Understanding the Aral Sea microbiome and resistome for restauration

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INTRODUCTION: The Aral Sea Expedition

The Aral Sea Expedition
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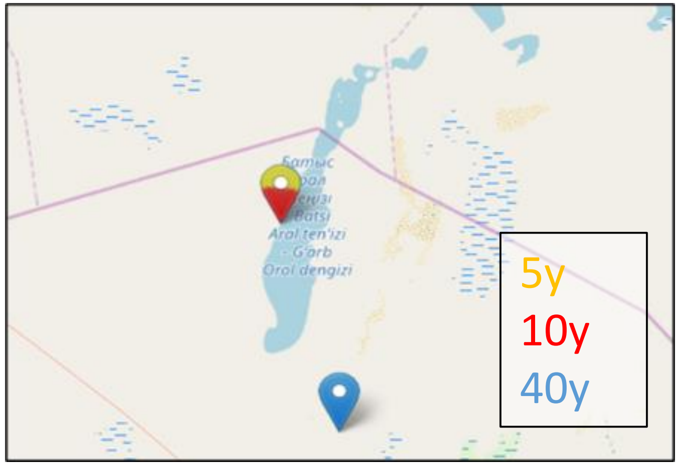
Objective:

I) to understand the microbiome and resistome in a highly disturbed ecosystem

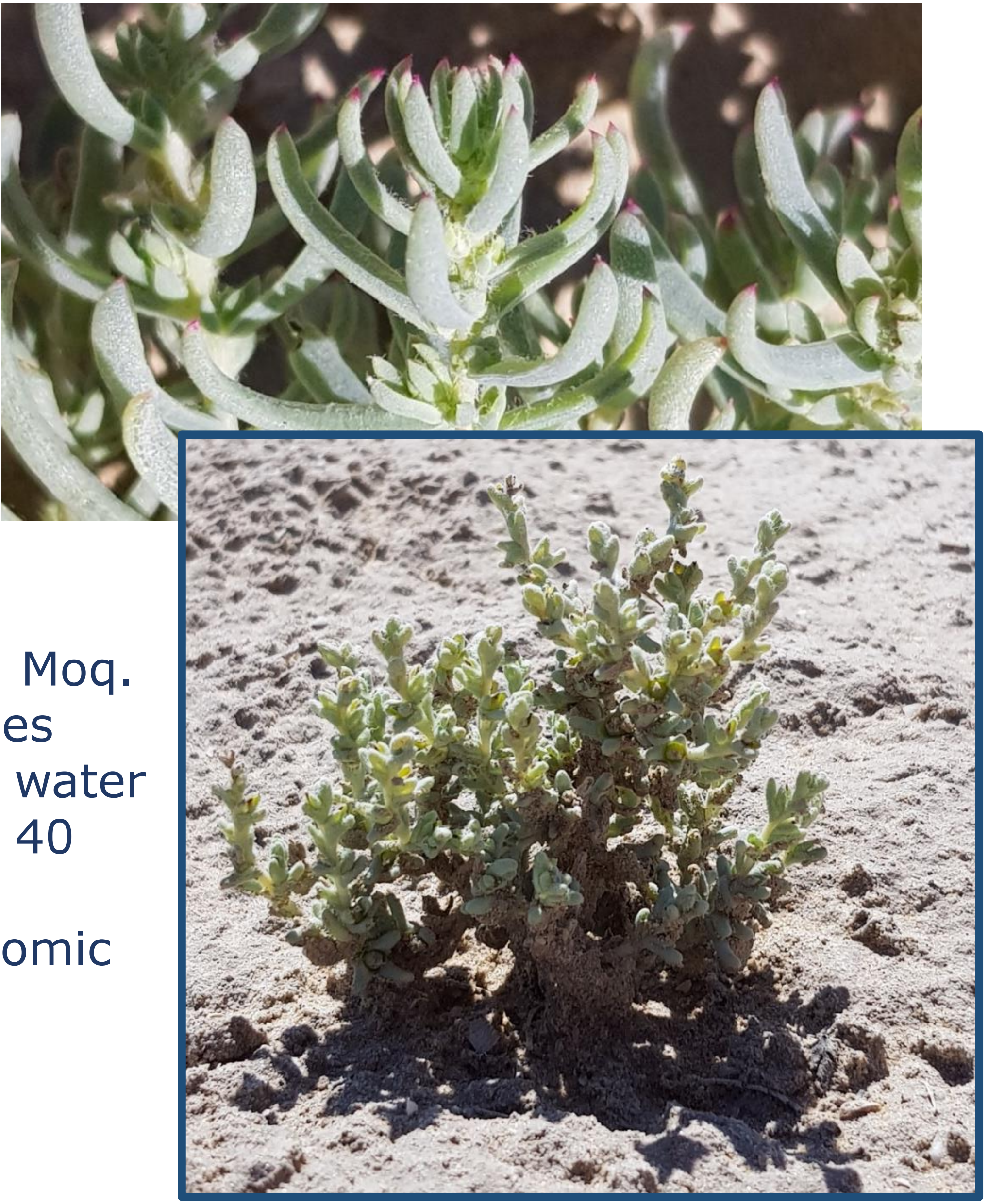
II) to find solutions for restauration

INTRODUCTION: The Sampling and method design



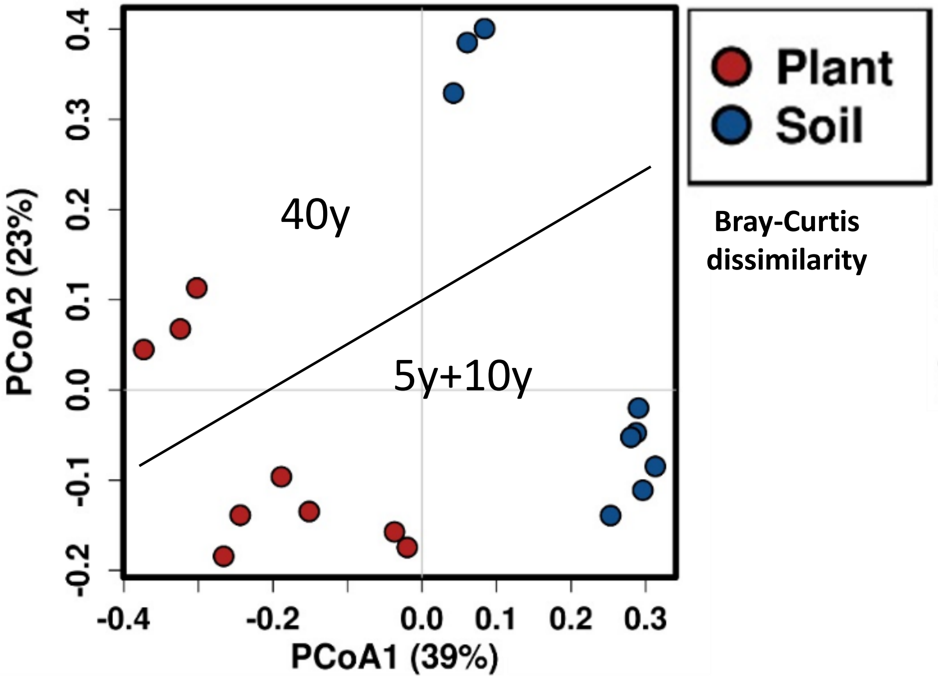
Suaeda acuminata (C.A.Mey.) Moq. rhizosphere and bulk soil samples

- at the Aral Sea shores where water receded 5years, 10years and 40 years ago
- 16S rRNA gene and metagenomic sequencing



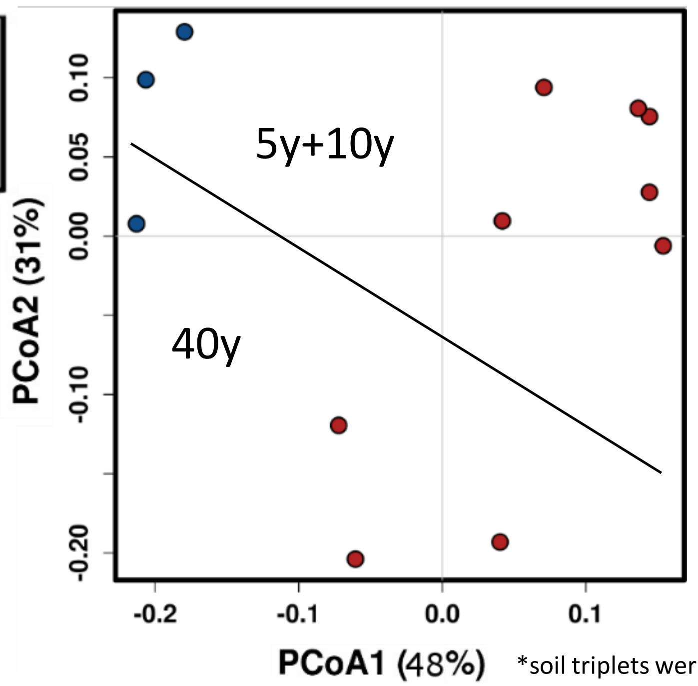
RESULTS: Microbiome: Very distinct microbial communities

16S rRNA gene amplicons



Bray-Curtis dissimilarity

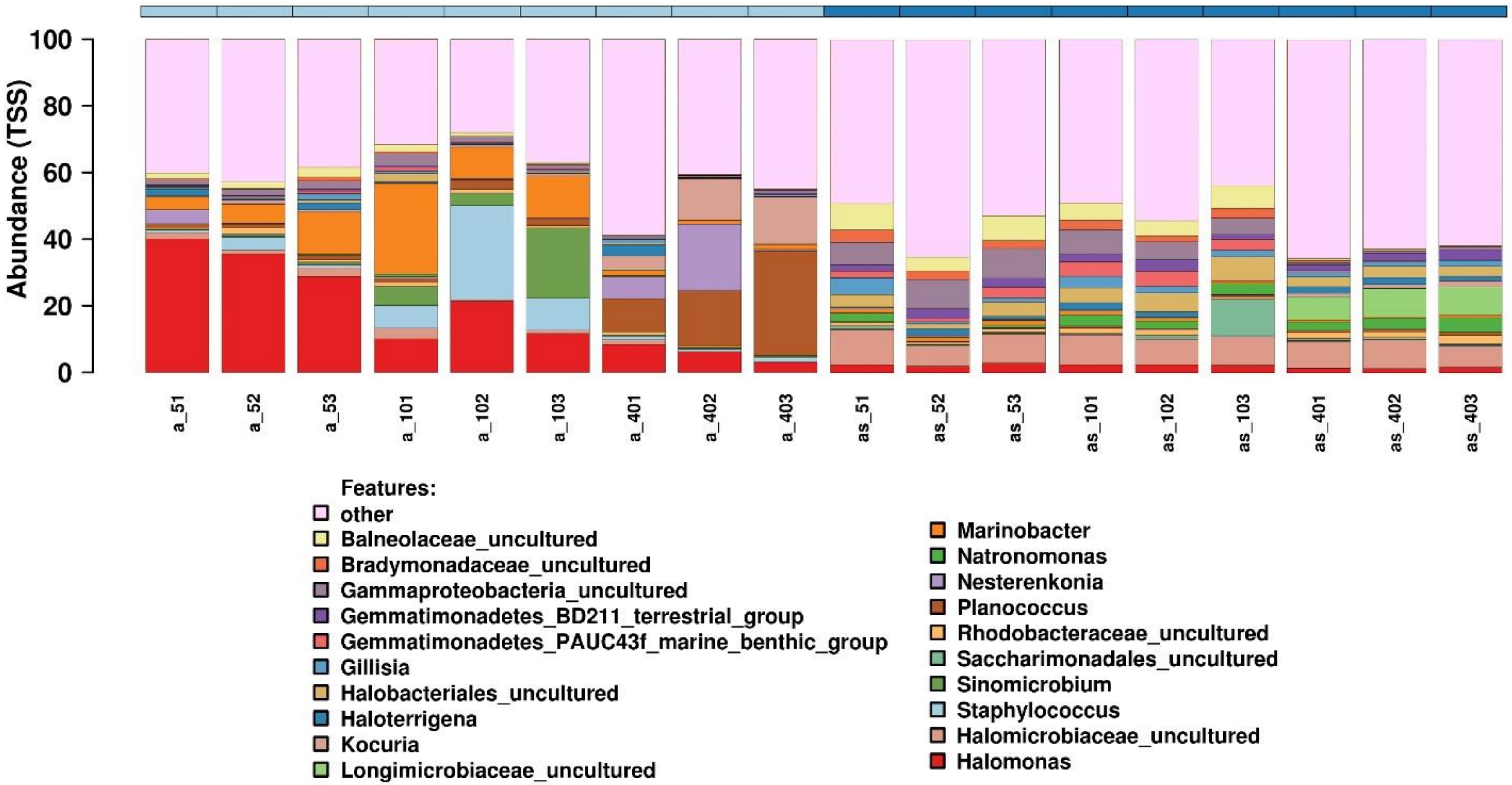
Metagenome*

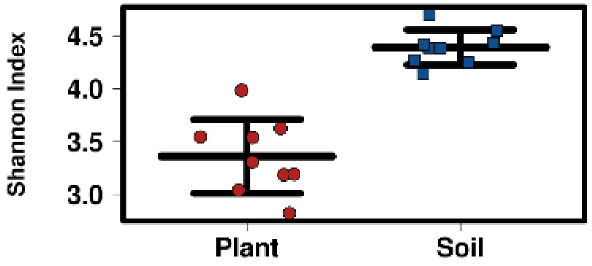


*soil triplets were merged for metagenomic sequencing

Age and microhabitat were the most important drivers

RESULTS: Community composition and alpha diversity



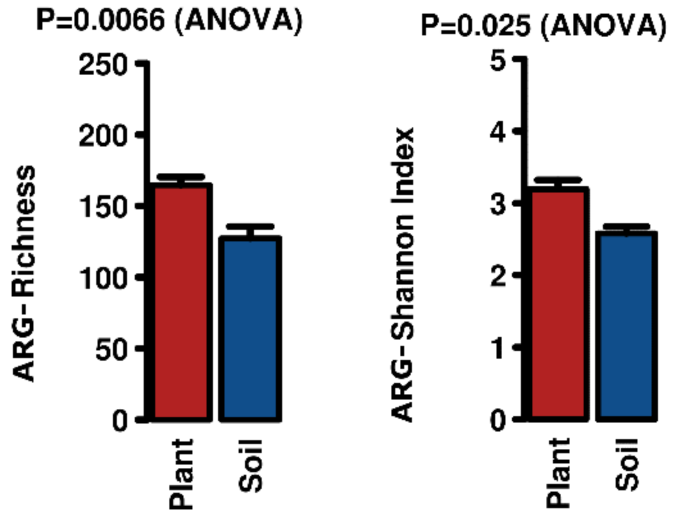


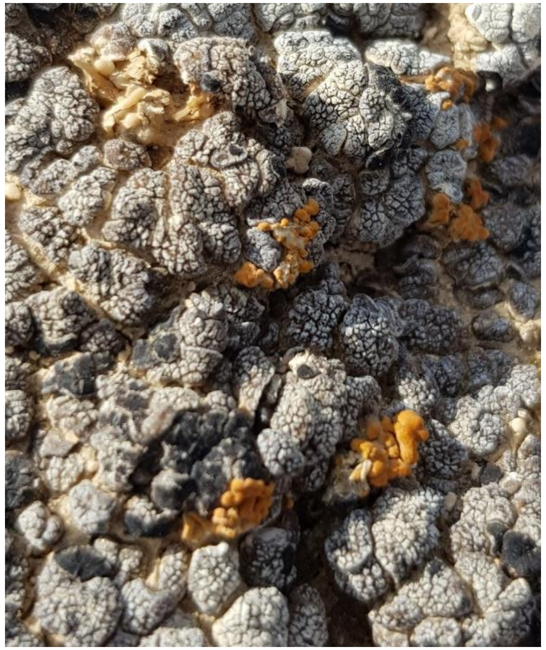
- Statistically significant difference in alpha diversity between plant and soil samples but not over time

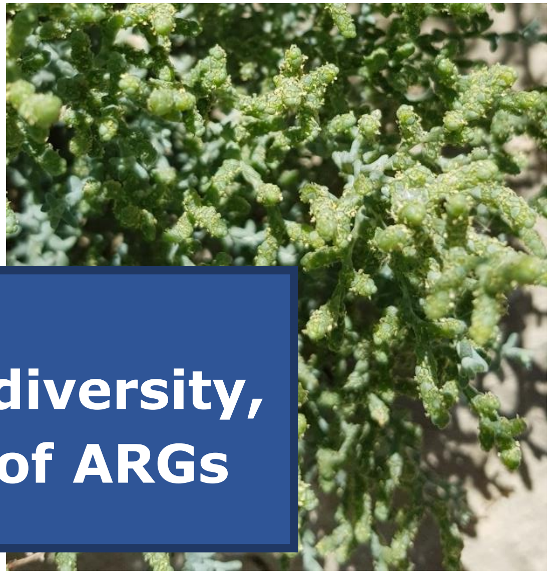
↓*Halomonas* and ↑*Planococcus* over time without water

RESULTS: Resistome diversity versus Bacterial diversity

Antibiotic Resistance Genes (ARGs)



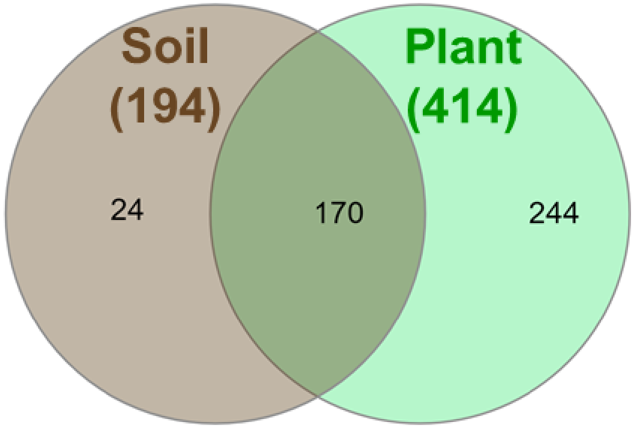


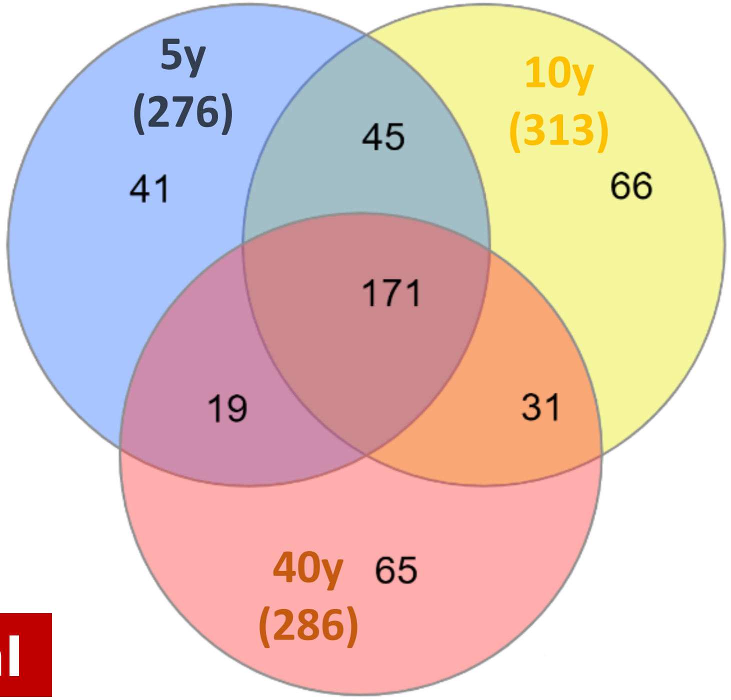


Soil:
High bacterial diversity,
low diversity of ARGs

Rhizosphere:
Lower bacterial diversity,
higher diversity of ARGs

RESULTS: Resistome diversity versus Bacterial diversity

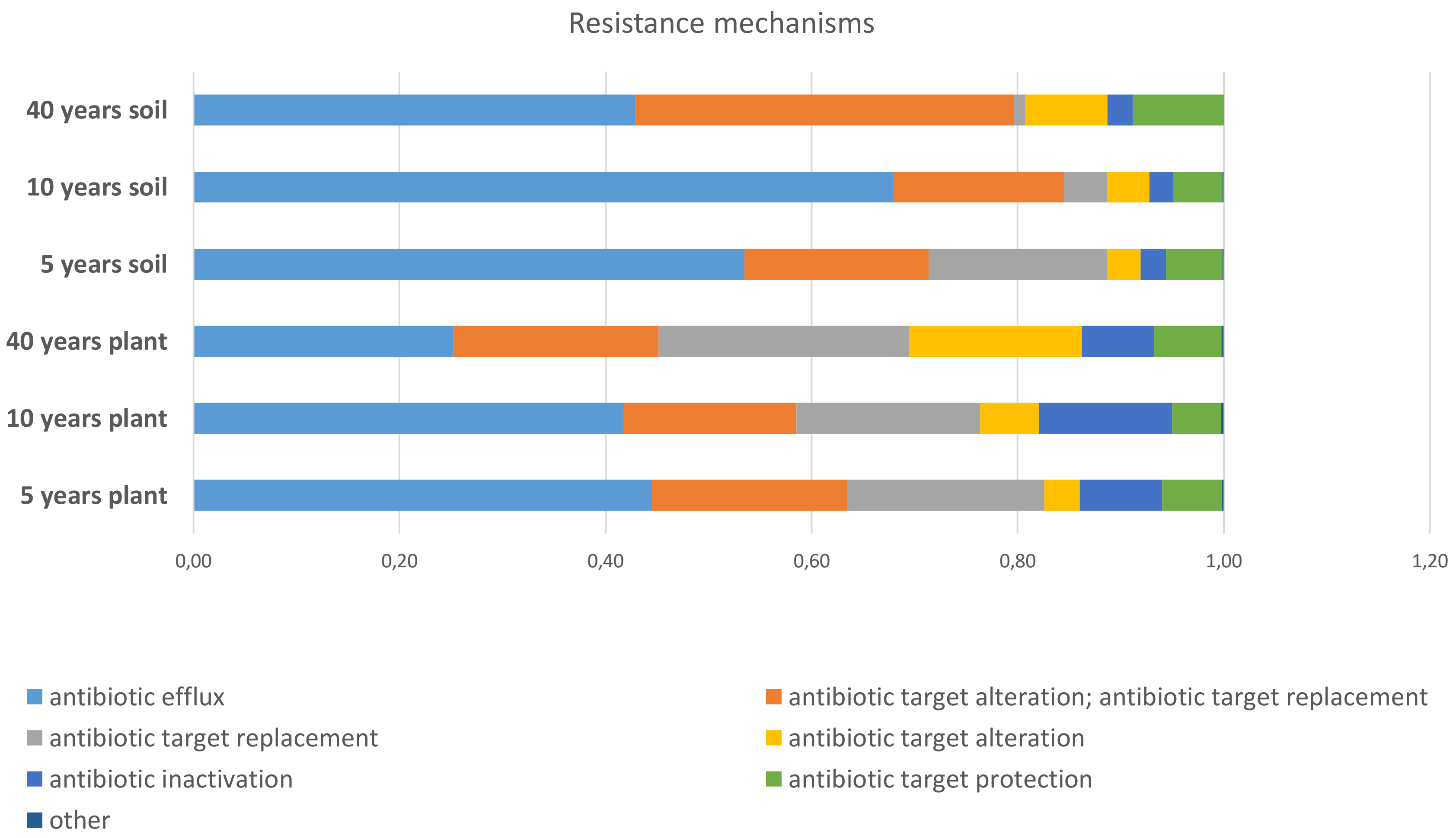




438 different ARGs in total

Habitat and Age-specific resistome

RESULTS: Resistance mechanisms

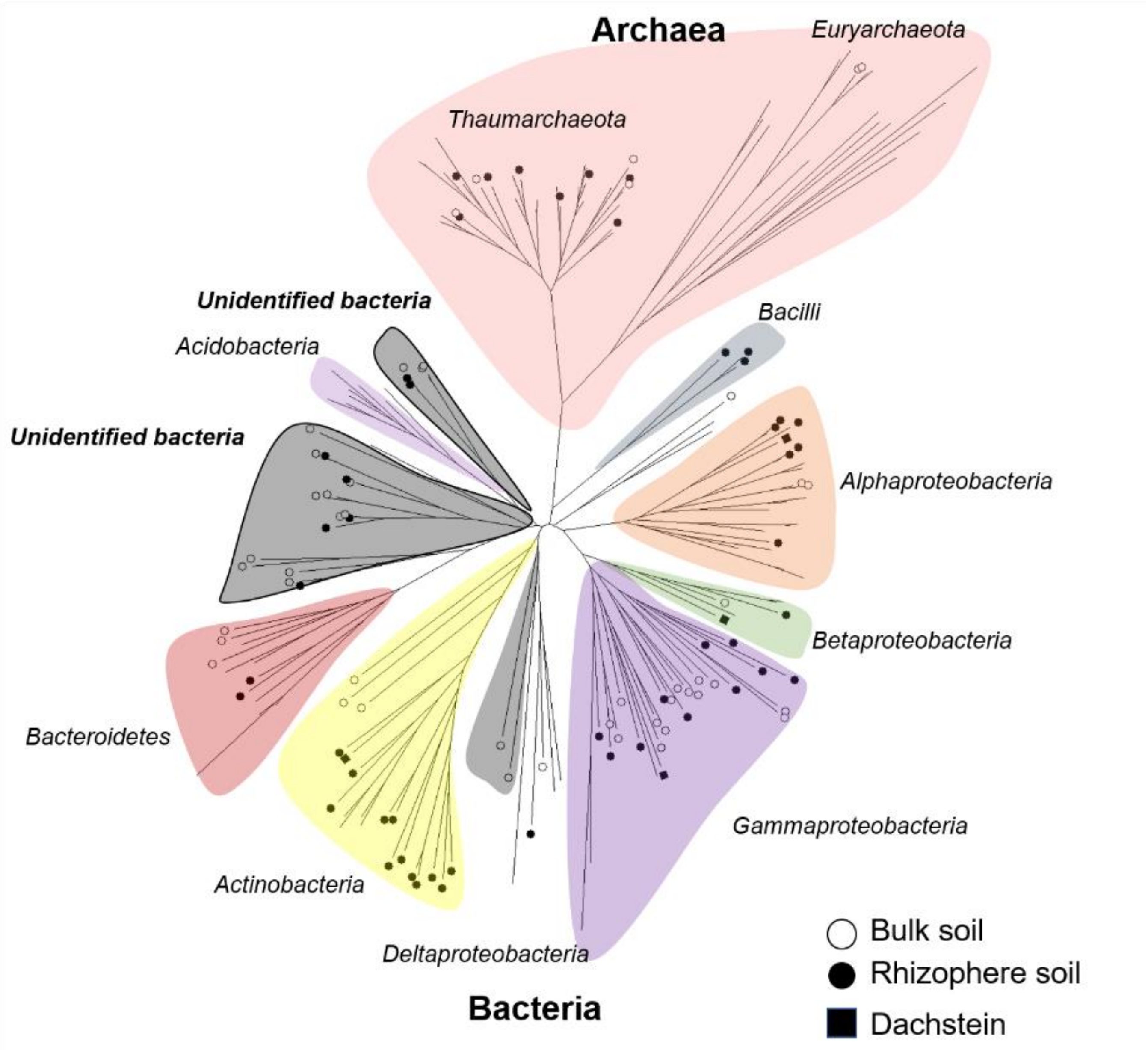


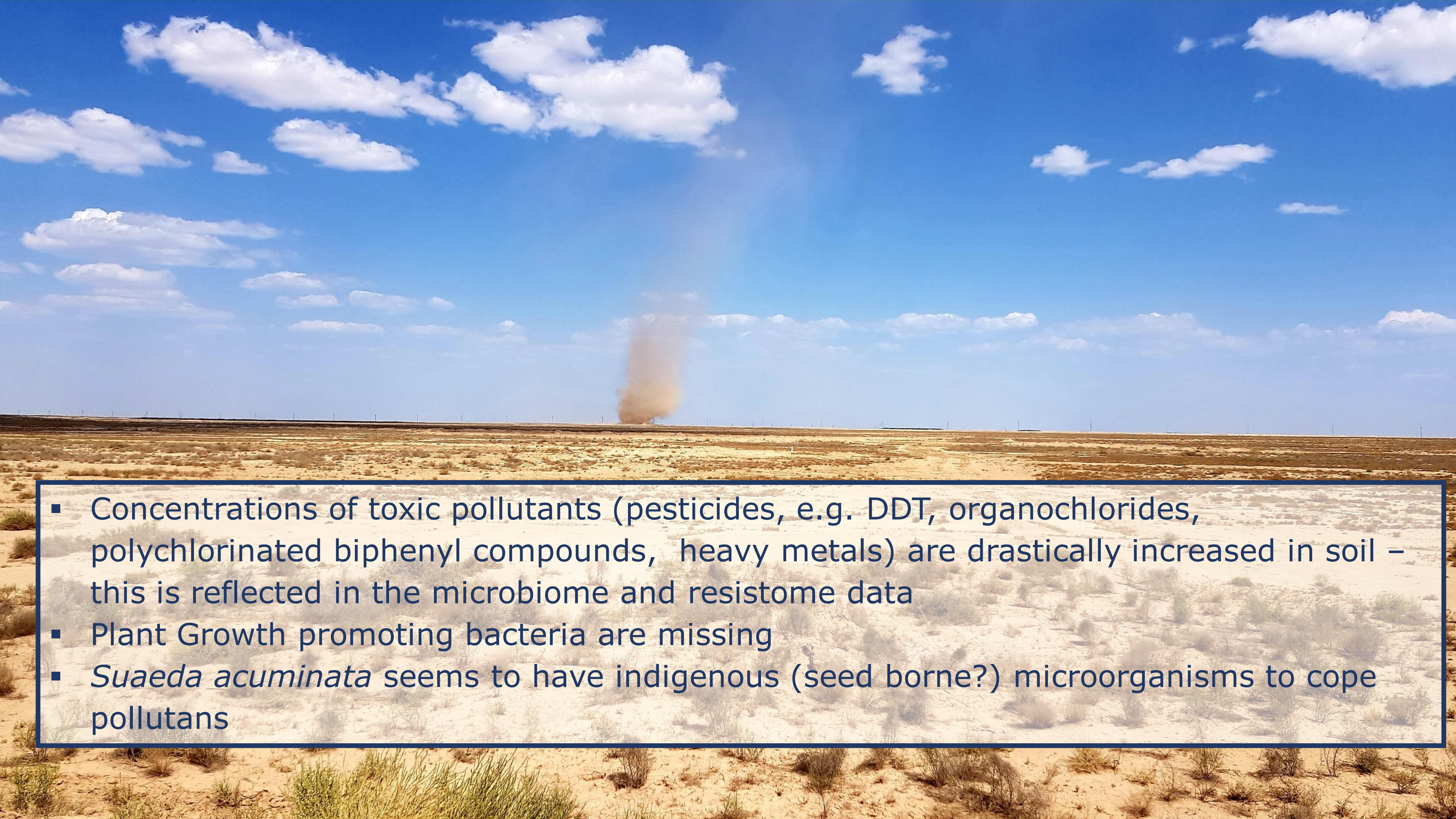
Dominance of (general) efflux mechanisms which is decreasing over time without water

Metagenome assembled genomes (MAGs)

97 MAGs from Aral Sea samples (Bacteria & Archaea)

Comparison to MAGs from environments with low anthropological input (here Dachstein Glacier, Austria, 7 MAGs)





- Concentrations of toxic pollutants (pesticides, e.g. DDT, organochlorides, polychlorinated biphenyl compounds, heavy metals) are drastically increased in soil – this is reflected in the microbiome and resistome data
- Plant Growth promoting bacteria are missing
- *Suaeda acuminata* seems to have indigenous (seed borne?) microorganisms to cope pollutans

What can we do for restauration?

- **Microbial inoculants** with plant growth promoting and stress protecting bacteria are necessary for plant growth
- **Plant rhizospheres** have a high activity, which can help to restore soil quality and recycle pollutants