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Understanding the link between moisture dynamics and microbial activity in mobile dunes

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Barchan dunes in southeastern Qatar are relentlessly pushed by northwesterly, shamal, winds. This research aims to understand whether a synergy between moisture retention and microbial growth could be exploited to stop them from upsetting natural habitat as they pass. These mobile dunes in Qatar also constitute a unique test area in which to study mechanisms of desertification.

After characterizing the behavior and shape of the dune field west of Umm Said, we developed unique instruments for detecting humidity in hyper-arid environments. Using those, we measured diurnal variations in temperature and humidity beneath the dune, as well as fluxes of carbon dioxide through the surface. We also recorded temperature and humidity from a probe initially buried on the dune's avalanche face, emerging 15 months later on its windward face. In the laboratory, we measured effective diffusion, permeability and activity of its sands. By inserting an artificial rippled porous surface in our wind tunnel, we recorded how winds can induce a flow of air within porous sands, thus facilitating moisture and dust intake.

Metagenomic analysis of DNA extracted from two dunes revealed that the dune microbial communities were dominated by bacteria from the actinobacteria and firmicutes phyla. Consistent with the known metabolic capacity of these phyla, in silico assessment of the metabolic potential of the dune microbial community suggests that is dominated by heterotrophic bacteria, with surprising few genes for photosynthesis being detected. Other genes, however, were detected that may prove useful in dune stabilization efforts such as urease, and in biotechnology applications such as antibiotic biosynthesis. We succeeded in adapting cultivation independent methods for quantifying viable microbes directly from the sand and in culturing microbes found on individual sand grains. Analysis of the metabolic potential of these isolates is ongoing.