Bacterial colonies evolve amazing diversity

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Like human societies—think New York City—bacterial colonies have immense diversity among their inhabitants, often generated in the absence of specific selection pressures, according to a paper published ahead of print in the *Journal of Bacteriology*.

Microbiologists have long been aware of this phenomenon, and they credit it as a reason microbes have been able to colonize almost every conceivable terrestrial habitat from underground Antarctic lakes to hot springs to intensely radioactive pools, says corresponding author Ivan Matic, of INSERM, Paris. But none had tried to track it at the level of single cells.

"By using up to date experimental tools that allowed us to follow individual living cells, we were able to enter into this amazing, beautiful world of bacterial multicellular structures," says Matic. "We observed massive phenotypic diversification in aging *Escherichia coli* colonies. Some variants showed improved capacity to produce biofilms, whereas others were able to use different nutrients, or to tolerate antibiotics, or oxidative stress, compared to the ancestral strain."

In the study, the researchers started each colony with a small number of identical cells, and observed them as they grew and as the colony aged. An aging colony is one where growth has stopped, because nutrients have been exhausted and/or toxins have accumulated.

"At this point most cells in the colony stop dividing and dead cells accumulate," says Matic.

Even in the growth phase, a colony is environmentally diverse. For example, since it grows on a solid medium, nutrients diffuse from the bottom up, resulting in a nutritional gradient with lower levels at greater elevation above the medium. Similarly, oxygen and UV radiation decline with distance from the colony's surface, so that cells close to the top have ample oxygen, while those well below exist under anaerobic conditions.

In the elderly colony, the rising toxins and falling nutrients are also not homogeneously distributed. For example, despite general nutrient depletion, new nutrients become available from dead cells.

"We showed that the rare survivors of a senescent colony are very diverse and are different from their ancestors," says Matic. "We found different metabolic capacities, different levels of stress resistance, improved capacity to produce biofilms, and the ability to use different nutrients. Some of these capacities probably evolved due to obvious selection pressures, such as utilization of alternative energy sources."

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