The mustard war wasn't so racy after all

The battle's been raging for almost 9 million years, but contrary to a beloved evolutionary theory, there was no arms race between the plant and its pest.

Molecular biology's much-studied mustard, *Arabidopsis thaliana*, and the plant's old enemy, a *Pseudomonas* bacterial rot, have not been trumping each other's defenses with escalating innovations, report Eli A. Stahl of the University of Chicago and his colleagues.

Instead, analysis of DNA regions around the plant's rot-resistance gene suggests that pretty much the same old weapons have gone through cycles of use and disuse in what the researchers describe as "trench warfare." For the mustard-rot war, "we reject the arms race hypothesis," they state flatly in the Aug. 12 NATURE.

Their manifesto challenges what evolutionary ecologist Peter M. Kareiva from the National Oceanic and Atmospheric Administration in Seattle calls "one of the more compelling metaphors of biology." The idea resounds through tales of interplay between diseases and hosts and between herbivores and food plants.

"I don't think there has ever been that much empirical evidence for any sort of escalating arms race," Kareiva says. "The power of the idea was mostly the power of the metaphor."

Much of the support for the notion came from observations of intricate ways that one organism overcomes another's defenses, Kareiva points out. For example, he describes a plant covered with tiny spikes that stab invading bugs. One successful attacker, however, spins a web to traverse the spikes and reach a naked leaf edge, where it can nibble unscathed.

For a rigorous look at the history of such conflicts, Stahl and his colleagues sequenced DNA from mustard plants collected in 26 locales ranging from Indiana to Kazakhstan. Twelve populations had a gene, *rpm1*, that allows the plant to recognize the rot and mount a physiological defense. The others had no resistance gene and developed soft, mushy lesions when exposed to the pest.

Had there been an arms race, the currently effective resistance would have evolved recently. The researchers instead found that *rpm1* has been around for about as long as the species itself. The diversity in the inactive DNA flanking the resistance gene indicates its ancient origin, argues coauthor Joy Bergelson, also of Chicago.

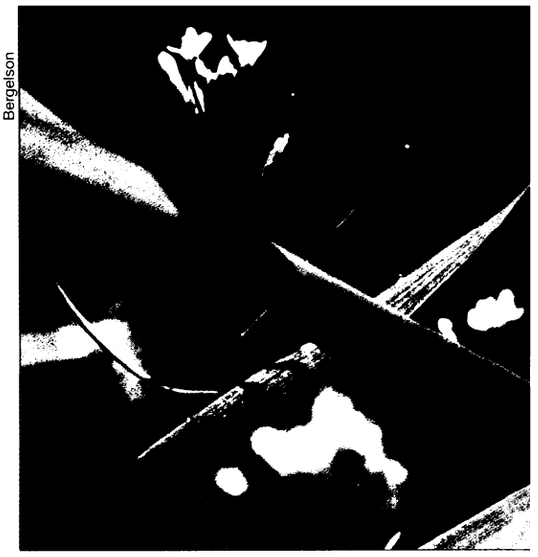
"It was very surprising," Bergelson says. This evidence suggests to her that raging epidemics favor the spread of the resistance genes until so many plants are protected that the rot runs out of victims and recedes. Then *rpm1* itself, which might drain some of the plant's resources and thus exact some maintenance cost, wanes in the population until the next epidemic.

"It's very clever, and it's probably right," comments Kareiva. However, he muses that there may be too little evidence yet to accept a new model. For example, "it's often hard to identify a cost of resistance," he cautions.

Regardless, the mustard's history is hardly an arms race, says Barbara A. Schaal of Washington University in St. Louis. In the classic scenario, any variation is transient. Yet in the mustard's, there's "good evidence that natural selection is operating to maintain diversity," she says.

Without more molecular tests, Bergelson doesn't claim to know whether other conflicts follow the same pattern as the mustard-rot scenario. As Kareiva puts it, however, now "there will be a lot of labs looking at sequencing data." —*S. Milius*

Bergelson



For millions of years, this mustard species, Arabidopsis thaliana, *has deployed the same defense against a pesky rot.*

Deep encounter reveals asteroid's ancestry

A tiny, wayward asteroid called 9969 Braille left home a long time ago, but astronomers may have just identified its parent. Infrared spectra taken by the Deep Space 1 spacecraft in late July suggest that Braille, only 2 kilometers long, is a chip off the old block 4 Vesta, the third largest asteroid in the solar system.

At 12:46 a.m. EDT on July 29, Deep Space 1 passed within 26 km of Braille. That's the closest a spacecraft has ever flown by an asteroid. At the crucial moment, however, the craft's camera did not point in the right direction and failed to capture close-up images of the rock.

Planetary scientists got a consolation prize, however. Infrared light reflected from Braille revealed the unmistakable fingerprint of the mineral pyroxene. Vesta is one of the few objects in the main asteroid belt, located between Mars and Jupiter, with a high concentration of this mineral.

"It's a perfect match," says Deep Space 1 researcher Daniel Britt of the University of Tennessee at Knoxville. "If I would have made up the data, I would have put in more noise to make it believable."

NASA released the Deep Space 1 findings last week at a press briefing at the Jet Propulsion Laboratory in Pasadena, Calif.

Recent images from the Hubble Space Telescope show that Vesta has a giant crater (SN: 9/20/97, p. 184). Braille, which had exited the main belt and crossed Mars' orbit, probably represents a fragment gouged from Vesta during the collision that made the crater. Alternatively, Vesta could be Braille's big brother rather than its parent, with both rocks ejected from an even larger body.

The link between Braille and Vesta is especially intriguing because NASA chose Braille at random to study, and few asteroids have shown a composition similar to that of Vesta. About 500 km in diameter, potato-shaped Vesta is the presumed source of a small class of meteorites that fall to Earth. Known as basaltic achondrites, the group accounts for only 6 percent of terrestrial meteorites.

JPL/NASA

The Deep Space 1 spacecraft took this composite image of the elongated asteroid 9969 Braille about 15 minutes after its closest approach.

Its placement in the asteroid belt prevents Vesta from directly delivering its fragments to Earth. In the early 1990s, however, researchers found a string of small asteroids with Vesta-like composition that lie at the right place in the belt to do so (SN: 10/24/92, p. 286). Like a breadcrumb trail, the discovery of several small asteroids, including Braille, that lie nearer Earth strengthens the association between Vesta and the meteorites, says Richard P. Binzel of the Massachusetts Institute of Technology. Braille is expected to cross Earth's orbit in a few thousand years.

Even if its camera had been properly pointed, the craft's photo opportunity wouldn't have been ideal. Deep Space 1 was hurtling past Braille at 40,000 km per hour. In contrast, the Near Earth Asteroid Rendezvous mission is expected to cozy up to the asteroid 433 Eros early next year and remain close for 12 months. —*R. Cowen*