DANIËL ROZEN
Institute of Biology Leiden

Bacteria have their own wars

With an extensive series of tests, published in PNAS, Daniel Rozen proved that bacteria produce antibiotics to beat their competitors. An alternative view, namely that bacteria use these compounds in communication and cooperation, is not tenable anymore. His research has clinical importance, as it reveals how bacteria may be induced to produce new antibiotics in the lab.

By Willy van Strien

After finishing his PhD on bacterial evolution at Michigan State University, Daniel Rozen had a few post doc positions and a tenure track in Manchester (England). In 2012, he settled at Leiden University.

To fight infectious disease, we successfully use antibiotics that are produced by bacteria. But these organisms do not produce these compounds to help us. They fight their own war against their bacterial competitors, and antibiotics are their weapons. Most biologists agree on this. "But I was surprised to learn that some did not", Daniel Rozen says. "They argued that the amounts of antibiotics in nature are too low to kill organisms. Instead, they suggested that antibiotics are signals for microbial cooperation."

Rozen designed an experiment to settle the issue. From a handful of soil sampled close to his lab, he grew ten strains of Streptomyces and added three lab strains. All these bacterial strains live on organic material and are considered to be competitors. He first tested the ability of each strain to inhibit each other strain (a challenger) when cultured alone (13x13=169 combinations), and then how this aggressiveness was altered when one of the other strains grew in close proximity (169x13=2197 combinations).

When two strains grew together, one of the strains induced its neighbour to produce antibiotics in many cases. In other couples, one strain suppressed the production of antibiotics in the other. But in only few cases did the strains stimulate each other to upregulate the production of antibiotics, fighting the challenger together. So it is war, not communication that the antibiotics are used for.

It makes sense that antibiotics occur in low amounts in nature, according to Rozen. "A strain only kills another strain when it is in close proximity. So it is sufficient if local concentrations are high, on a micro-scale."

From a medical point of view, the findings are interesting as Streptomyces are important producers of antibiotics for human use. But in the lab the bacteria only synthesize part of the many different antibiotics they are able to produce; many synthetic pathways remain silent. Rozen: "Now we know that silent pathways may be activated by growing different strains together."