Tiny droplets allow bacteria to survive daytime dryness on leaves

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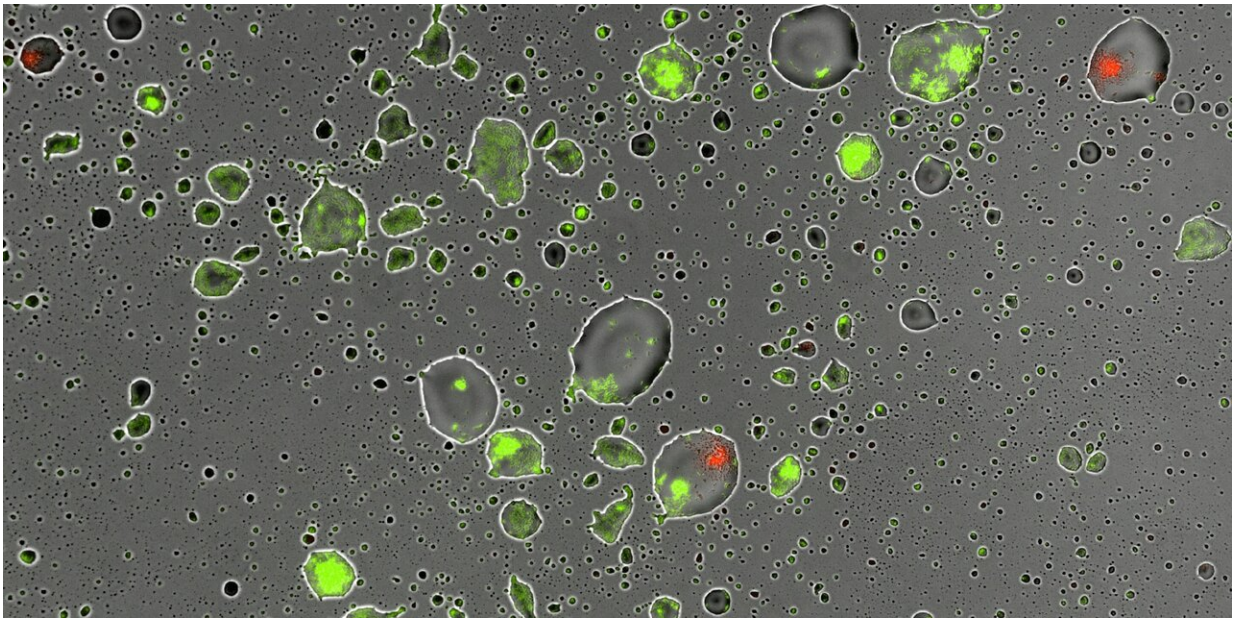

The formation of microdroplets around bacterial cells and aggregates on a drying surface. The green and red cells are two fluorescently tagged strains of Pseudomonas fluorescens bacteria. Credit: Grinberg et al. (CC BY 4.0)

Microscopic droplets on the surface of leaves give refuge to bacteria that otherwise may not survive during the dry daytime, according to a new study published today in *eLife*.

Understanding this bacterial survival strategy for dry conditions may

enable scientists to develop practices that support healthy plant microbiomes in agricultural and natural settings.

The surface of an average plant leaf is teeming with about 10 million microbes—a population comparable to that of large cities—that contribute to the health and day-to-day functioning of the plant. Scientists have long wondered how bacteria are able to survive as daytime temperatures and sunlight dry off leaf surfaces.

"While leaves may appear to be completely dry during the day, there is evidence that they are frequently covered by thin liquid films or micrometre-sized droplets that are invisible to the naked eye," says co-lead author Maor Grinberg, a Ph.D. student at Hebrew University's Robert H. Smith Faculty of Agriculture, Food, and Environment in Rehovot, Israel. "It wasn't clear until now whether this microscopic wetness was enough to protect bacteria from drying out."

To answer this question, Grinberg, together with co-lead author and Research Scientist Tomer Orevi and their team, recreated leaf surface-like conditions in the laboratory using glass plates that were exposed to various levels of humidity. They then conducted experiments with more than a dozen different bacteria species in these conditions.

They observed that while these surfaces appeared dry to the naked eye, under a microscope bacteria cells and aggregates were safely shielded in miniscule droplets. Interestingly, larger droplets formed around aggregates of more than one cell, while only tiny droplets formed around solitary cells. This microscopic wetness is caused by a process called deliquescence—where hygroscopic substances, such as aerosols, that are prevalent on leaves absorb moisture from the atmosphere and dissolve within the moisture to form the droplets.

"We found that bacteria cells can survive inside these droplets for more

than 24 hours and that survival rates were much higher in larger droplets," Orevi explains. "Our results suggest that through methods of self-organisation, for example by aggregation, these cells can improve their survival chances in environments frequently exposed to drying."

These findings could have important implications for agriculture as human practices may inadvertently interfere with this bacterial survival mechanism, endangering the health of crops and natural vegetation, according to senior author Nadav Kashtan, Ph.D., Assistant Professor at Hebrew University's Robert H. Smith Faculty of Agriculture, Food, and Environment. "A greater understanding of how microscopic leaf wetness may protect the healthy plant microbiome and how it might be disrupted by agricultural practices and human aerosol emissions is of great importance," he says.

Kashtan also notes that similar microscopic surface wetness likely occurs in soil, in the built environment, on human and animal skin, and potentially even in extra-terrestrial systems where conditions might allow, suggesting such bacterial survival strategies are not limited to leaf surfaces.

More information: Maor Grinberg et al, Bacterial survival in microscopic surface wetness, *eLife* (2019). DOI: 10.7554/eLife.48508

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