Beneficial Bacteria

Dr. Osnat Gillor

Consider your average Tyrannosaurus.

Suppose you wanted to learn how the famous fierce-toothed dinosaur evolved, how it adapted to its changing environment. Where would you start?

The most obvious problem is the lack of a Tyrannosaurus to study, since they've been extinct for about 65 million years. But even if you had one on hand, there's another problem. The massive lizards – 13 meters (43 feet) long, tipping the scales at 7 metric tons (15,000 lbs) – didn't reproduce until they became teenagers. So if you wanted to study how they evolved, adapted and changed over many generations, your own research would require dozens of generations of humans. Who has time?

That said, the evolutionary process of the Tyrannosaurus – and other extinct species – is of great interest to scientists today. If nothing else, it would be good to know why their heads were over 1.5 meters long, when the brain inside was only big enough to hold about a liter of liquid.

Meet Dr. Osnat Gillor, a research scientist at the Zuckerberg Institute for Water Research at the Jacob Blaustein Institutes for Desert Research at BGU's Sede Boqer campus, who is working on a facet of what is called "experimental evolution." She is one of a number of scientists who are ferreting out the secrets of evolutionary behavior – but doing it by studying a different species altogether. For example, instead of studying an actual Tyrannosaurus, scientists study the evolutionary process of bacteria. Tiny, microscopic bacteria.

Why? "Because by using bacteria to study how evolution proceeded, we can drastically cut the length of time needed to observe mutations and change," says Gillor. "Because generation time is so short for some bacteria – an hour to an hour and a half – the process of mutation can be observed in a relatively short time. You know where you start. You are able to examine the mutations that occur all along the intermediate stages, and then you know where you end. Scientists can study 10,000 generations, 100,000, or even a half million, and learn all along the way. If you were working with a larger and more complicated species, that wouldn't be possible."

In Gillor's lab, the specific research involves antibiotic-producing bacteria. "Bacteria live in an environment where they are forced to compete for resources," she says. "Whatever they are attached to – whether a table, a leaf, or a tooth – bacteria have to fight for survival – beat out other bacteria for whatever they need in terms of nutrients, a carbon source, or living space. So in order to improve their chances of survival, bacteria manufacture antibiotics that are harmful to their competitors," she explains. "Not a broad-spectrum antibiotic that would kill many other bacteria, because some are beneficial, and they want those. But they produce a very specific antibiotic that's designed to kill only those bacteria that they compete with in terms of food or space.

"So that's what we're studying: the ecology of the evolution of the bacteria that produce the antibiotics. We're using the bacteria as models – we're interested in a wider topic, but we use the bacteria to demonstrate the process."

Gillor's work has an enormously beneficial practical application, too, in an area critical to Israel and other arid locations. "One of the big problems in desalinating water – removing unwanted dissolved salts to make the water potable – is the problem of bacteria that grow on the surface of the filtering membranes and clog them up. If we could learn to use the bacterially-produced antibiotics to kill the bacteria growing on the filters, that would be very helpful. In addition, the antibiotics could be utilized to detect the presence of harmful bacteria in water – to prevent problems before they begin – putting us several steps ahead."

Gillor's interest in science and in environmental microbiology in particular didn't kick in until she was in the Israel Defense Forces (IDF). "I loved my work in the IDF, and decided then that I wanted to study science. But I hadn't studied science in high school, so I had to work enormously hard to catch up. After I received my Ph.D. from the Hebrew University of Jerusalem, I spent four years at Yale and the University of Massachusetts working with Prof. Margaret Reilly, exploring ways to detect and deal with waterborne pathogens. When the opportunity arose to work in the Department of Environmental Hydrology and Microbiology at the Zuckerberg Institute for Water Research, I jumped at it. There's a wonderfully supportive and visionary environment at the Institute."

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Another project in Gillor's lab came about last year thanks to Fred Rainey, a visiting professor from Louisiana State University. "He saw that a Long Term Ecological Research (LTER) project initiated and led by Prof. Moshe Shachak of the Mitrani Department of Desert Ecology had started years ago in collaboration with a number of participants from various universities and research institutes in Israel. Yet, Rainey had noticed that they did not include bacteria in their analysis and suggested that I and Dr. Soares, a colleague in my Department, who was hosting him, pick the project up, and we're moving ahead."

The objective of LETR is to collect ecological information about almost everything that impacts an ecosystem over an extended period of time. To that end, five LETR plots have been established along the rainfall gradient in Israel, in locations ranging from the far north to the south near Sede Boqer. "In each plot, many aspects are studied: weather, soil chemistry, perennial and annual plants, animals and insects, and now our group is studying the soil microorganisms. Each group examines the effects of various land-use strategies, such as grazing and clear cutting, on the organism of choice, with the aim of eventually integrating all the emerging data and establish guidelines for sustainable development of open land in Israel."

Just like Gillor's bacterial-evolution project, the LETR is a long-term proposition, with study and research that will continue indefinitely. For Gillor, who lives in Sede Boqer with her husband and three children, it's a labor of love. The opportunity to work in the inter-disciplinary, cutting-edge research environment of the Zuckerberg Institute – work that is destined to improve the quality of life in the world's desert areas – is more than welcome. ■