Survival of Fungal Spores and Pollen under some Mars conditions

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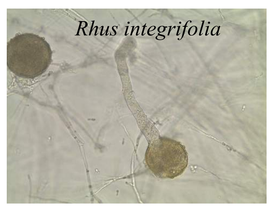
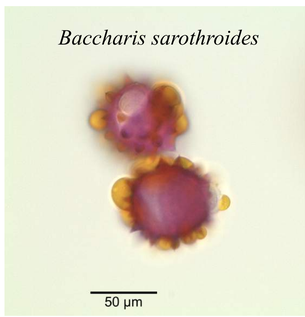
INTRODUCTION

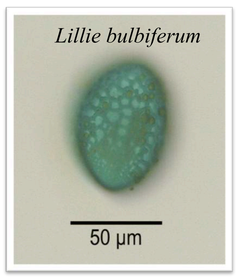
Studies have been conducted on the possibility that organisms can be transported by reverse panspermia (lithopanspermia) from Earth to other bodies in the Solar System (Reyes-Ruiz M. et. al. 2012), showing that material ejected can collide with Mars only if the eject velocity is at least 105% of Earth escape velocity. In this expelled materials, could be added to clays, pollen grains, and spores.

If we assume that spores or pollen reach Mars, a very hostile environment for life can still be found. However, some extremophiles are good candidates to survive such harsh conditions. The approximate average temperature on Mars is -65 °C and its average surface pressure is 560 Pa, not allowing the presence of liquid water over long periods. Another factor that makes difficult to survive on Mars is UV radiation. The UV-C ($\lambda < 280$ nm) and UV-B ($280 < \lambda < 320$) radiations are extremely damaging to organisms, and are present in the Martian atmosphere with significant flow rates (Córdoba-Jabonero C. et. al. 2003; Patel M. R. et. al. 2002). With respect to the soil analysis of the Viking and Phoenix landers, it was detected alkaline pH on the Martian soil, about 8 and 7.7 ± 5, respectively (Schuerger A. C. et. al. 2012).

One of the most resistant extremophiles are fungi. Even though many analyzes performed for viability and germination of fungi are focused at high temperatures and acidic pH (Panagou E. Z. et. al. 2003), is remarkable the fungi tolerance to drastic changes in those parameters.
In addition, pollen of flowering plants can survive extreme dehydration and radiation via several mechanisms, including a reversible wall-folding pathway that results in complete impermeability.







OBJECTIVES

- To study pollen grains of different species of extreme enviroments of Baja California (Mexico) and various features, as well as fungal spores, able to take refuge in their walls, to know its viability under extreme conditions of pH and UV similar to the Martian soil radiation.
- To know what features of pollen grains and spores affect their viability to such conditions and how they do it.


Rhus integrifolia


Baccharis sarothroides


Lillie bulbiferum

METHODOLGY

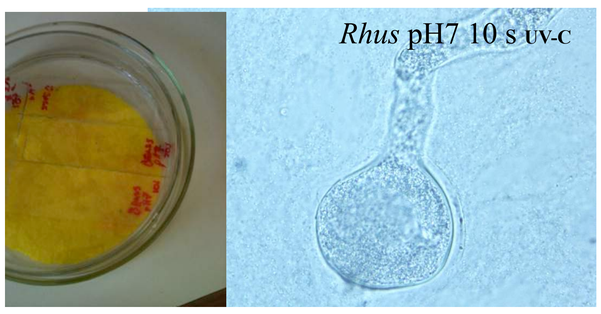
Pollen: The pollen grains were collected fresh from plants found in the vicinity near Ensenada, Baja California. grains species show different characteristics from each other in size and structure were used. Species collected pollen grains were as follows:
Lillie bulbiferum, Pinus jefrey, Baccharis sarothroides, Baccharis pilularis, Arctostaphylos glauca, Ostespermum ecklonis, Yucca Shidigera, Atriplex canescens, Brassica Tournefortii, Mirtillocactus sp., Agave attenuata, Ricinus communis, Rhus integrifolia, Ambrosia chenopodifolia, Albizia sp.

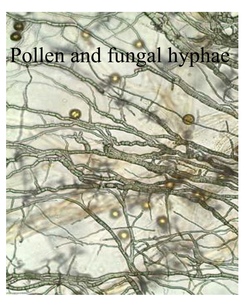
Then, we proceeded to determine their viability by staining. Slides concave media were placed in humidity chambers for greater permeability. They were incubated at 21°C (28°C) for minimum 24-hour periods and even some days to some species.

For analysis of the effects of UV radiation incidence of pollen grains Hg lamp 75 $\mu W/cm^2$ was used, at different times.

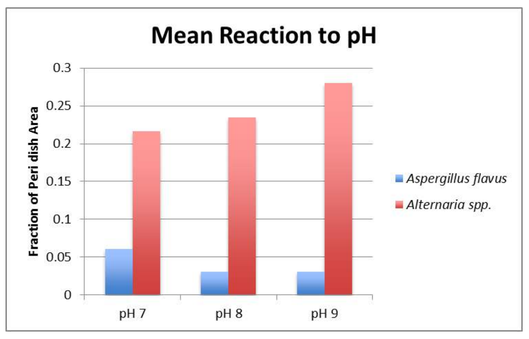
Fungi Spores: Two groups of samples for each fungal genus (*Aspergillus sp., Alternaria sp.*) were cultivated on Petri dishes with agar-agar at three different pH: 7, 8 and 9. After a week on incubator at 28°C, growth of the four groups of samples were measured and a mean growth was obtained for each pH value.

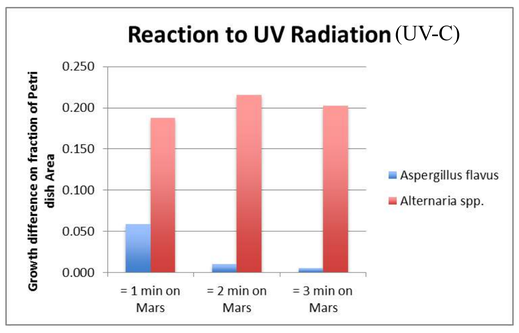
The two genera of fungi, after a week of growth in pH 8 agar-agar, were irradiated with an UV lamp [General Electric germicidal UVC lamp, max flux at 254nm, irradiation of 17.7 $\mu W/cm^2$] during three time frames (3,06, 12,24 and 30,6 hours equivalent to 1, 2, and 3 minutes at daytime with maximum flow on Mars equator [Córdoba-Jabonero, 2004]). After irradiation, all the samples were grown on incubator for one week. The growth differences were measured and compared.

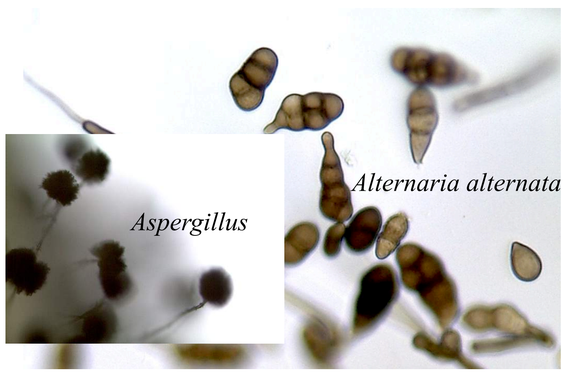


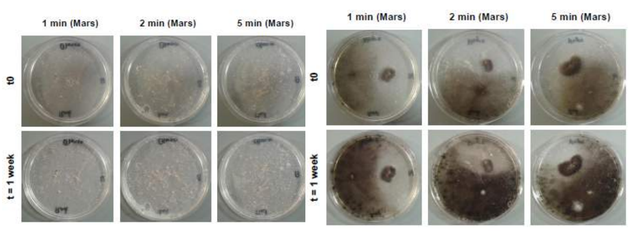


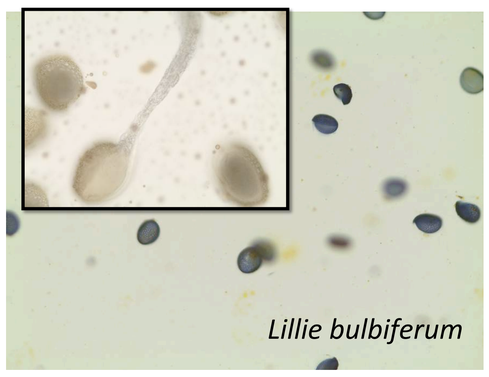
RESULTS

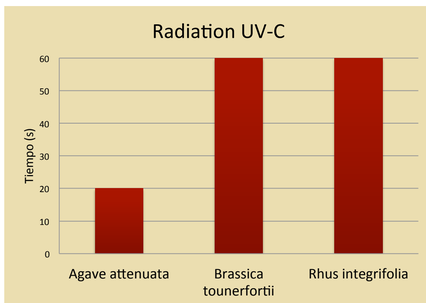


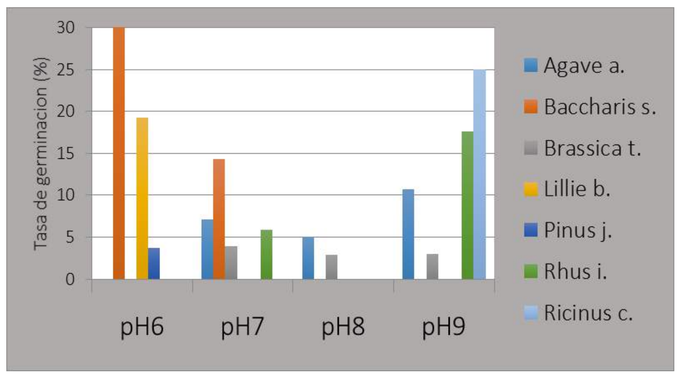












DISCUSSION and CONCLUSION

In this study we analyze the survival of fungi spores (*Alternaria sp.*, *Aspergillus sp.*) and pollen under conditions of temperature, pH and UV radiation similar to those present on Mars. In natural conditions spores are present in the atmosphere of Earth, as well a some pollen grains, in many cases we found that spores of fungi tend to stick to the outer layer and inner layer of the apertures of pollen, this could be a way to be protected through the journey to Mars.

Growth of *Aspergillus sp.* decreased at greater pH levels, while *Alternaria spp.* showed an inverse behavior, although these had a significant growth at any of the three pH levels. In all cases, *Alternaria sp.* had a more efficient growth rate.

We assume that this resistance is because of its composition, both, pollen and spores of fungi are formed by a wall of a complex material called Sporopollenin; this is a polymer of carotenoids and carotenoid esters (Brooks and Shaw, 1968). In the case of the pollen grains wall tends to be a more complex structure and has different layers; so it is believed to provide greater resistance to adverse conditions, like in the atmosphere of Mars.

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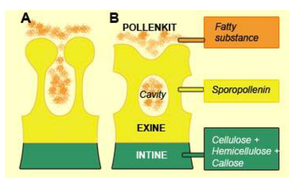

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