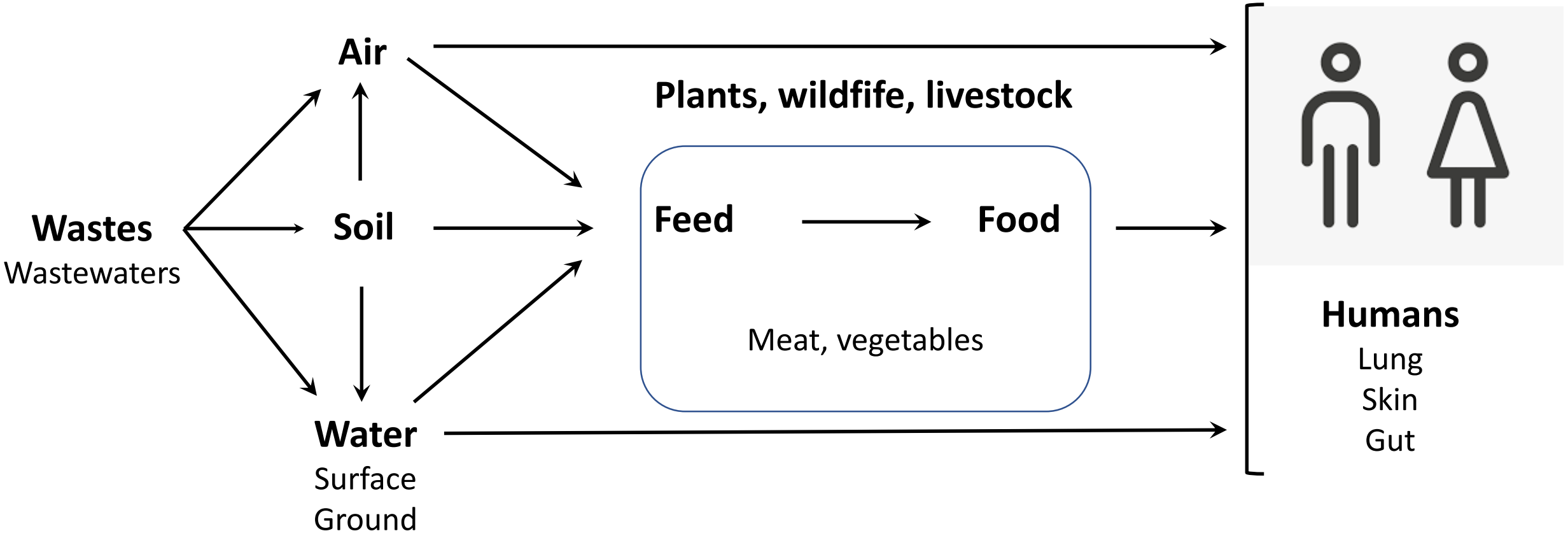
The microbiomes potentially affected by pollutions



- **Microbiomes interactions not fully taken into account**

Plastics, micro- and nano-… the plastisphere

Plastics: currently a major concern of worldwide physical and chemical pollution

- Components (monomers): PE, PS, PVC…
- Catalysts: metals
- Additives: phthalates, bisphenols…
- Loading agents: TiO_2
- Environmental adsorbed pollutants: metals, POPs, PFAS…
- Invasive species

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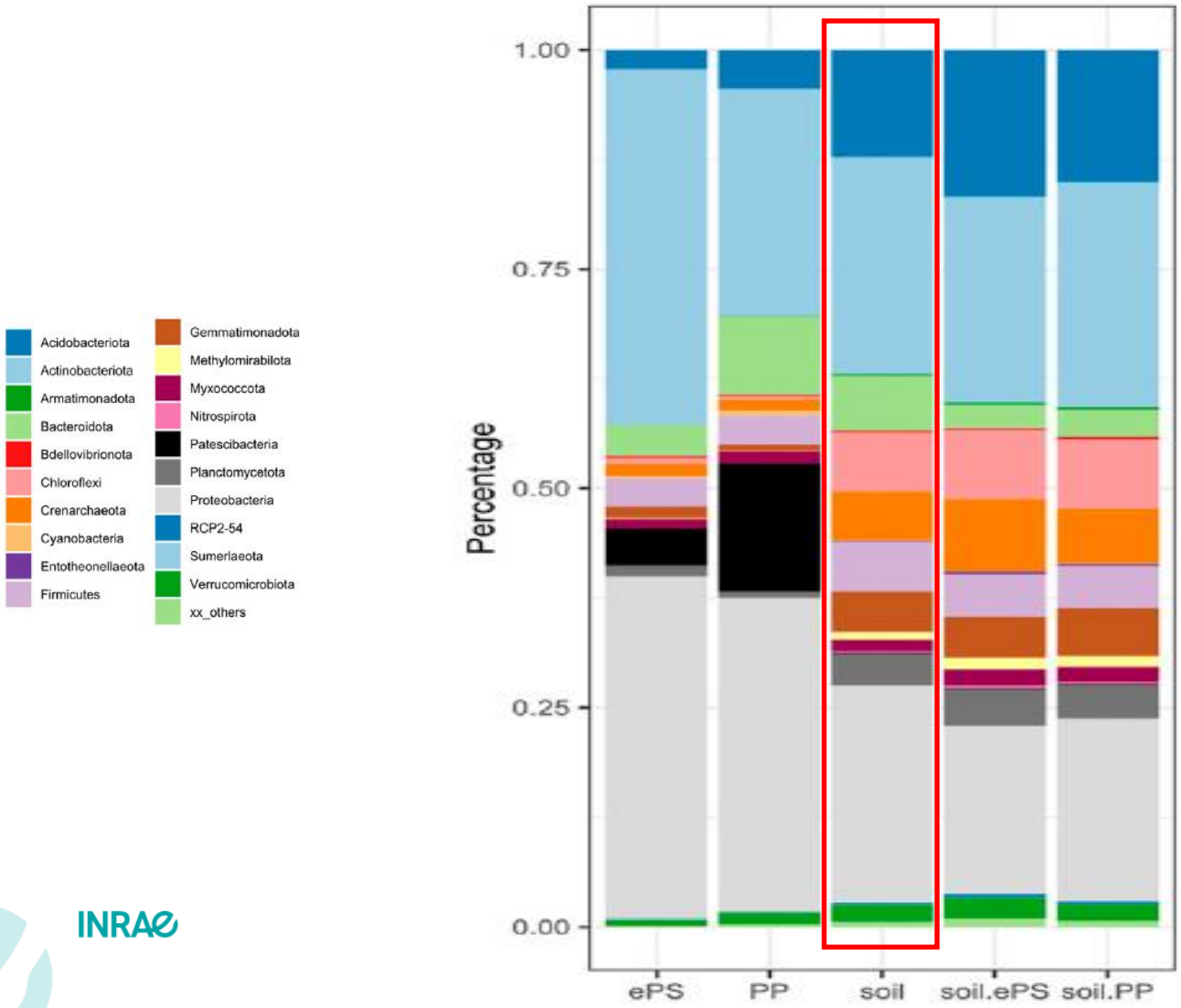
Microplastics and soil microbiome

Soil bacterial community structure after 8 weeks of incubation with plastics (PP and PS)

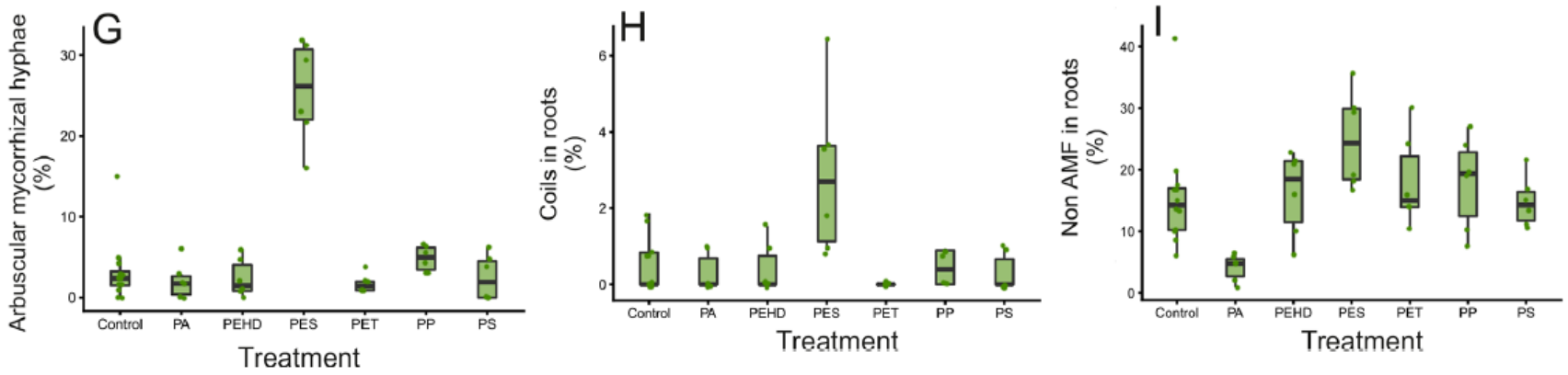


- **MP materials form a new niche for microbes in soils and induce a new microbial habitat**

Kublik et al., Front Environ Sci, 2022, 10:989267

Microplastics and root microbiome

Effects on plastics on root symbioses after 11 weeks of exposure to plastics (spring onion *A. fistulosum)*



Root colonization affected by MP materials:

(G) arbuscular mycorrhizal fungi

(H) mycorrhizal fungal coils

(I) non arbuscular mycorrhizal fungal structures

➢ **MP materials significantly alter root symbioses, root traits and then plant performance**

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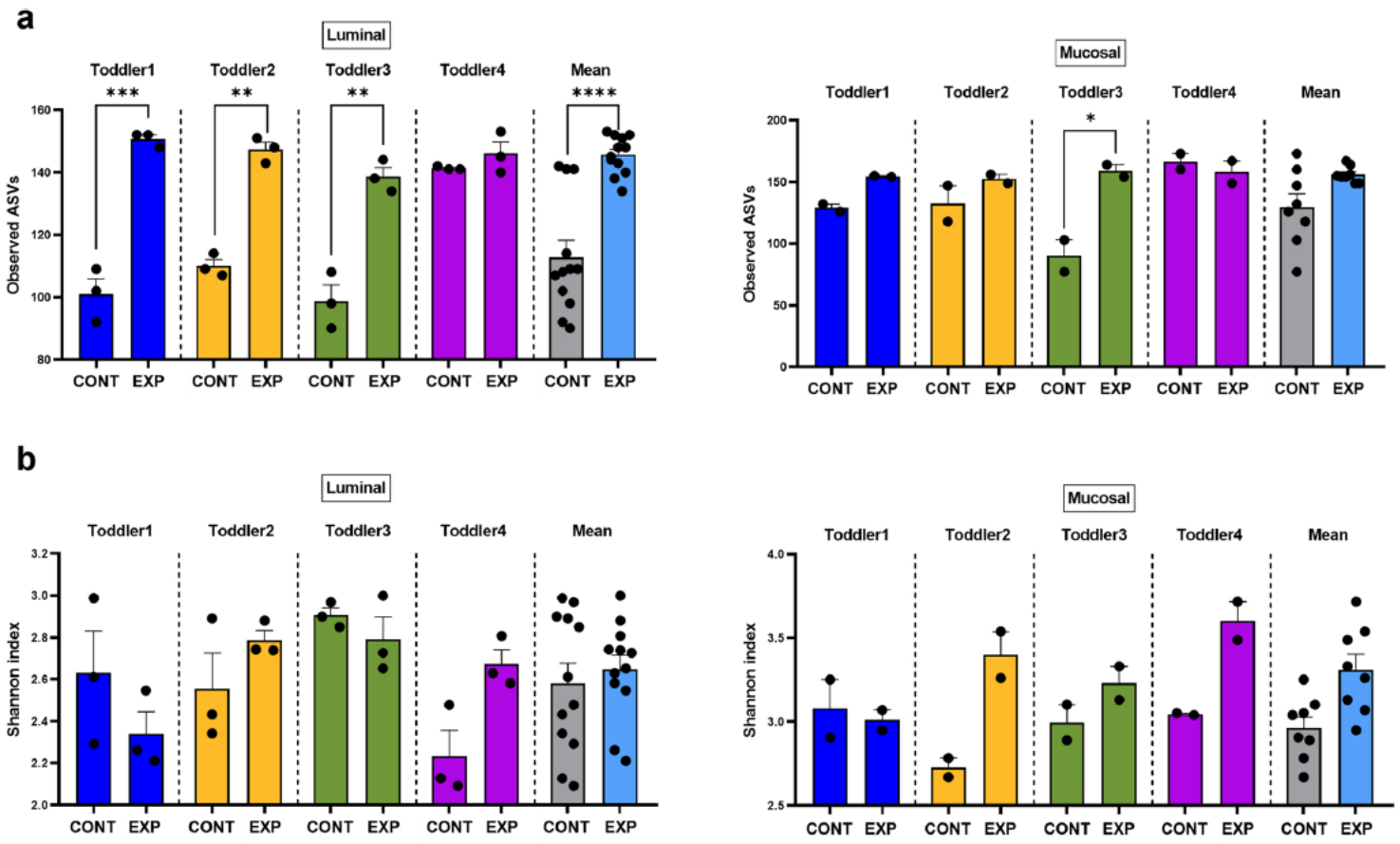
De Souza Machado et al., Environ Sci Technol, 2019, 53: 6044-6052

Microplastics and gut microbiome in young children

In vitro effect of chronic exposure to PE MPs on diversity of gut bacterial communities

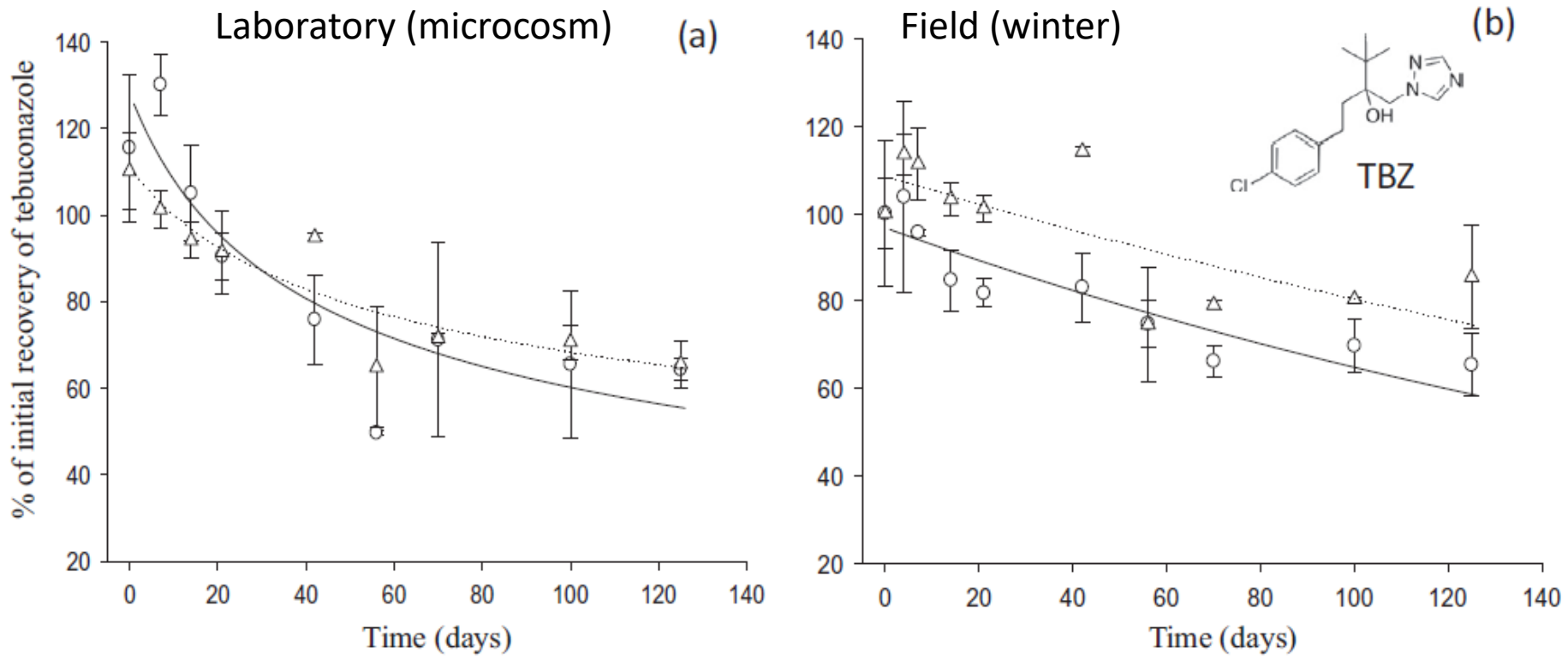


MPs increases the α-diversity indexes (ASV-a and Shannon-b) and may modify gut physiology

➢ **Towards a gut plastisphere?**

Fournier et al., J Hazard Mat, 2023, 443:130383

Environmental fate of the fungicide tebuconazole

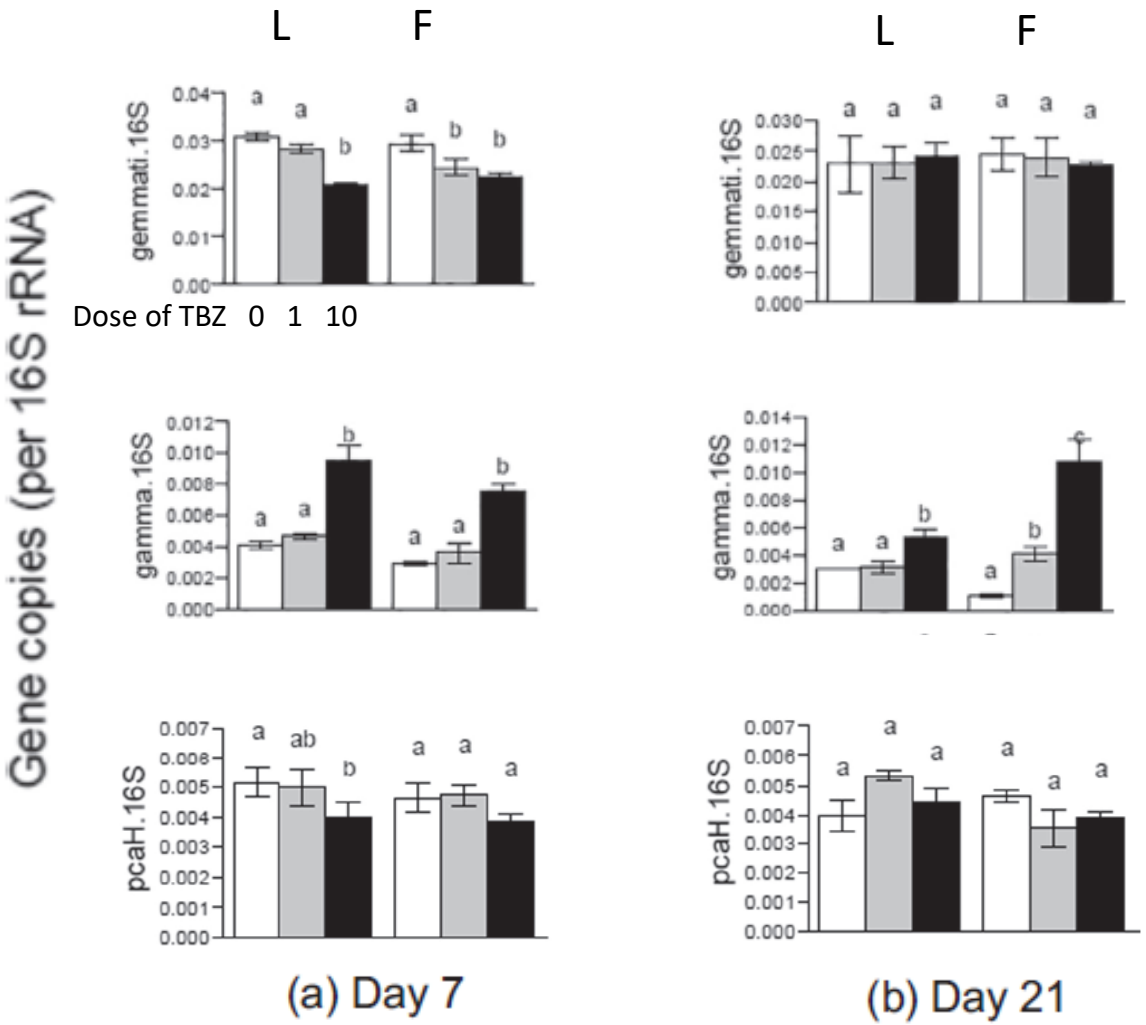


- **No clear effect of incubation conditions on fungicide persistence in soil**

Papadopoulou et al., 2016, Science of the Total Environment, collaboration: Aeiforia Univ. Thessaly

Love-to-Hate, “pesticides: felicity or curse for the soil microbial community?” IAPP Project

Effect of tebuconazole dose on the composition of soil bacterial community



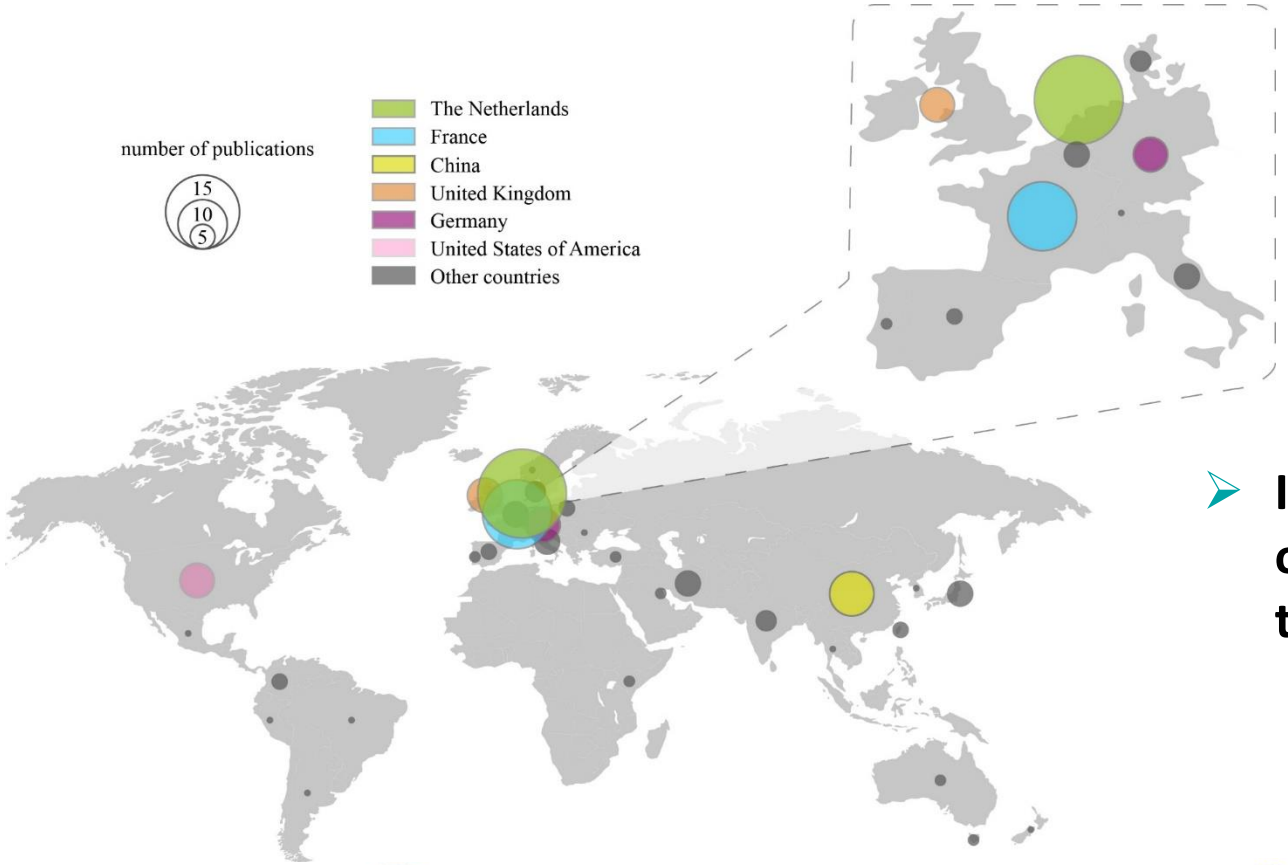
16 groups of microorganisms studied

- **Transitory decrease in the abundance** of gemmati
- **Increase in the abundance** of gamma
- **Transitory decrease in the abundance** of *pcaH*

EL Azhari et al. STOTEN , 2018, 637-638: 892-906

Cases of azole resistance in environment and humans

Netherlands: 1st country to use triazole for crop protection (tulip bulbs…)



- **Increase in the number of cases of resistant strains carrying tandem mutations**

Rocchi et al., Emerging Contaminants: Emergence Of A Pathogenic Fungi Resistant To Antifungals, A Threat From The Environment, 2021. "Emerging Contaminants". Springer Nature

Human triazole resistance

- **For more than 20 years, emergence of resistance to antifungal drugs for animals and humans**
- **1st case of triazole resistance of *A. fumigatus* reported in 1997 in the Netherlands**
- **Correlation between resistant *A. fumigatus* and use of propiconazole, bromuconazole, tebucanazole, eporxyconazole and difeconazole in agricultural soils**
- **Tulip bulbs : transfer of resistances over long distances?**
- **But also green wastes, wood chips as hotspots of resistance**
- ***A. Fumigatus* resistant two triazole fungicides**

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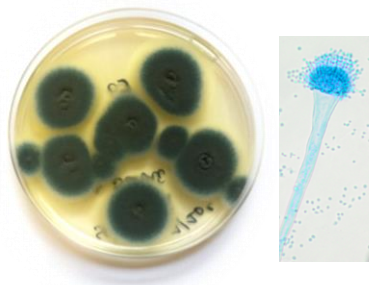
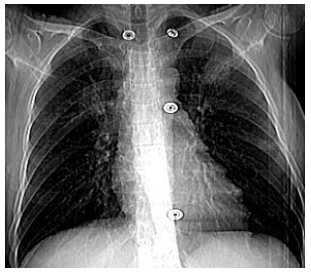
Aspergillosis: impact on wildflife, cattle and human health



Aspergillus fumigatus

ASPERGILLOSIS



Lung infection

HUMAN: immunodepressed patients (cystic fibrosis, flu, COVID-19 …)

ANIMALS: wild and domestic ecosystems (insects, birds, cattle, horses, dogs, cats, monkeys), or aquatic ecosystems (corals, sponges, insects, marine mammals, fish, amphibians, reptiles)

(SEEDS: other strains**)**

An increasing prevalence of resistant fungus observed in human clinical specimens (> 10%)

Resistance to fungicides, a complementary problem of resistance to antibiotics!!!

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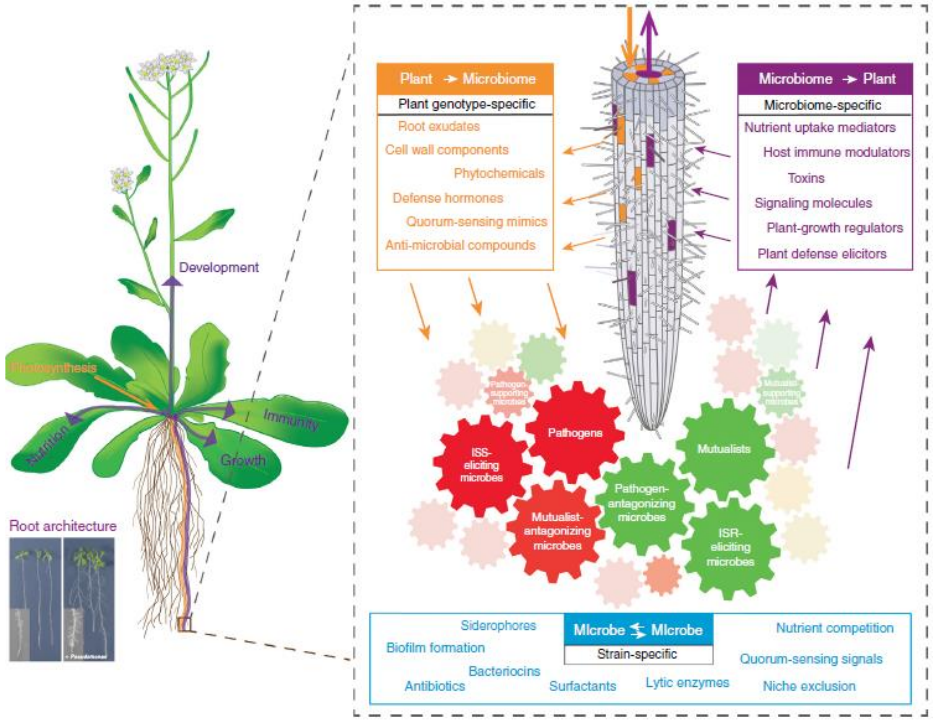
But also… microbiomes can reduce pollutions!

- **Use of the degradation capacities of soil and plant microbiomes for bio- and phyto-remediation**

- **Deciphering plant-microbiota interactions to enhance crop defense to pests and reduce/suppress the use of pesticides : project DEEP-IMPACT : Christophe MOUGEL, INRAE**

  - How should we tackle plant associated microbiota diversity and functional traits to better manage plant health ?
  - What are the plant x microbiota genetic traits important for plant health ?

  ➢ **Results in a next meeting?**



Pieterse et al., 2016, Trends in Plant Science 21(3): 171-173

Conclusions

- **Soil, plant, animal and human microbiomes are affected by chemical pollution, at the least in terms of community structure and abundance**
- **Functional consequences (performance, ecosystem functions, metabolic disorders and pathologies…) need to be precised**
- **In the context of pollutions, microbiomes interactions are poorly considered**
- **Additional research is needed to better understand the impact of microbiome on chemical pollutions and vice versa, and consequences on the 'One Health'**
- **What is the impact of climate change on microbiomes interactions?**

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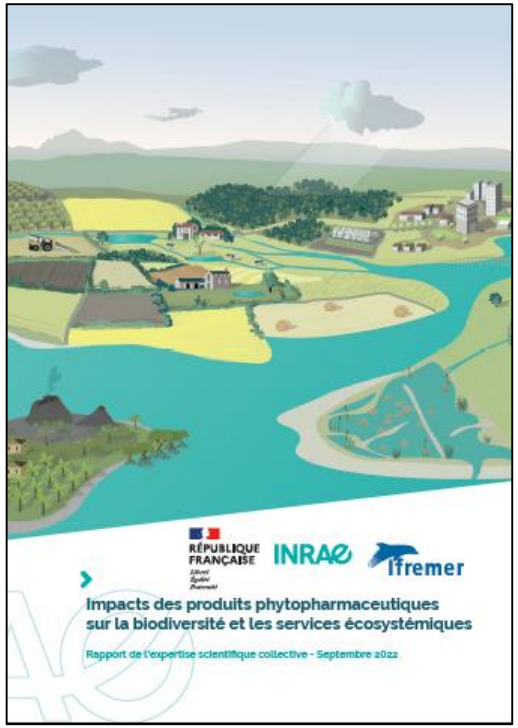
To find out more… the CSAs

Pesticides and human health

Pesticides, biodiversity and ecosystem functions



Ongoing:

Plastics of the agri-food sector

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Thanks for your attention!