Bacteria join ranks of lazy cheaters

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Baseball had its steroids and Black Sox. Politics lived through Watergate. Wall Street has been riddled with insider trading scandals. And before we cast the first stone, who among us has never tried to get through an intersection on a yellow light?

But bacteria? Even BACTERIA are lousy little cheaters, doing anything they can to gain an edge? Say it ain't so, Shoeless Joe.

Alas, it appears to be. According to a new study by microbiologists at Oregon State University, one type of bacteria has mutants that shut down certain communication systems so they don't have to share the communal burden of obtaining nutrients. This "cheating" mechanism forces other bacteria do all the work while the lazy bacteria save their energy, grow faster and out-compete other cells.

The findings, just published online in *Proceedings of the National Academy of Sciences*, not only explain a paradox in microbiology but also support new strategies to combat bacterial infections.

"This research proves that social cheating is going on even during bacterial communication," said Martin Schuster, an assistant professor of microbiology at OSU. "It's an insight into how these microorganisms evolved and function, and makes it clear that some bacteria are taking advantage of others, letting them do the work necessary for survival."

Also of interest, though, is that while the cheaters crowd their luck just as far as they can, there are also genetic mechanisms at work which

allow them to change their ways, and begin contributing to the survival of the broader group before too many cheaters lead the whole group towards mass starvation. They'll cheat about as long as they are allowed to, and then no further.

The study actually examined the process of "quorum sensing" among bacteria, in which these very tiny microorganisms have developed a type of chemical communication, using diffusible signal molecules, that lets them know when a critical mass of other bacteria are around them. If the task at hand is to release an enzyme that could break down some nearby nutrient, it's far more efficient if many bacteria share the work.

Bacteria are extraordinarily tiny – you can find 40 million in a gram of soil – and their normal life function often depends on cooperation. In many bacteria, cooperation requires communication. But communication and cooperation can drain the bacteria of energy, so there's a value to letting all the other bacteria do the work, while a few cheaters share the benefits.

"We found that in one type of bacteria, called Pseudomonas aeruginosa, mutant variants emerge in which the primary communication gene gets shut down," Schuster said. "In a group of bacteria, this allows them to thrive while other bacteria with normal communication do the work of breaking down food."

That can work fine for these bacteria, up to a point, Schuster said.

"If one person cheats on their taxes and gets away with it, it can benefit that person," Schuster said. "But if everyone did that, there would be no money for schools, roads or police, and social structure breaks down. It's somewhat similar with bacteria."

Researchers found that when there are too many cheaters, the whole

population pays the price. At that point, the study discovered, the cheaters have compensatory genetic mechanisms to recognize the problem, and some of them go back to cooperative behaviors that favor survival of the group – and themselves.

The bacterium the scientists studied is important by itself – it's an opportunistic pathogen that can cause persistent infections in humans, including pneumonia, and is often the cause of death for patients with cystic fibrosis, a chronic lung disease. It's also a serious concern with hospital-acquired infections, AIDS patients, people who use catheters, and other issues. The mutant "cheating" bacteria are often found in patients with these disease problems. Their emergence had appeared to be a paradox, however, because bacterial communication is required for infection.

This study resolved that paradox, suggesting that the emergence of a cheating sub-population is in fact favored when bacterial communication is required for survival. And it supports an unconventional approach to antibiotic therapy - interfering with bacterial communication. Such drug design concepts could become a new concept in antibiotics, researchers say.

The study also provides fundamental insights into the evolution of the "quorum sensing" mechanism among bacteria, why it's essential to group survival under certain conditions, and how some "cheating" bacteria can thrive without the ability to communicate.

Bacteria are very useful model organisms to study the process of evolution, researchers say, because of their fast growth. Unlike with higher organisms, their evolution can be observed in real time in the laboratory.

Source: Oregon State University