


# **Microbial ecology of hydrocarbon polluted soils and prospects for *Populus* based rhizoremediation**

**Shinjini Mukherjee**  
**Molecular Environmental Microbiology Group**  
**Department of Biosciences**  
**University of Helsinki**



## Hydrocarbon pollution: A global problem

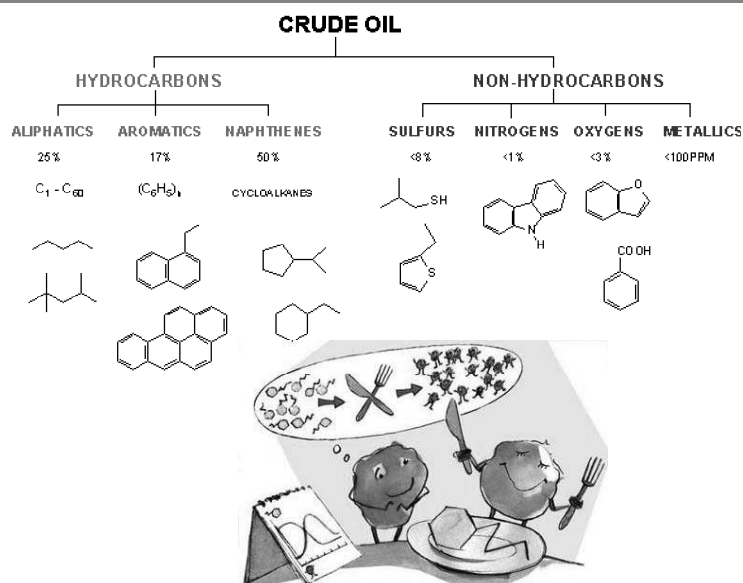


Marine oil spills

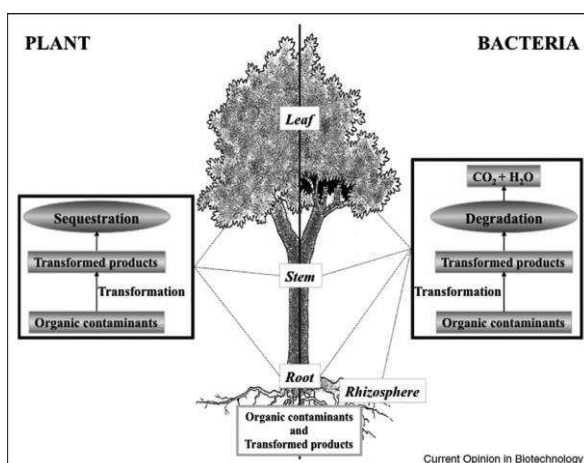


Terrestrial: surface and  
subsurface pollution

## Bioremediation of organic contaminants

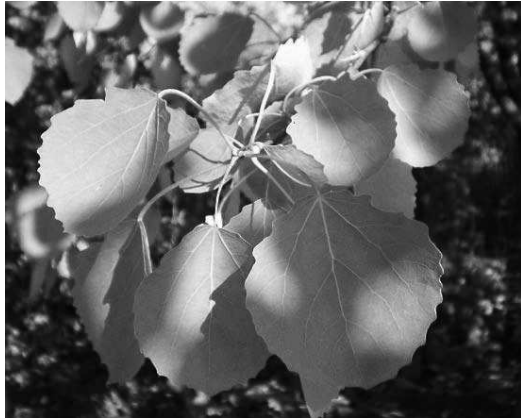


## Phyto/rhizo-remediation of organic contaminants



Weyens *et al.* 2009

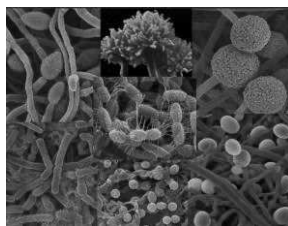
## Populus for rhizoremediation



Aspen/*Populus*

- Model woody plant
- Deep root systems
- Ability to form hybrids
- Low maintenance
- Biomass production for energy
- Economic value of wood
- Sustainable development

## Microbial Diversity in soil and rhizosphere



$10^8 - 10^9$  / gram of soil



Culture based methods



Molecular methods

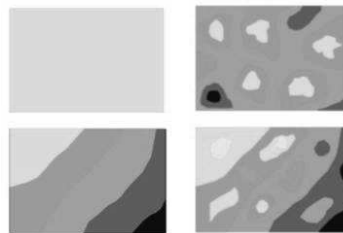
## Temporal and spatial variation of microbes in pollution

### Temporal variation

- Stages of biodegradation
- Seasonal changes
- Plant age modifying rhizosphere population
- Toxicity of contaminants
- Bioavailability of contaminants

### Spatial heterogeneity in polluted sites

- Patchiness and gradients of chemical parameters



### Greenhouse



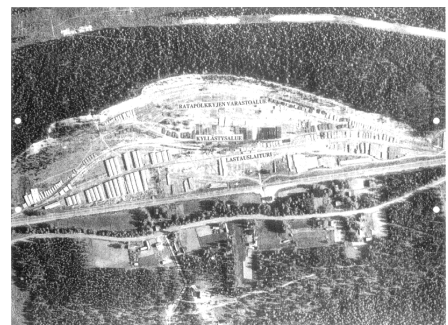
Bacterial community dynamics during initial 10 weeks after oil pollution

### Field experiment



Bacterial community dynamics during 2 years of field study

### Aged polluted site

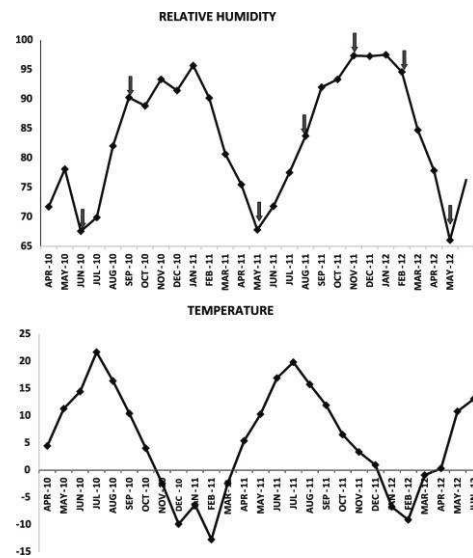


Spatial heterogeneity of contaminants, soil chemistry and microbiological parameters

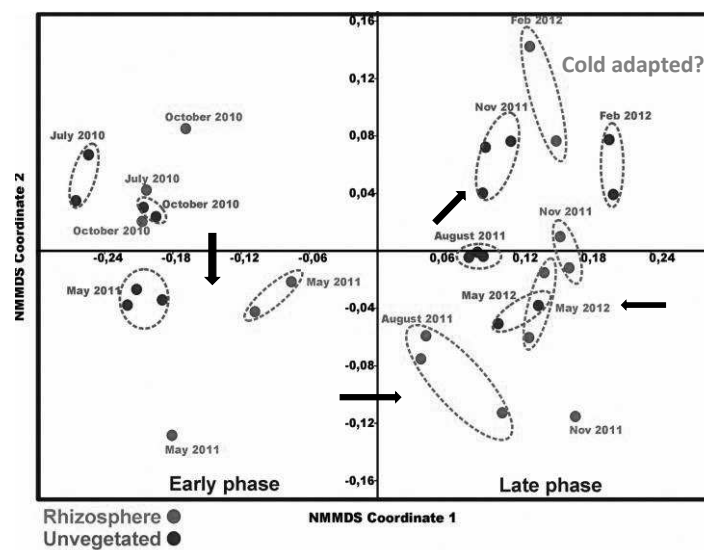
Temporal variation

Spatial variation

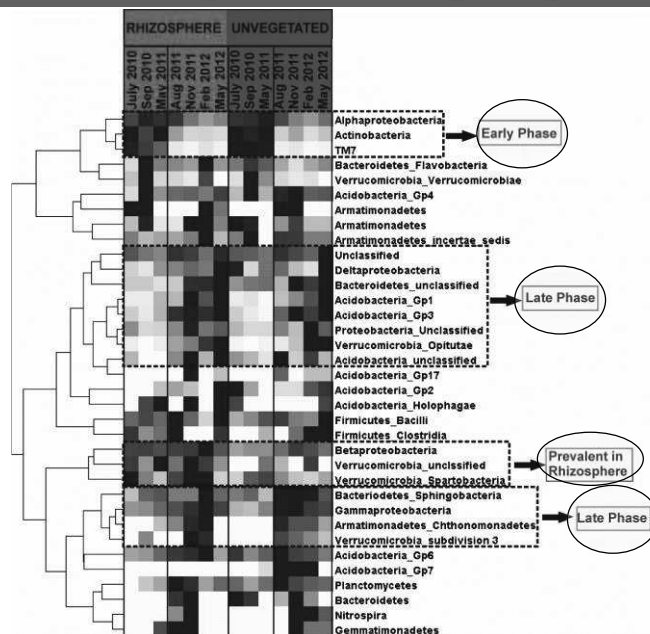
## Temporal variation during 2 years of rhizoremediation



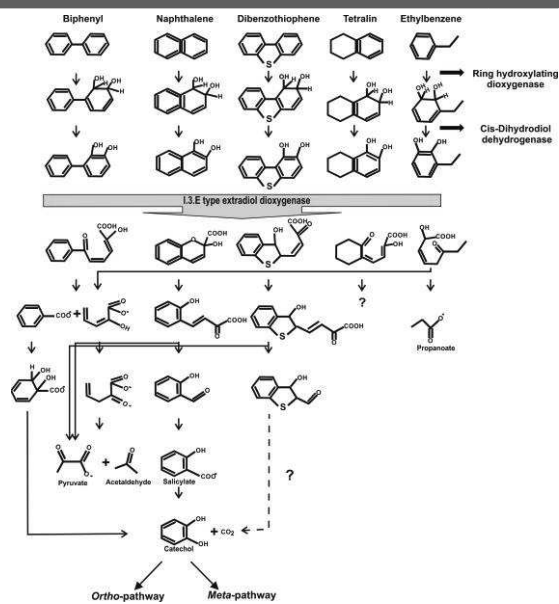
## Microbial population dynamics



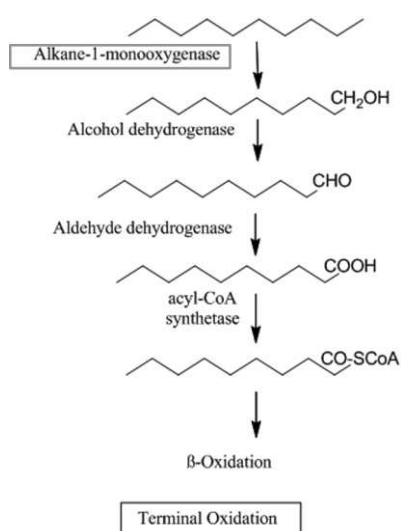
## The key Bacterial groups



## Aromatic degraders: Ring cleavage dioxygenases

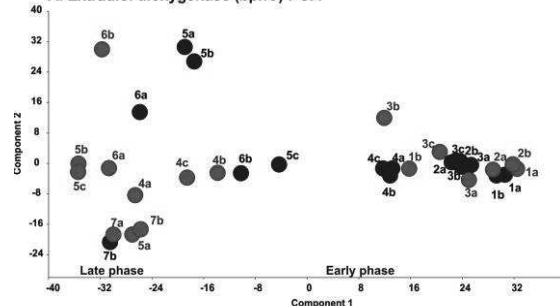


## Aliphatic degraders: alkane hydroxylases

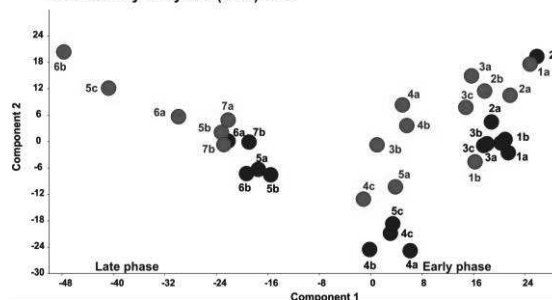


## Aromatic and aliphatic degraders

A. Extradiol dioxygenase (bphC) PCA



B. Alkane hydroxylase (alkB) PCA



## Creosote polluted site in Luumäki



## Implementing *Populus* based rhizoremediation

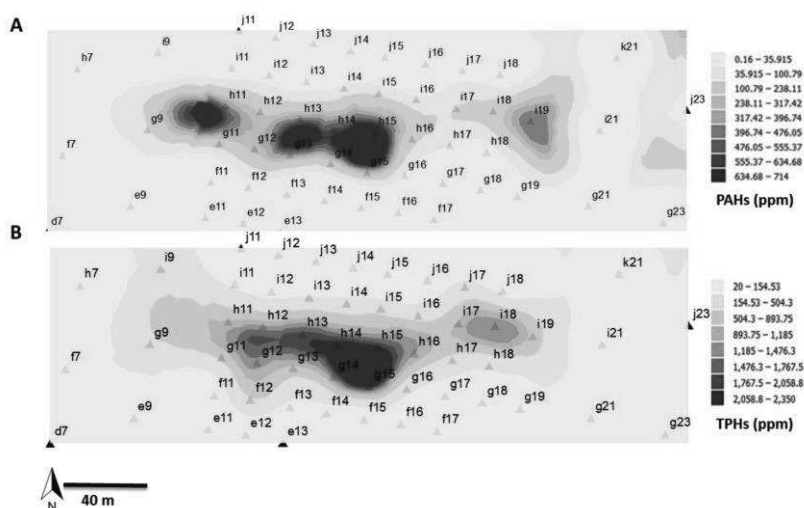




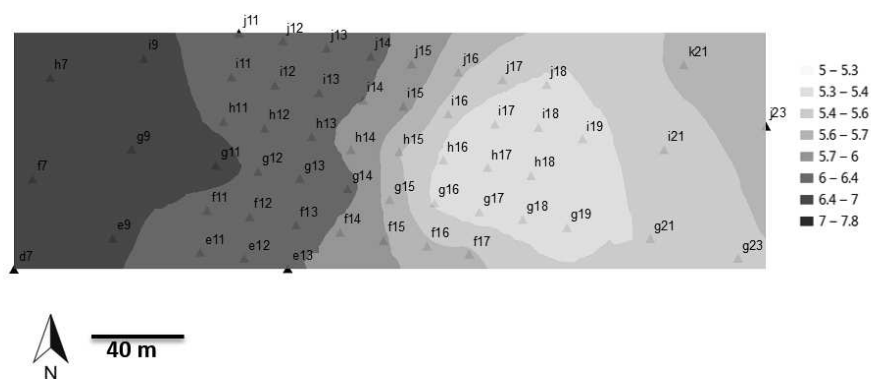
## Chemical pre-evaluation of the polluted site



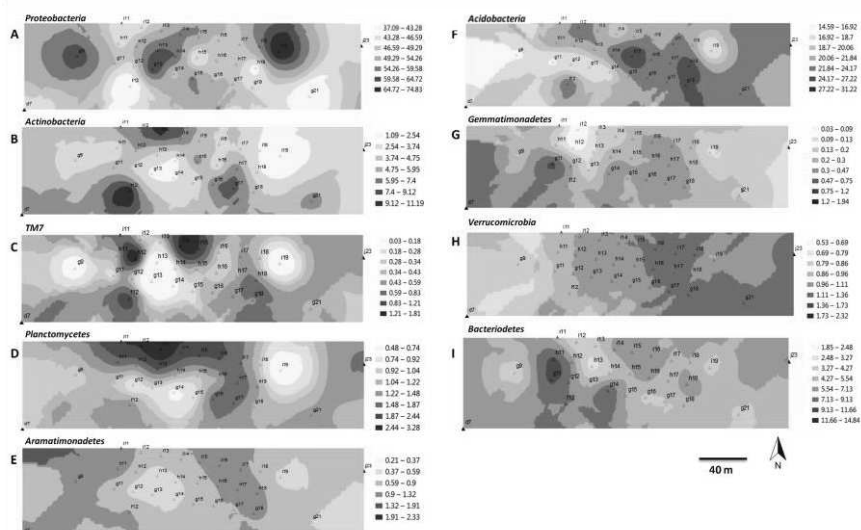
## Chemical pre-evaluation: Krigged maps of pollutant concentration



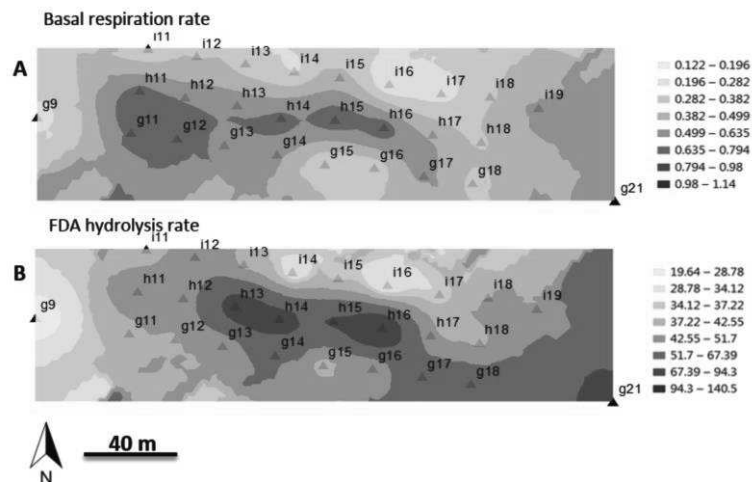
## Chemical pre-evaluation: Kriged map of pH on site



## Microbiological pre-evaluation: kriged maps of bacterial phyla



## Microbiological pre-evaluation: kriged maps of microbial activity



## Conclusions

- Acknowledging the vast diversity and potential role of microbes in remediation of polluted soils.
- Implementing advanced methods in analysing and interpreting microbial ecology of polluted sites.
- Integrating microbial analysis in routine risk assessment and monitoring.
- Combining microbial analysis with chemical analysis for a thorough understanding of biological and chemical aspects of polluted sites.

## Acknowledgements

- **Kim Yrjälä, Timo Sipilä and Heli Jutonen**

MEM Group, University of Helsinki

- **Pertti Pulkkinen and Raimo Jaatinen**

Finnish Forest Research Institute (Metla)

- **Pirjo Tuomi**

Golder associates

- **Jaak Truu**

University of Tartu, Estonia

- **Carsten Suhr Jacobsen**

Geological survey of Denmark and Greenland

- **Emilio O. Casamayor**

CEAB-CSIC Blanes, Spain



MAJ AND TOR NESSLING FOUNDATION



Nordic Environmental  
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**Mutku ry**