Ants’ Gardening Partners May Provide New Drugs

While the ant *Trachymyrmex sepentrionalis* tends its fungus garden, a bacterial friend rides piggy-back on its body. This bacterium is one of many microbes in a complex ant-fungus-bacteria neighborhood that makes this a true community garden. Assistant Professor Jonathan Klassen studies this community to learn how these partners work together. He also hopes to discover new antibiotics that the microbes produce to keep out unwanted microbial garden pests.

Why do the ant-associated bacteria produce antibiotics? What triggers these bacteria and the other microbes to make antibiotics against one another? “What drives our ecological research is the why question,” Klassen said. “Why have the (antibiotic) molecules at all? Understanding that will help us figure out what the triggers are.”

Antibiotic discovery from natural habitats by pharmaceutical companies entered

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“Leaves that Crawl” Speak to Nature’s Ingenuity

Plants are plants and animals are animals, and plants make food for animals by photosynthesis. So say our Biology textbooks anyway. But Nature does not like to draw lines between organisms like we do. Professor Mary Rumpho studies a natural enigma, a photosynthetic animal. She examines a green sea slug that is in the habit of stealing the photosynthetic organelles, called chloroplasts or plastids, from algae. Rumpho wants to know how this animal evolved to harvest light energy by hijacking the photosynthetic machinery from algae.

Rumpho collects the sea slug *Elysia chlorotica* from the intertidal zone off Martha’s Vineyard and raises the animals in the lab for about 10 months using artificial seawater,

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MCB Factoid

Fall 2013 posts record of 309 Molecular and Cell Biology undergraduate majors, continuing a multi-year trend.

More Notes on page 3:

♦ Prof. Benson speaks to the need for “Tacit Diplomacy” through international collaborations
♦ “Microbe Minutes” engage students in Asst. Prof. Feldman’s early morning microbiology classes
**Ants and their tinier friends**

Lean years when infectious diseases were thought to be under control using conventional drugs. However, antibiotic-resistant bacterial strains have evolved now so that many front-line drugs are proving useless. New searches for new drugs are underway and Klassen believes that communities of microbe-host associations provide fertile ground for finding them. "I am struck by how limited the impact of evolutionary and ecological thinking has been in drug discovery," Klassen noted. "(Those studies are) function-driven, disregarding the why question," he said.

Klassen scours fields from Florida to New Jersey to dig up nests of *T. sepentrionalis* ants, bring them and their fungal gardens into the lab, and nurture them to study their interactions. He can cultivate most of the 10 to 20 different microbial species separately outside their gardens so that he can recombine them in different combinations to see what effect the absence of a given member of the community has. Using this strategy Klassen says he “can start to experimentally observe these networks of organisms specifically interacting with other organisms.” For example, bacteria make antibiotics to fight pathogens, which may inadvertently select for antibiotic-resistant pathogens. Other bacteria may then arise using a different means to fight the pathogen. Observing changes in the microbiomes, “we can chase down this arms race in the system,” Klassen said.

To determine which microbes are in the ant nests he harvests (their “microbiome”), Klassen extracts and sequences the DNA of all the microbes in the gardens. Using this information he compares their microbiomes to find patterns in the compositions of their communities and so infer the functions of each member. "The problem is that it is always inferences," Klassen pointed out. "The culture-based work (in the lab) helps to validate the patterns of interactions suggested by the microbiome work."

Klassen’s approach has relevance beyond the ant gardens. "Maybe we can take this (approach) back to something that is much more complicated like the human microbiome," he said. From his studies with the simpler ant garden microbiome, perhaps “we can extrapolate what we have validated experimentally to something that is more complicated, that we are not going to be able to experiment on," Klassen explained.

As the 17th century British historian Thomas Fuller observed, "Many things grow in the garden that were never sown there." Prof. Klassen’s ants know this only too well and, with their bacterial compatriots, they battle those invaders with antimicrobial tools that Klassen may bring to us.

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**Slugs Masquerade as Plants**

Carbon dioxide-enriched air, and light. Early in her studies Rumpho experienced difficulties harvesting eggs and raising the animals from the hatchlings using artificial seawater. Others were doing this using fresh cool seawater, only available to labs near the ocean. Proving Pasteur’s maxim that fortune favors the prepared mind, a mistake by an undergraduate researcher in her lab led to the discovery that temperature was the stumbling block. "Once (the student) pulled the newly hatched larvae out of the 10°C (50°F) incubator and set them on the lab bench, they all metamorphosed with the algae present," Rumpho explained.

Newly hatched larvae are of special interest because they are not photosynthetic. To survive, they must...
feed on algae for at least 7 days to extract their photosynthetic organelles, the plastids, and immediately metamorphose into juvenile slugs. “If you feed them for less than seven days and take the algae away, they immediately start to lose their color and turn brown,” said Rumpho. “So there was a window for five to seven days that was like a switch that they were either going to keep the plastids or they were going to lose them.”

In an upcoming publication, Rumpho’s research associate, Dr. Karen Pelletreau, reports that during this development phase, cells of slug juveniles contain large deposits of fats that are apparently produced by the plastids. If juveniles are placed in the dark for several days, these fats disappear and the juveniles die. The function of these fats is not known. They might protect the slug from harmful products made by the plastids during photosynthesis since the fats are like those known to be powerful antioxidants in our food.

Rumpho has also studied how animal cells can maintain plastids. To function, plastids need proteins produced from genes in the algal nucleus. Some of these proteins are part of the plastids’ light harvesting apparatus and others protect the plastids from excessive light. If a plastid is placed inside an animal cell, how can it survive? Rumpho has sequenced the slug’s chromosomal DNA and found that algal chromosomal genes are not transferred to the animal’s chromosomes during feeding. “We think it is a transient transfer of (algal chromosomal) genes that may be held extrachromosomally,” she said. Viruses may be involved in carrying these genes.

Some slug species live longer than 10 months while others have to keep eating algae all along or will die because they cannot maintain the chloroplasts. “Do the animals die because the chloroplasts give out or do they die because this virus takes over? And does the virus take over because the chloroplasts are giving out?” Rumpho asks. Much more research is necessary to untangle the puzzles of these “leaves that crawl.”

MORE NOTES

“Tacit Diplomacy” importance touted in Prof. Benson’s article. Prof. David Benson’s article in the March issue of Science and Diplomacy (co-authored with Utah State Univ. Prof. Roger Kjelgren) on “Tacit Diplomacy in Life Sciences” discusses how international collaborations among life scientists can create a “tacit diplomacy” in their community to mitigate public and governmental concerns about new technologies and global security. Benson recently returned from his service at the US Department of State as a Jefferson Science Fellow.

Microbes are the stars of Prof. Feldman’s Microbe Minutes. Kathleen Feldman, MCB assistant professor in residence, published the results of her “Microbe Minute” in her undergrad MCB course “Fundamentals of Microbiology” in the December issue of Journal of Microbiology & Biology Education. These unannounced presentations of interesting microbes in her 8 am class enhanced interest in microbiology and revealed how microbiology can be applied to the students’ lives. It also gave students an additional incentive to arrive to lectures on time.

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