Plant 'sight' from pores and pumps

To a plant, breathing involves a built-in cost-benefit analysis. The wider the gas-exchanging pores on the leaf surface are open, the greater the supply of carbon dioxide for photosynthesis. But wide-open pores also allow evaporation of water, so the plant must balance the benefits of increased carbon dioxide against the cost of water loss.

Key to this balancing operation is a light-sensing process, one of several factors that stimulate the opening of the plant pores, called stomata. It allows plants to perceive their environment, in a manner similar to the way animals see, says Eduardo Zeiger of Stanford University. This mechanism provides a plant with an increased supply of carbon dioxide only when light is available to power photosynthesis. Zeiger and his colleagues now report unexpected characteristics of central components of this process, and they are beginning to apply their findings to improving crop yields.

The light-sensing operation that opens pores is distinct from the absorption of light used directly for photosynthesis. Blue light directly triggers the pore response, whereas both blue and red light are absorbed by chloroplasts, the structures that carry out photosynthesis. This difference has allowed Zeiger to characterize the stomatal response.

Under some conditions, blue light can dramatically stimulate plant growth, Zeiger reports. He has worked with orchids, which grow slowly because they open their pores only slightly. With scientists at the Smithsonian Environmental Research Center in Rockville, Md., Zeiger grew orchids in either artificial sunlight or light having double the natural amount of blue. The stomata did open wider under the blue-light-enriched condition, and those plants grew 50 to 70 percent more in three weeks.

A surprising mechanism underlies the stomatal response to blue light. The light turns on a pump that removes protons — positively charged hydrogen ions — from a cell. Such pumps had previously been observed only in certain bacteria (SN: 2/25/78, p. 119).

The light-sensitive pump occurs in the guard cells, which surround the gas-exchange pore. The pump, when active, creates an electrical gradient across the cell membrane. This gradient pulls potassium ions and water into the cells. The cells then swell, opening the pore.

The proton pump of guard cells was reported in the Nov. 21 NATURE by Sally M. Assmann, a colleague of Zeiger's at Stanford, and Luciana Simoncini and Julia I. Schroeder of the Max Planck Institute for Biophysical Chemistry in Göttingen, West Germany.

In addition, the guard cells of most plants contain rudimentary chloroplasts, which also absorb light. Scientists disagree over whether these function or are simply evolutionary vestiges of primitive plants. Zeiger and his co-workers now have isolated guard cell chloroplasts and report that they convert light into a cellular fuel, ATP, as do the functional chloroplasts elsewhere in the plants. Zeiger hypothesizes that the guard cell chloroplasts fuel the light-activated proton pump. "This is very controversial," he says.

Zeiger and Paul Moore of the U.S. Department of Agriculture in Aeia, Hawaii, are applying their new knowledge about how stomata function to the breeding of sugar cane. They hope to increase the carbon dioxide supply and reduce water loss. — *J.A. Miller*

Infanticide: All in the coterie

Black-tailed prairie dogs are engaging, social creatures that live in large underground communities and use a series of barks to warn neighbors of approaching predators (SN: 1/10/81, p. 29). Researchers have, however, documented a grisly side to their nature: This strain of prairie dog kills a substantial number of its own young, and the culprits are most often females who have recently had a litter and then attack the youngsters of close kin.

"I was flabbergasted at the extent and nature of infanticide [among these prairie dogs]," says biologist John L. Hoogland of the University of Maryland in Frostburg. "My co-workers and I watched them for five years before suspecting what was going on."

It appears, he reports in the Nov. 29 SCIENCE, that infanticide is the major source of juvenile mortality among black-tailed prairie dogs, accounting for the total or partial demise of half of all litters born within a 16-acre colony at Wind Cave National Park in South Dakota. From 1978 to 1984, Hoogland and his assistants detected 73 cases of infanticide. In 40 of the cases, the "marauder" was a nursing female raising a litter of her own. She was usually a close relative — mother, daughter, sister, aunt, niece or cousin — of the victims' mother. Genetic relationships have been carefully determined for all young weaned at the colony since 1975.

Other types of infanticide included the killing of abandoned young by members of a coterie (a family group consisting of a male, several females and their young living in the same area) or by outsiders.

Killers sometimes eat parts of their prey, says Hoogland. This was confirmed by an excavation to retrieve several victims. Frequently, he adds, a marauder emerges from a burrow with a bloody face, suggesting that he or she cannibalized a litter.

Infanticide occurs in several groups of mammals where one male mates with a group of females. For example, male lions and langurs (SN: 7/10/82, p. 26) entering a group regularly kill the young fathered by the males they replace. The "payoff" for such males, says Hoogland, may be that females who lose offspring come into estrus and conceive more quickly than those who continue to nurse their young.

In prairie dogs, however, the payoff for male marauders is not so clear. They usually attack litters after nursing has stopped, Hoogland explains, and infanticide does not reduce the time until the next female estrus. Males may be attempting to reduce competition by yearlings in the next breeding season, he suggests.

Female infanticide is even more perplexing, he says. It may be a necessary way to get adequate nutrition while nursing; since coterie members defend against outside attacks, the offspring of kin are more accessible. If natural food supplies are limited, infanticide reduces future competition. Also, mothers whose litters are killed are more likely to help defend remaining litters. Ironically, notes Hoogland, mothers who attack litters of close kin leave their own offspring unguarded.

"I have some dandy hypotheses," he says, "but I can't show with numbers what the payoff is [for marauding prairie dogs]." — *B. Bower*

HeH: Excimer compound

Chemistry textbooks used to say that the noble gases are called noble because they do not form compounds. Their nobility has been compromised for decades — under admittedly unusual conditions, they do compound. In the Nov. 11 PHYSICAL REVIEW LETTERS, Thomas Möller, Michael Beland and Georg Zimmerer of the University of Hamburg in West Germany report evidence for the formation of the simplest possible noble-gas compound, helium hydride. It forms when a mixture of helium and hydrogen is energetically excited by ultraviolet radiation from a synchrotron. Noble-gas compounds are interesting to theoretical chemists for the information they give about compound formation, and to technologists for possible use in lasers. □