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Interactive comment on "The composition of endolithic communities in gypcrete is determined by the specific microhabitat architecture" *by* María Cristina Casero et al.

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We are grateful for Ref. # 2 and your comments focused on microhabitat's architecture and its relations with environmental factors in that very microhabitat. It was several years ago when we discovered the presence of endolithic microorganisms within several substrates in the hyperarid Atacama Desert as the last refugees of life in these harsh environmental conditions (review in Wierzchos et al. 2018). The attached Table summarizes the presence of dominant microorganisms within three different endolithic habitats (crypto-, chasmo- and hypoendolithic) in only one Ca-sulfate lithic substrates.

Hence the endolithic habitat could be the same, their dwelling microbial communities'

composition could be very different. It means that the denomination and nature of endolithic habitat is not a driver of microbial structure. If we compare the Ca-sulfate substrates from different climatic regimes of the Atacama Desert it is obvious that indeed these characteristics of climate regimes (T, RH, rainfall, dewfall, etc.) must have the main influence on the endolithic microbial communities' composition. Definitely, for this reason, our study was performed within the same external climate regime and more: within the same piece of gypcrete with three well defined endolithic microhabitats. This was a challenging question: how are the structure and composition of endolithic colonization within the same climatic regimen and the same piece of the rock? Our work answers that there are certain differences in endolithic microbial structure among crypto-, chasmo- and hypoendolithic habitats. We would like to again underline that the external climatic regime was absolutely the same for studied rock pieces and one could expect the same or very similar microbial structure colonization within all three endolithic habitats. However, our results have shown that indeed the structure of these microbial colonization's is different among endolithic habitats. How is a driver of these differences? Of course different microclimatic regimes at the micro-scale within different endolithic microhabitats. Obviously, it is impossible to measure microclimate parameters such as T, RH, dewfall, gravity water flow, water nanopore condensation, evaporation rates, solar irradiance, heat irradiance, etc. within endolithic microhabitats. However, it is and it was possible to describe and characterize the "architecture" of these microhabitats (this work and references in a review in Wierzchos et al., 2018). The term rock architecture was for the first time introduced by Wierzchos et al. (2015) as follows:

..."4.6. Architecture of a lithic substrate As observed with microscopy techniques, internal structural elements such as porosity, pore-size distribution, presence of large pores and cavities, light transparency and light scattering properties, dissolution and crystallization features, and sepiolite nodules distribution varied significantly within various location of the gypsum substrate. These all together structural, physical, chemical and mineral elements give rise to a new understanding of the features and functions relevant to the rock bioreceptive characteristics. We suggest using the term of "rock architecture" instead of "rock structure" to emphasize the functional role of the rock interior. As such, this new concept of the architecture of a lithic substrate encompasses the internal structures of a rock with all mentioned elements that are essential as a habitat for microbial life. It is about perceiving the rock interior from the existence of porous spaces of different sizes and shapes, interconnected or not; the solid structures that divide and support these spaces, and the minerals and salts that can be transformed. All these components and elements are interrelated and influence one another, thus fulfilling a requisite: they might shape a suitable architecture to hold microbial life. The architecture of habitable rocks provides resources (water, light and nutrients, above all) and guarantees effective protection from excessive evapotranspiration, thus assuring efficient gas exchange and provides long-time stable fabric. Considering the architecture of a rock can provide an integrated view of its potential habitability for endolithic microbial communities. All porous rocks have a structure, yet very few show such a suitable architecture for endolithic microbial colonization, even under extreme environmental conditions, as the Atacama's gypsum do."...

Following this definition, we can distinguish different architecture of the substrate within different endolithic microhabitats, and indeed these differences will induce different microenvironmental characteristics on the microscale. And these microenvironmental characteristics shaping the different microbial structures within different endolithic microhabitats what was shown in our paper. As so, we do not pretend to separate the influence of the architecture of the microhabitat from the myriad of other environmental variables. Quite opposite. We consider that indeed distinct differences in the microarchitecture of the microhabitats have an influence on environmental variables at the microscale and shape microbial colonization structure. We consider that the endolithic communities are determined by endolithic microhabitat architecture and not by the endolithic microhabitat type (crypto-, chasmo- and hypoendo) (see Table 1). However, we agree that a much more precise conceptual definition of the above-mentioned relationships is needed and appropriate corrections were introduced in the text of the

manuscript as follows:

Introduction section:

The concept of rock architecture was introduced by Wierzchos et al. (2015) for colonized gypcrete substrate and encompasses the internal structures of rock with all elements that are essential for microbial life. Microhabitat architecture allows perceiving the rock interior from the existence of porous spaces of different sizes and also the solid structures that divide and support these spaces. All these components and elements are interrelated and influence one another, thus fulfilling a requisite: they might shape a suitable architecture to hold microbial life.

Discussion section:

Our work answers that there are certain differences in endolithic microbial communities' structure among crypto-, chasmo- and hypoendolithic habitats. Considering that the external climatic regime was the same for studied pieces of rock, our results have shown that the structure of these microbial communities was different among endolithic habitats. Following the definition of microhabitat architecture by Wierzchos et al. (2015) we can distinguish different architecture of the substrate within different endolithic microhabitats. In this context, our work suggests that distinct features of microhabitat architecture that have an influence on microenvironmental variables at the microscale would shape microbial communities' structure.

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Table 1. Dominant microorganisms within three different endolithic habitats. *Endolithic algae-fungi association: **The works where endolithic microhabitats were well defined.

Endolithic habitats in Ca-sulfate-bearing substrates	**Nature of Ca-sulfate substrates / Locality**	**Algae**	**Fungal hyphae**	**Proto-lichens***	**Cyanobacteria**	**Heterotrophic bacteria**	**References****
Cryptoendolithic	Gypsum/anhydrite crusts on soil surface / Tarapacá	🟩	🟧	🟪	🟩	🟦	Wierzchos et al. (2011), Vítek et al. (2013)
Cryptoendolithic	Gypsum+anhydrite crusts on soil surface / Salar Navidad			🟪	🟩	🟦	Culka et al. (2017)
Cryptoendolithic	Gypcrete / Cordon de Lila	🟩			🟩	🟦	Wierzchos et al. (2015)
Chasmoendolithic	Gypsum crust on the surface of rhyolite / Tilocalar				🟩	🟦	DiRuggiero et al. (2013)
Hypoendolithic	Gypsum/anhydrite crusts on soil surface / Tarapacá			🟪			Wierzchos et al. (2011)
Hypoendolithic	Gypcrete / Cordon de Lila				🟩	🟦	Wierzchos et al. (2015)
Crypto-, Chasmo- and Hypoendolithic	Gypcrete / Cordon de Lila				🟩	🟦	**This work**

Fig. 1.