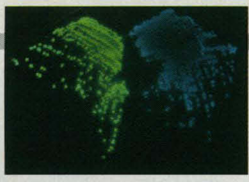

ANDREA SMALL

NED RUBY

Symbiotic squid. In the light, the bacteria-filled light organ (arrow) is visible in the still-translucent young squid. In the dark, different bacterial strains glow in distinctive colors *(above)*.

Nishiguchi. That glow comes from a bilobed light organ. Each lobe's branching chambers are filled with bioluminescent bacteria. At sunrise, the squid expels most of the glowing microbes, possibly to reduce the cost of maintaining the bacteria all day or to get rid of aging microbes. Then it sneaks back into the sand, where the remaining bacteria repopulate the light organ. Newly hatched squid must acquire the bacteria from the surrounding seawater.

To trace the origins of this symbiotic relationship, Nishiguchi analyzed genetic material from seven close cousins of *E. scolopes*: one each from Japan and Australia, and five that occur in the Mediterranean. She also examined DNA from another type of squid, a Loliginid from Australia, that uses a different bioluminescent bacterium. Based on similarities and differences between each species' DNA, she constructed a phylogenetic tree showing which were most closely related. She also constructed a phylogenetic tree for the squids' bacterial guests, incorporating all the relevant strains. The two trees had the same order and branching pattern, and each squid matched up with its corresponding bacterium, suggesting that the organisms had coevolved.

If so, each strain of bacteria should be best adapted to partnership with its particular host squid. To test that idea, Nishiguchi exposed *E. scolopes* to bacteria from the other squid species. She found that microbes from the Loliginid failed to colonize the light organ in this Hawaiian squid. All the *Vibrio* strains did manage to grow in *E. scolopes*, but in direct competition with *Vibrio* from other squid species the squid's true partner "always wins," and eventually the less familiar microbe disappears. "There's definitely a specificity, even though the [bacteria] are the same species," says Nishiguchi. And among the losers, bacteria from more closely related cousins of *E. scolopes* did better than those from more distant relatives.

"It was an excellent paper," says Lenski. "[It] tied together phylogenetic work, on a molecular level, and ecological work—the performance of the bacteria. Very few studies go that extra step, beyond the molecular data," he says. " Clearly [the bacteria] have adapted to the squid," Lenski says, adding that it's likely the squid has adapted too, perhaps by creating a signaling system understood only by it and its proper microbial partner. That's something experiments have yet to shed light on, Nishiguchi notes.

–Elizabeth Pennisi

RADIO ASTRONOMY

Twinkle, Twinkle, Little Quasar

It's eye-catching behavior, even for a quasar. Thought to be the nuclei of young galaxies, quasars are by far the brightest objects in the universe, and they are visible in its farthest reaches. Now Australian radio astronomers have spotted a quasar with an impressive talent: It winks far faster than any other known quasar.

Dubbed PKS 0405-385, the quasar emits a radio signal that fluctuates as much as 60% in half an hour at a wavelength of 3 centimeters. Observed by Lucyna Kedziora-Chudczer of the University of Sydney with the Australia Telescope Compact Array in Narrabri as part of a project to study hour-by-hour changes in extragalactic radio sources, the quasar's odd behavior quickly stole attention from the other objects. Says team member Mark Wieringa of the Australia Telescope National Facility, "PKS 0405-385 displayed such enormously rapid variations that most of the available observing time was spent on monitoring this source." The team put out the word about their find late last month in an International Astronomical Union circular.

The radio astronomers were intrigued by this puzzling effect, Wieringa says, because quasars are not supposed to vary so quickly. If the intensity of a source changes very rapidly, the theory goes, it must be very small: Fluctuations cannot occur faster than the time it takes light to cross the emitting object—otherwise, how would all parts of the object know when to fluctuate? The speed of the changes in PKS 0405-385, the astronomers calculated, implies that its radio-emitting region is much smaller than our solar system. But to account for the quasar's prodigious output of radio waves and other radiation, an object that small would need a temperature of about 10^{20} degrees.

That is a hundred million times hotter than the maximum temperature allowed by theory. The radio emission astronomers pick up is synchrotron radiation, generated by electrons traveling at relativistic speeds—close to the speed of light—in strong magnetic fields. But when temperatures get too high, the electrons start losing energy by interacting with the large number of high-energy photons, in a process called inverse Compton scattering, so theory predicts an upper temperature limit of 10^{12} degrees for an object emitting synchrotron radiation.

Quasar expert Peter Barthel of the Kapteyn Astronomical Institute in Groningen, the Netherlands, thinks there is a way to explain the flickering without invoking such a tiny source. He points out that PKS 0405-385 has also been detected as a source of gamma rays by EGRET, an instrument on board NASA's orbiting Compton Gamma Ray Observatory, which singles out a particular kind of quasar. "In the distant universe," he says, "EGRET exclusively finds blazars: radio-loud quasars in which a jet of relativistic electrons is pointing in our direction." Because their radio-emitting jets are moving toward Earth at nearly the speed of light, blazars exhibit all kinds of bizarre effects, including apparent faster-than-light movements of blobs and shock waves in the jets, which could account for the rapid flickering. "PKS 0405-385 has all the looks of an extreme form of blazar," says Barthel. "It's interesting, but I'm not too excited."

AUSTRALIA TELESCOPE NATIONAL FACILITY

Starry eyes. The Australia Telescope Compact Array captured a quasar's flickers.

But relativistic beaming cannot be the whole story, says Mark Walker, a theorist who recently joined the Australian team. The relativistic effects needed to explain the variability would have to be about 100 times as strong as have ever been seen in a quasar jet. Walker thinks another effect may offer a way out of the puzzle: interstellar scintillation, or twinkling, of the radio source. Gas clouds in our own galaxy can cause distant radio beacons to scintillate, just as Earth's atmosphere causes stars to twinkle. To see whether this effect is playing a role, the Australian astronomers have requested observing time on NASA's Rossi X-ray Timing Explorer satellite. If scintillation is causing the quasar's radio fluctuations, its x-rays should be unaffected. If, however, PKS 0405-385 also shows rapid x-ray variability, quasar watchers will still have a mystery on their hands.

–Govert Schilling

Govert Schilling is a science writer in Utrecht, the Netherlands.