Geophysical Research Abstracts
Vol. 21, EGU2019-14558, 2019
EGU General Assembly 2019

Protist evolution in the Atacama Desert - speciation driven by extreme environmental conditions exemplified by aquatic choanoflagellates and soil ciliates

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The Atacama Desert is one of the most hostile environment on our planet. In particular, the extreme high UV radiation causes high mutation rates specially in aquatic organisms. The other abiotic factors like high and fluctuating salinities and variable salt composition within the habitat favor positive mutations and hence adaptation. In our study, we investigated on the one hand aquatic protists, choanoflagellates and on the other hand ciliates from soil. We hypothesize that aquatic protists underlie a much higher mutation rate compared to soil protists, which are protected by soil and cyst formation. Based on geological estimates on the age of the different salt lakes and soil sampling sites we calculated the mutation rate. Using transcriptome analysis, based on SSU rDNA, light and electron microscopy, we found seven new choanoflagellate species which cluster on two separated branches in the phylogenetic analysis. This indicates that two invasions took place in the past, which later one evolved to seven different species, well adapted to the specific habitats. The mutation rate we found is up to 20 times higher than under normal conditions. In contrast, we found 14 new colpodean species from different soil samples which had a much lower mutation rate compared to choanoflagellates, comparable with the rate under normal conditions. Our data indicates that at least five invasions of the different habitats occurred in the past. Both, choanoflagellates and colpodean ciliates are groups of well-studied protists, hence the finding of over twenty new species underlines the high evolution rate with in the Atacama Desert caused by the prevailing extreme conditions.