Message from a bog

Nitrogen-rich diet threatens pitcher plants

For tens of thousands of years, carnivorous pitcher plants have lived in the inhospitable, low-nitrogen environment of a bog, getting along just fine on the unfortunate ants or flies that came their way.

But, thanks to acid rain, the pitcher plant's diet is changing, says Biology Professor Nick Gotelli. "In the past 50 years, because of the burning of fossil fuels, and especially because of synthetic fertilizers, we humans are now releasing all sorts of reactive nitrogen into the environment," he says. "Suddenly, these plants, because they are taking in rainwater, are absorbing excess nitrogen."

Bogs are among nature's most unlikely and elegant ecosystems. A typical bog forms on top of a geological "kettlehole": a pit, left behind by scouring glaciers, that fills with rainwater. Because there is almost no flow in or out of a bog, its water is very low in oxygen and supplies few nutrients, including nitrogen. Still, a sheet of sphagnum moss slowly grows across the hole, and, over millennia, fills it with peat. Living on top of this "bog mat," pitcher plants employ cup-shaped leaves to capture insects and rain that provide nutrients not available from a bog's saturated soils.

"If we could maintain current rates of nitrogen deposition, or perhaps see a slight decline, pitcher plant populations would be in pretty good shape," says Gotelli, "but if we see modest increases, say on the order of one to two percent per year, which is likely, these populations look like they will be doomed to extinction."

A glut of nitrogen from rain and snow makes a dangerously unbalanced pitcher plant diet, Gotelli explains, drawing on ten years of research in bogs of Vermont and Massachusetts. "When the plants receive natural prey items, they are, in addition to receiving nitrogen, also receiving phosphorous, which the plants need," Gotelli says, "but the atmospheric deposition has no phosphorous in it, so it shifts the nitrogen/phosphorous ratio." And this shift makes the pitcher plant give up its pitcher. Instead of developing its characteristic tubular leaf, the plant changes morphology and forms a flat leaf that increases photosynthesis. The plant is also more likely to flower in the spring on its newfangled diet.

These might seem like benefits, but the result is less survival in juvenile plants. In Gotelli's models, a century or two of this reduced survivorship draws a population line down to zero. And these problems scale up from the individual plant to the bog ecosystem.

Gotelli's findings are part of a body of research suggesting that damaging feedback loops may develop: as nitrogen levels increase, some bog-specializing plants are killed off, while others, especially grasses, begin colonizing these once unwelcoming habitats. This may have implications for global warming. Though peat bogs cover only a small amount of the Earth's surface area, they have locked up perhaps 30 percent of the planet's terrestrial carbon. If bogs start to disappear, "how much of this carbon will be released into the atmosphere?" Gotelli wonders, since more atmospheric carbon means a stronger greenhouse effect.

—Joshua Brown

Sarracenia purpurea

Nicholas Gotelli is among the 2005-2006 University Scholars, who also include John Burke, professor of microbiology and molecular genetics; Carol Miller, professor of psychology; and Robyn Warhol, professor of English. The Graduate College annually honors four professors as University Scholars in recognition of sustained excellence in research and scholarship.