Prokaryotic community composition and extracellular polymeric substances affect soil microaggregation in carbonate containing semiarid grasslands

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Introduction

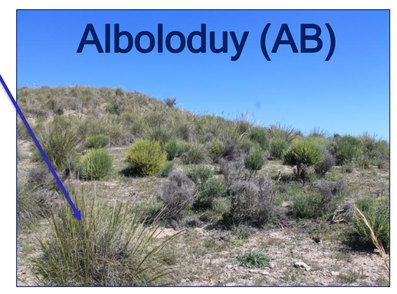
Under semiarid climate conditions complex soil-vegetation interactions are present. Individual plant species enhance the surrounding area via litter input and soil-root interaction. Despite the better conditions in these resource islands, the microbial community experiences drought stress on a regular base. It has been suggested that microbes form a more stable environment in which to live by producing extracellular polymeric substances (EPS). The effects of EPS on aggregate stability seems to be twofold, as it adsorbs to mineral surfaces and forms bridges between mineral surfaces.

Objective: To determine the influence of two plant types on the prokaryotic community composition, EPS content and microaggregate stability, depending on parent material.

Study Area

- Semiarid, 250 mm annual precipitation
- Perennial grass *Macrochloa tenacissima*
- Legumes shrub *Anthyllis cytisoides*
- 2 Sampling sites, 5 replicate plots, on south facing slopes of 15-20°

Alboloduy (AB) – Sierra Nevada
Loamy sand soil; mica schist; high carbonate content
Rambla Honda (RH) – Sierra de los Filabres
Loamy sand soil; graphitic mica schist; low carbonate content

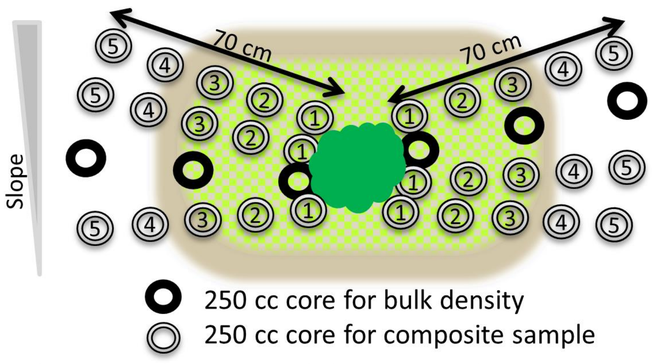


Methods

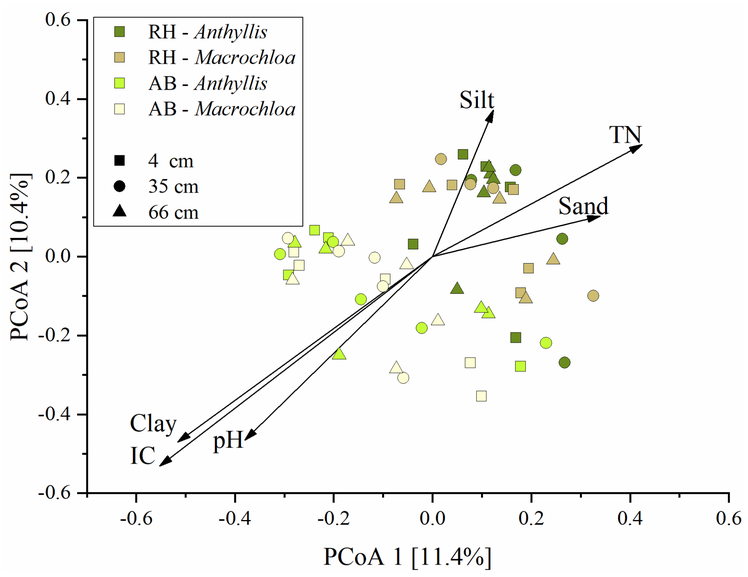
- ✓ Plants pruned and undergrowth clipped
- ✓ Sieving crust removed by gently brushing
- ✓ 6x 250cc (5cm deep) soil cores taken and mixed in composite sample

- Illumina Sequencing of Bacterial and Archaeal 16S rRNA Gene Amplicons.
- EPS extracted after Redmile-Gordon et al. (2014) and total saccharide quantified after Dubois et al. (1956)
- Microaggregate fraction (< 250 µm) by dry-sieving
- Mean weight diameter of microaggregate fraction after fast wetting, by laser diffraction particle size scanner (Coulter LS2000)
- Microaggregate wettability after Bachmann et al. (2013)

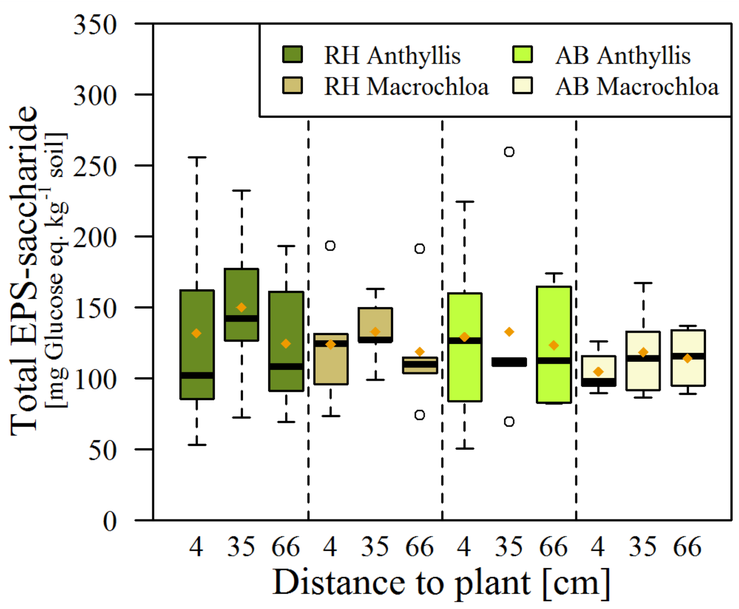
2 sites
5 plots
2 plant species
5 distances:
4/19.5/35/50.5/66 cm
Focus on 3 distances:
4/35/66 cm



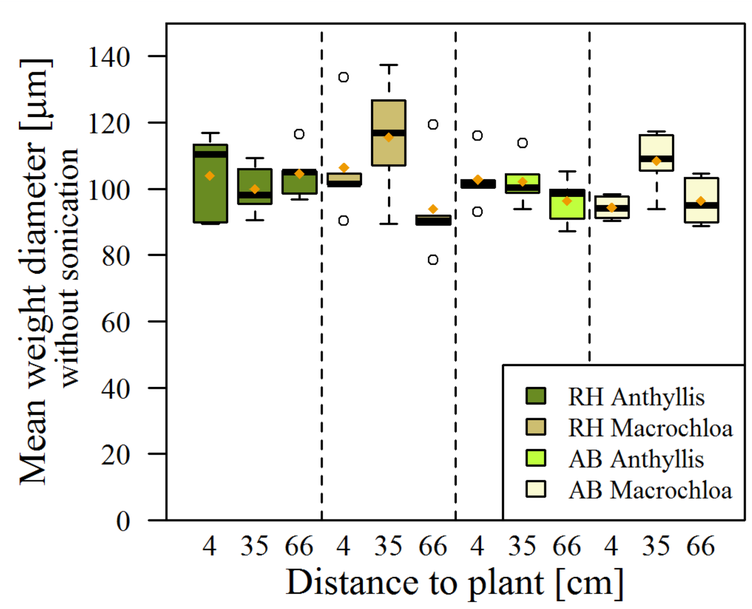
Numbers stand for the distance between the centre of the core to the stem, i.e., 4 (1), 19.5 (2), 35 (3), 50.5 (4), and 66 (5) cm. Average canopy diameter is indicated with light green (blocked pattern) for Anthyllis and brown for Macrochloa. (Zethof et al., 2020)



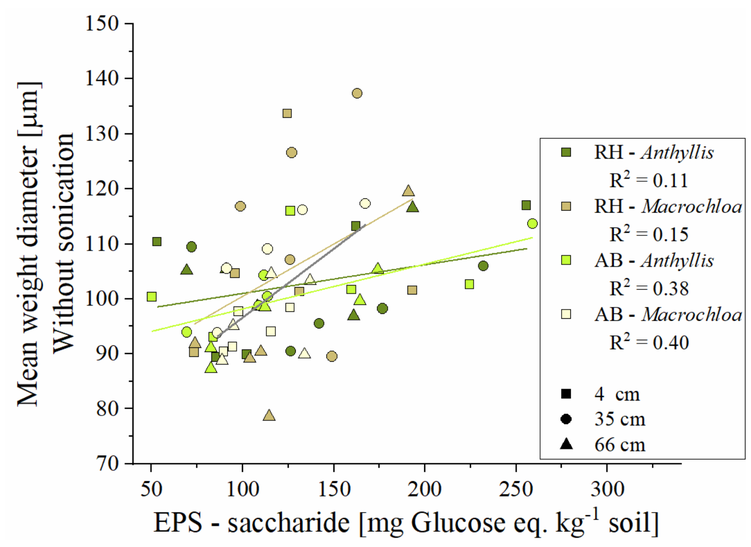
Prokaryotic community differed between sites, not plant species



EPS-saccharide content hardly changes over distance to the plant



Microaggregate stability significant higher at the *Macrochloa* canopy edge (35cm) than at furthest distance (66cm), independent of site.



Significant relationship between MWD of microaggregate fraction and EPS-saccharides content in Alboloduy (AB) site

Structural equation modelling revealed:

- **Differences in prokaryotic community composition linked to graphitic C content in Rambla Honda**
- **In Alboloduy, both organic C and total N drives differences in prokaryotic community composition**
- **EPS-saccharide content is driven by organic C content, independent of parent material**
- **At Alboloduy, EPS-saccharide content is related to differences in prokaryotic community**
- **Microaggregate wettability is related to EPS-saccharide content at Rambla Honda and Alboloduy - *Anthyllis***
- **EPS-saccharide content drives microaggregation in the carbonate rich Alboloduy site.**

(Figures from Zethof et al. 2020)

Conclusion

OM drives soil EPS-saccharide content by shaping the soil prokaryotic community. Large contents of polyvalent cations, as found in carbonate enriched soils, promote the stabilizing effect of EPS on soil microaggregation.

More detailed description (accepted and available soon):

Zethof JHT, Bettermann A, Vogel C, Babin D, Cammeraat ELH, Solé-Benet A, Lázaro R, Luna L, Nesme J, Woche SK, Sørensen SJ, Smalla K and Kalbitz K (2020): Prokaryotic Community Composition and Extracellular Polymeric Substances Affect Soil Microaggregation in Carbonate Containing Semiarid Grasslands. *Front. Environ. Sci. 8:51.* doi: 10.3389/fenvs.2020.00051

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