Exploiting beneficial interactions between plants and bacteria: PCB biodegradation by soil microbiota upon stimulation by root exudates

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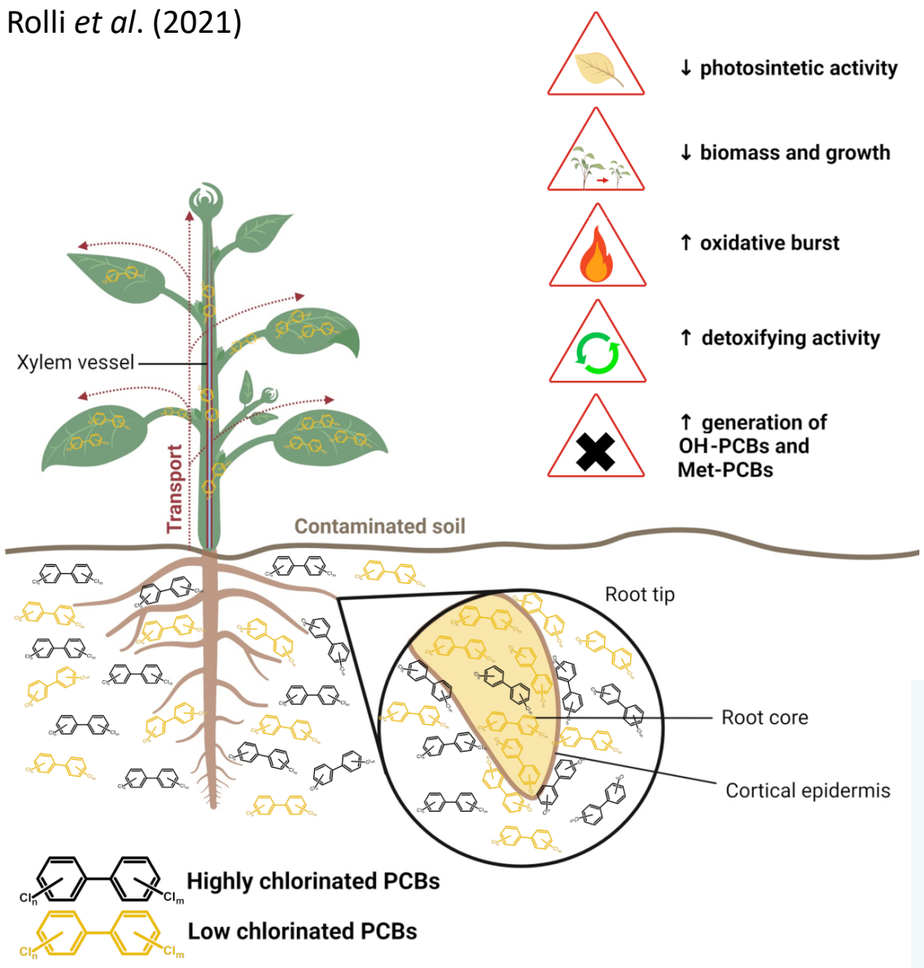
INTRODUCTION

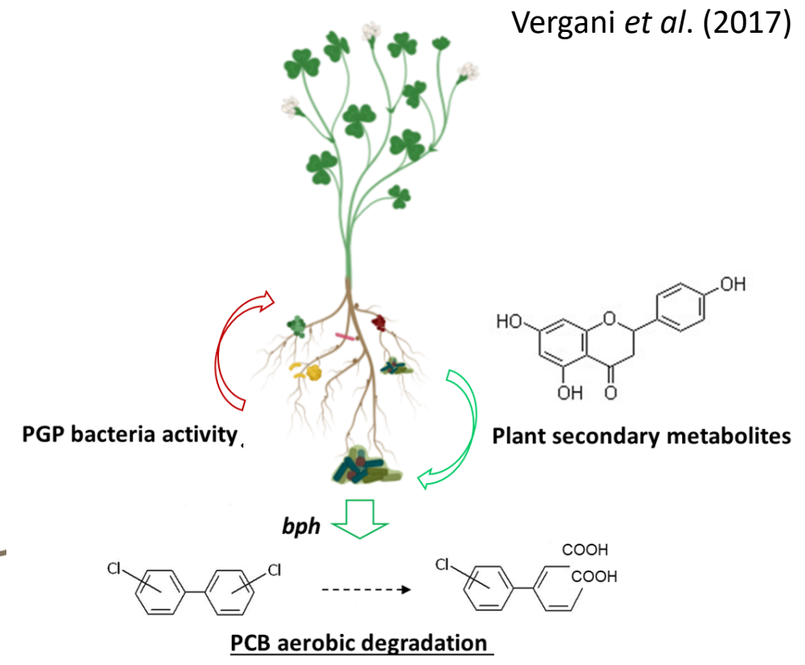
Polychlorinated biphenyls (PCBs) are xenobiotic compounds that have been massively used in the last century for several industrial applications. The spread of these toxic molecules led to a severe contamination of soils and groundwaters and to their biomagnification in the food chain, posing a serious threat on human health and ecosystems. They are now listed as Persistent Organic Pollutants (POPs) and their production and utilization banned[1].

Rhizoremediation is a sustainable strategy for the decontamination of soils polluted by PCBs, that takes advantage of the association and the crosstalk between plants and their microbiome, in particular rhizospheric and endophytic bacteria. The holobiont benefits of these interactions under stress conditions to improve its resistance: PCB-degrading microbes can degrade the contaminant, decreasing its phytotoxic effect [2,3].

Rolli *et al*. (2021)



Vergani *et al*. (2017)



Some bacterial species are known to degrade low-chlorinated PCBs in aerobic conditions due to the presence in their genome of the *bph*-operon, encoding for the biphenyl degradative pathway[4].

Plant root exudates and secondary metabolites play an important role in this process, stimulating the process of biodegradation in PCB-degrading bacteria. Some of these plant metabolites, mostly belonging to the class of phenylpropanoids, like flavonoids, have structure similarity with PCBs and can act as co-metabolites or inducers, leading to an increased degradation of the pollutant[5,6].

AIM OF THE PROJECT

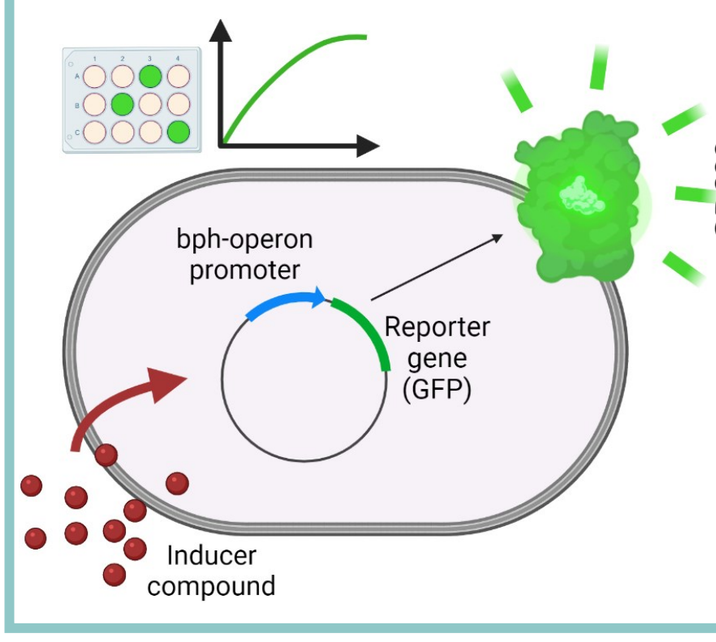
- Investigation of the **role played by secondary metabolites exudated from plant roots in inducing the expression of degradative genes** in PBC-degrading bacteria and **enhance their growth and degradative activity**
- Observing the **dynamics of activation** of the PCB degradative pathway in response to specific root exudates using **bacterial biosensors**

WORKPLAN OF THE PROJECT

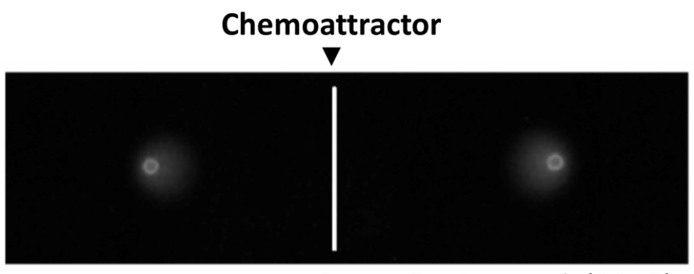
1. Generation of bacterial biosensors

to monitor the induction of the PCB-degradative pathway (mediated by the *bph*-operon) upon stimulation by root exudates

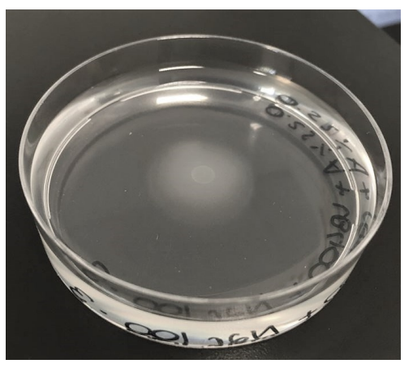
Model for a REs-responsive bacterial biosensor

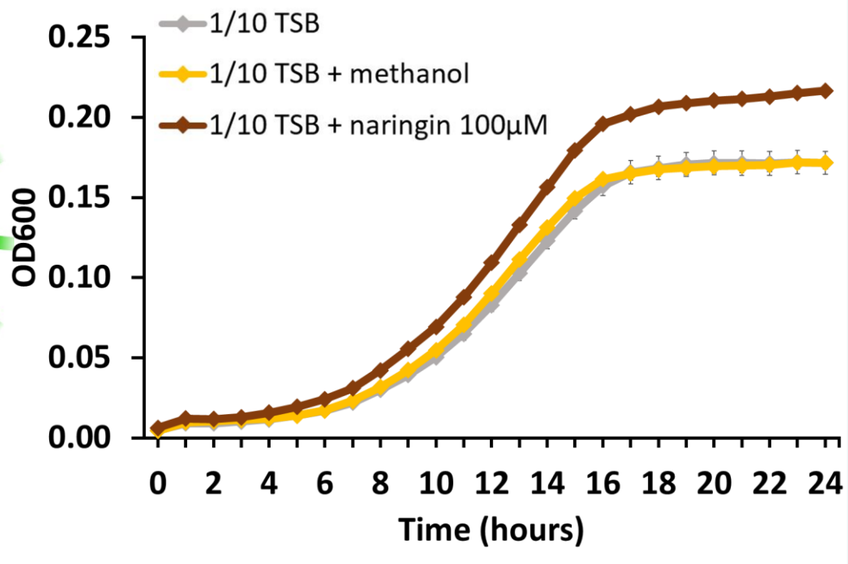


Chemotaxis and motility assays



Reyes-Darias *et al.* (2015)





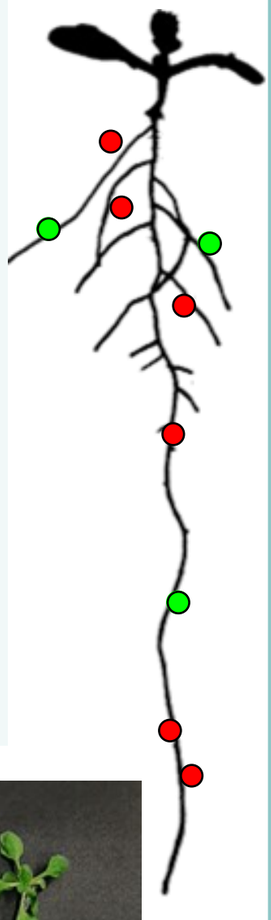
Growth curves in presence/absence of REs

2. *In vitro* tests

to evaluate how different root exudated compounds affect bacterial growth and other features linked to root colonization in presence or absence of PCBs

3. *In vivo* tests

to monitor the colonization efficiency of the bacterial biosensors on *A. thaliana* and to obtain information about the spatial localization and temporal dynamics of activation of PCB-degradation *in planta*



EXPECTED OUTCOMES

- **Improving rhizoremediation strategies** for PCB polluted soils
- Use of **biosensors as powerful miniaturized tools** for the study of plant-microbiome interactions in stress conditions → deeper knowledge of **plant-microbe crosstalk** on a molecular level

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