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Dune sand as material for testing life detection methods

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Metabolic experiments carried out during the Viking Mission to Mars and further discussion on their results clearly demonstrated a general difficulty in obtaining decisive evidence proving or precluding presence of life in extraterrestrial locations. Consequently, an array of experiments is necessary to exclude artifacts or contaminations and discover any possible inorganic pathways that could mimic metabolism. Preparation of future life detection experiments requires recognition of different sites, which are similar to extraterrestrial ones in terms of environmental conditions and geochemical composition (so called analog sites) or simply in terms of low abundance of organisms. In this study we described dune sand, which, under natural conditions, is subjected to severe changes in environmental conditions and irregular supply of water. The sampling site was located at the southern Baltic Sea coast at a site under low anthropogenic pressure. Organic matter content in dune sand (0.11%) was low when compared to that reported from sandy dunes, deserts, and other poor soils. Consequently, we hypothesized that dune sand could be used for testing life detection methods as a site analogous to extraterrestrial environments.

To study microbial communities, dry dune sand was hydrated with sterile distilled water and incubated through 8 days in the darkness and at a room temperature. Each day separate samples were collected from the top and bottom layers of sand. Based on the measurements of adenosine triphosphate (ATP) concentration, it was demonstrated that significant microbial metabolic activity started shortly after hydration, but was low and lasted only 4 days. Observation under the confocal laser scanning microscope (CLSM) demonstrated a low abundance of bacteria (*sensu lato*, including archaea) – roughly a million per square centimeter of sand. Such abundance was low when compared with other soils and sediments. Actually, it was as low as in the open oceanic water. Observation under the scanning electron microscope (SEM) revealed also the presence of pennate diatoms from genera *Cocconeis* and *Kolbesia*. The pool of microorganisms and its changes during the course of incubation were assessed based on the 16S rDNA genes quantified with quantitative polymerase chain reaction (qPCR). After 7 days, the pool of target DNA was roughly doubled. This increase was statistically significant for the top of sand layer (p = 0.004).

The study demonstrates that microbial community of dune sand characterizes of very low abundance, but it immediately reacts to addition of water. Hence, it is suitable for testing life detection methods. Application of dune sand for such studies is reasonable, because sand areas and dunes are common in extraterrestrial locations e.g. on Mars.

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