Progressively intensifying drought shifts C allocation towards storage, with relative fungal resistance

Lisa Stein[1], Alberto Canarini[1,2], Lucia Fuchslueger[1], Hannes Schmidt[1], Victoria Marie Ritter[1], Michael Bahn[3], Andreas Schaumberger[4], and Andreas Richter[1,5]

Introduction

Microbial communities assimilate organic carbon and either allocate it to cell division (growth *sensu stricto*) or the synthesis of storage compounds or osmolytes (growth *sensu lato*). Under steady-state conditions, the partitioning of carbon between replicative and non-replicative growth may remain relatively constant, but climate change likely alters microbial growth dynamics and C allocation to different processes.

Research questions

- How does drought and future climate conditions, independently and in combination, influence microbial growth and storage compound synthesis?
- How does progressively intensifying drought impact microbial replicative and non-replicative growth?

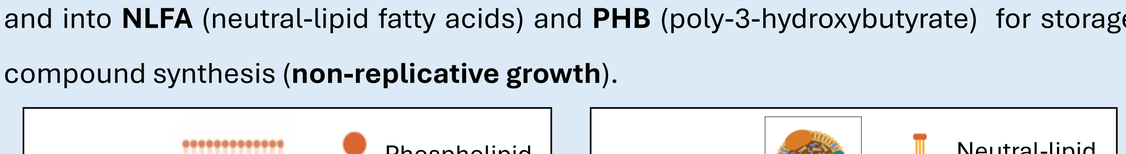
Study Design – ClimGrass

- Austrian sub-montane grassland in Raumberg-Gumpenstein, Styria
  - Ambient
  - Drought (ambient climate with summer drought)
  - Future climate (+3 °C, + 300 ppm)
  - Future climate + drought (+3 °C, + 300 ppm, with summer drought)
- May (before drought), June (intermittent drought), July (high drought) and August (severe drought)

Temperature (ambient, +3 °C) | CO_2 (ambient, +300 ppm) | Summer Drought (12 weeks without rain)

^2H – vapor – SIP

^2H incorporation into **PLFA** (phospholipid fatty acids) to quantify **replicative growth**, and into **NLFA** (neutral-lipid fatty acids) and **PHB** (poly-3-hydroxybutyrate) for storage compound synthesis (**non-replicative growth**).



Bacterial mass-specific growth rates decreased more strongly than fungal growth rates with drought

Figure 1: Mass specific growth rates for a) bacteria and b) fungi, and c) fungal to bacterial growth rate ratio under ambient, drought, future climate and future climate + drought conditions (May = before drought; June = 1 month of drought; July = 2 months of drought; August = 3 months of drought).

Mass-specific NLFA production rate increased with season in all treatments. Relative to PLFA production rates, both NLFA and PHB production rates increased with drought.

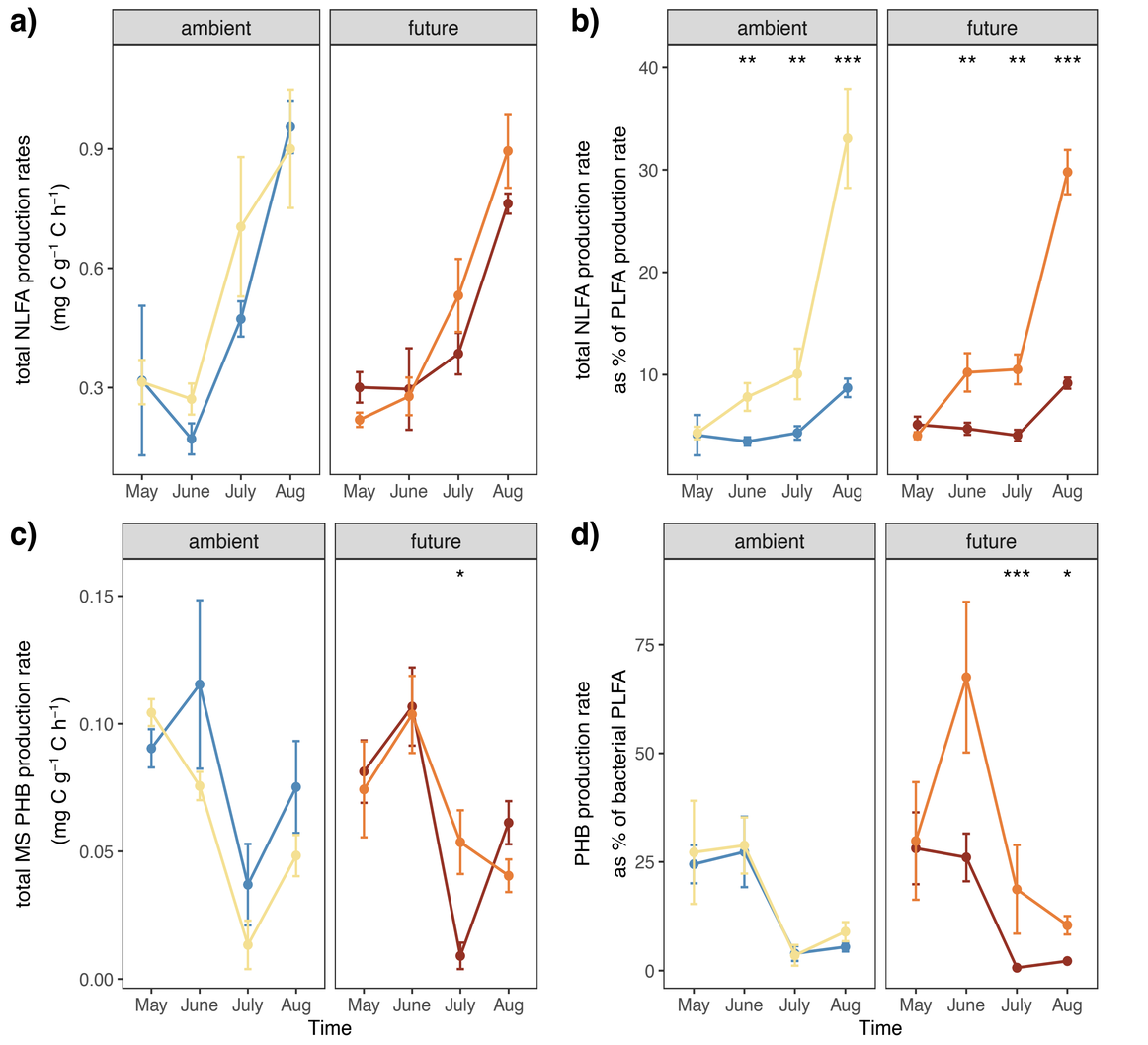


Figure 2: a) total mass-specific NLFA production rate b) NLFA production relative to PLFA production, c) total PHB production rate and d) PHB production relative to bacterial PLFA production under ambient, drought, future climate and future climate + drought conditions (May = before drought; June = 1 month of drought; July = 2 months of drought; August = 3 months of drought).

Actively growing microbial communities were separated according to future climate conditions (warming) in May but progressively became separated by drought.

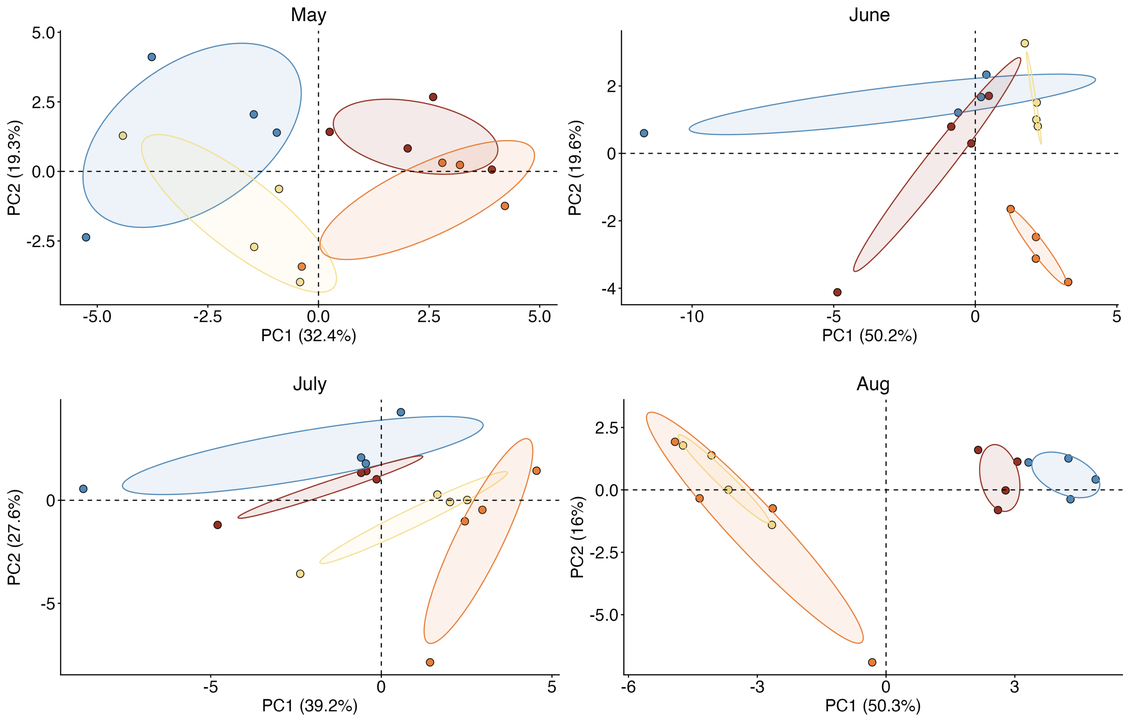


Figure 3: Principal component analysis (PCA) of the active microbial community based on ^2H incorporation into PLFA biomarkers. Active community composition colored by treatment is represented during 4 timepoints (May = before drought; June = 1 month of drought; July = 2 months of drought; August = 3 months of drought).

Conclusion

- Bacterial growth declines under all investigated treatments. However, fungal growth is more resistant towards drought. Prolonged drought of three months diminishes fungal resistance
- Separation of the active community by future climate shifts towards a separation according to drought.
- Mass-specific NLFA production rates increase progressively over the season in all treatments.
- Drought shifts C allocation from replicative growth to storage compound synthesis.

[1]University of Vienna, Centre for Microbiology and Environmental Systems Sciences, TER, Wien, Austria (lisa.stein@univie.ac.at)
[2]Department of Biological, Geological and Environmental Sciences, University of Bologna, Bologna, Italy
[4]Agricultural Research and Education Centre Raumberg-Gumpenstein, Irdning, Austria
[5]International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria