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Microbiology

Rare rains bring death to microbes of the Mars-Like Atacama Desert

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ABSTRACT

The Atacama Desert in Northern Chile is the driest and oldest desert on Earth. For this reason, it has been investigated as Mars analog model. We found that, unexpectedly, the increase of rainy days that happened since 2015 has killed most of the highly adapted microorganisms of this extremely dry and amazing desert.

A road in the Atacama Desert surrounded by natural lagoons.
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The Atacama Desert in northern Chile is the driest and oldest desert on earth. It has been an arid place for the last 150 million years, and hyperarid (an extremely dry place) for the last 15 million years. In the Atacama rain are extremely rare, averaging less than 1 mm/year. We have measured relative humidity in these areas many times, with values that reach zero in the afternoon hours. Thus, only microbial life has adapted to extremely low water availability of this desert, as well to its highly saline soils and high solar radiation. For these reasons, the Atacama Desert is a renowned analog model for Mars.

In May of 2015 we drove through the hyperarid core of the Atacama heading to the driest site of this desert which we reported a few months before. While driving on an endless road where nothing could be seen around, we were surprised to see several small lagoons besides the road. Some miles later, we observed a number of other lagoons, and still later, a few others.

Intrigued, we finally stopped and took some pictures. We assumed that these lagoons must have been caused by human activity in the surrounding area, as rain lagoons have never been seen in this area. So, we continue driving without giving it much thought.

It wasn't until 2017, when we observed this same phenomenon again, in a different place of the Atacama, realizing that both the 2015 and 2017

lagoons were in fact created by recent rain events, which were very unusual on the direction where the clouds came from, the amount of rains that affected the hyperarid core of the Atacama and the extensive areas that were affected.

We first thought that if you had water freely available in this extremely dry ecosystem, we would see an explosion of life. But to my surprise, when I inspected the water of these lagoons with a microscope, I could not see anything. We had to extract DNA from the water of these lagoons and cultivate samples in different growing media in order to find only four types of bacteria that were able to live in them. I later understood that if you suddenly add a lot of water to this microbial ecosystem, adapted for millions of years to extreme desiccation, you get the opposite effect; you rapidly kill most of the bacteria that were present in these soils as they were not able to adapt to the new watery conditions. We found evidence that most of these bacteria can not deal with so much water, so they inflate like balloons spreading their contents in the surrounding environment.

This showed us the unpredictable changes brought by global climate change, as this has caused the unusual rain events in the hyperarid core of the Atacama. It also showed us how fragile its ecosystems are, living at the brink of survival.

We know that at the local level, where these lagoons formed, most of the soil bacteria that previously inhabited the affected soils were killed. This caused not only a loss on biodiversity, but also consider the potential use of these bacteria, as for example, we have found that some of the bacteria that inhabit this extremely dry places belong to genus of bacteria well known for producing antibiotics, so who knows what critical genes useful for humanity we may be losing.

We know that Mars experienced a complex history of global climate change, including a first period between 4.5 and 3.5 billion of years ago when the planet sustained an active surface hydrosphere, and a subsequent transition to increasingly desiccated conditions, until Mars became the vast dry desert it is today. However, this transition was later episodically interrupted by enormous aqueous discharges that flooded regions of the surface on several occasions. Thus, if life ever arose on Mars, it should have adapted to an increasingly drier planet and the recurrence of liquid water might have later decimated local or regional ecosystems, instead of being an opportunity for life to bloom in the flooded areas.

In addition, the negative results obtained with the life-detecting instruments onboard the 1976 Viking landers may find the simplest explanation in the fact that in these experiments where Martian soils were tested for evidences of life, samples were first incubated with various watery solutions. Thus, any potential Martian cells would have first perished, and then its remnants be completely destroyed by the highly oxidant minerals characteristic of the Martian soil.