**INTRODUCTION**

**A: Introduce your topic: Specialized communities can adapt to changes via shifts in taxonomic composition.**

Microbial communities exposed to identical environmental conditions often converge on a similar functional potential landscape, as they are subjected to similar selective pressures [ref?]. Because the functional distance between organisms is at least partially linked to taxonomy, the higher order structure of such communities (i.e. the taxonomic composition at the phylum level or higher) is also expected to converge to a similar composition, and will remain relatively robust given unchanging environmental conditions [ref?].

While understanding the taxonomic classification of individual community members is useful for inferring lineages, this fine-scale community composition is often irrelevant to the overall functioning of the community, as many taxa can occupy the same functional niche within the microbiome [ref?]. This functional redundancy ensures that even after major perturbations to community structure, the functional potential of the microbiome persists. Therefore, while the higher order taxonomic structure of a microbial community is driven by selective pressures, the individual membership (i.e. individual species constituting the higher order taxonomy groups) of a microbiome may vary greatly across time and space, and can be stochastic in nature. [1, 2]

**B: Identify the knowledge gap: how do specialized communities adjust to rapid changes that they rarely encounter?**

Previous studies of controlled environments have shown that higher-order taxonomic composition as well as the functional landscape of microbiomes can be very resilient and can recover after significant artificial perturbations such as temperature changes and antibiotic administration [3-5]. However, while the recovered community may have the same higher order taxonomic composition and functional potential as before the perturbation, but be constituted of a new set of organisms.

**C: Explain how you are going to fill that knowledge gap: The response of halite microbiomes to the rare rain event are an ideal system to answer this.**

The North of the Atacama Desert is one of the driest and harshest places on Earth, receiving rainfall only every few years, exposed to high amounts of ultraviolet radiation, and being subject to extreme temperature and humidity swings throughout the dial cycle. Despite this, polyextremophilic microbiota residing in the desert evolved to exist in these extreme conditions. To survive extreme desiccation, these microbial communities rely on the protection of salt rock nodule formations (halites) found in the salars (salt flats) of the desert. Because of salt’s deliquescent properties, these endolithic microbiomes are able to survive by receiving almost all their water from the humidity in the air. [6-8]

Because the halite nodules are composed mostly of sodium chloride, the halite endolithic microbiomes are also hyper-halophilic [6, 7]. Because of this, the major taxonomic groups of these communities are *Halobacteria* and *Bacteroidetes* – two taxonomically different halophiles that through convergent evolution share a unique adaptation to high salt concentrations [7, 9, 10]. Instead of actively pumping sodium ions out of the cell (salt-out strategists), they selectively pump potassium ions into the cell instead (salt-in strategists). The high internal potassium concentrations balance out external osmotic pressure from sodium. This strategy is energetically favorable to actively pumping out sodium [11], but the proteomes of these cells must also adapt to function at high potassium concentrations. As a result, their proteomes have an extremely low isoelectric point (pI), which ensures protein surface stability under such conditions. [12-14]

In nature, highly specialized community members are more vulnerable to change compared to habitat generalists. [10] The unique adaptations of halite microbiomes to survive under the specific and harsh conditions of the Atacama Desert could potentially render them more sensitive to unexpected perturbations, making this system an interesting target to study the resilience of microbial community structure. Because the halite nodules are comprised mostly of porous salt [15], a major rain event could at temporarily alter the external osmotic conditions surrounding the endolithic microbiota, thus creating a major shock and perturbation.

Due to their isolated nature, the endolithic halite microbial communities receive very little biomass exchange with the outside world. [8] The only major inputs that a halite communities receive are sunlight, atmospheric gases, and humidity from the air. [6, 7] As such, each halite nodule represents a near-closed system, which offers a unique opportunity to investigate the response of microbiomes to external stimuli and perturbations in their natural habitat without other external factors compounding the results.

**What is the paper about?**

1. There are two types of community shifts:
   1. Gradual shifts via changes in relative abundances of major taxonomic groups
   2. Rapid shifts via changes in abundances of major taxonomic groups, and rearrangement within those groups.
2. Microbiomes are overall resilient at the taxonomic and functional scales
3. Individual community composition can be permanently rearranged by rapid perturbations

**Major concerns about intro:**

You need to be more precise about references, add more in the right places, and add the right ones. Look up our previous papers for references!

1. You need to end the intro by describing in broad terms what you did and what you found. Here you should say that you used an unusual rain event in the Atacama to investigate he response of microbiomes to external stimuli and perturbations in their natural habitat. Our longitudinal study revealed ….….

Info about the desert being very dry needs to be more developed, i.e. why is it so dry and how dry (give numbers and references), how extreme, i.e. UV and temp (give references). Take the opportunity to stress the last of rain fall.

There are more than just salt rocks colonized, you need to acknowledge that and give references. Also expend what these salars are, how they formed/geology – references. The papers you cite do not address what salt flats are and the deliquescence itself (see next comment)

Expend on this, i.e. deliquescence provides liquid water in the halites – see Jacek and Alfonso paper about that. Why are halites so interesting?

You should start by reporting the findings of previous studies on halites (ours and others) describing what we know of these communities. Not all members of the community are salt-in strategist. I think this should be part of the discussion.

**Bibliography:**

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