Biology

One giant leap for aphid-kind

In certain situations, pea aphids infested with deadly parasitic wasps jump to almost certain death. Scientists now suggest that the aphids apparently are pushed by instinct to protect other aphids from being parasitized by the wasps, thereby saving the aphid colony by their own demise. Recent studies of this complex suicidal behavior in aphid populations provide "the first convincing evidence in support of the host suicide hypothesis," say researchers at Simon Fraser University in Burnaby, British Columbia.

Described in 1981 and rooted in evolution theory, the host suicide hypothesis suggests that individual animals containing parasites deadly to their relatives will endanger their own lives in a form of suicide, thereby ridding the population of any threat from the parasite. In studying host suicide, Murdoch K. McAllister and Bernard D. Roitberg used pea aphids bred from distinct British Columbia populations: one from the coastal town of Chilliwack, the others from the hot, dry areas near Kamloops and Okanagan Falls. Because the aphids reproduce asexually, members of a colony are genetically identical. This implies that self-sacrifice does not erase genes from the aphids' genetic pool, say the scientists in the Aug. 27 NATURE.

Roitberg and others had reported earlier that when confronted by predatory beetles, pea aphids follow one of three possible escape plans: remaining still after backing up a short distance, running away on the leaf's surface or dropping from the plant. Because many predators of the aphids are ineffective hunters, in many cases dropping from the plant is not necessary to avoid the beetles, say Roitberg and McAllister.

In their controlled-climate laboratory, they compared the escape-response behavior of parasitized and unparasitized aphids living on bean leaves. They forced the aphids to choose escape routes by frightening them with either the approach of ladybird beetles or the presence of alarm pheromones "gently squeezed" from other aphids held nearby. Pheromones are chemical signals sent from one animal to another. Aphids do not systematically drop from plants without alarm pheromones or other "predator signals" being present.

Parasitized aphids from the drier areas are about twice as likely to drop off their leaves than are their unparasitized kin, concluded the scientists. No such preference for "suicide" by parasitized aphids has evolved in Chilliwack populations, however. According to the authors, falling off a plant in locations like Kamloops can be fatal, because aphids lying on the arid ground dry up quickly. The moist weather in Chilliwack, however, makes "desiccation on the ground" less certain, and leaping less likely to benefit the community.

Counting on a high-tech pest patrol

Electronic infrared sensors may someday replace the stroll through the field to assess the number of crop-eating insects. Last month, after four years of testing prototype systems, researchers from the U.S. Department of Agriculture (USDA) laboratory in Weslaco, Tex., installed a demonstration model of a "ground-based remote sensing" system on a farm near Austin. Developed by USDA entomologist Donovan E. Hendricks, the field system consists of portable sensors that transmit radio signals to a standard personal computer at farm headquarters. Sex pheromones are used to "bait" the sensors, which send coded messages each time flying insects pass through their infrared beams.

The system could be adapted for "any crop, any pest, any time of year," Hendricks told SCIENCE NEWS. He says that moths alone cause $7 million to $10 million in crop damage each year. More important than the economic benefits, says Hendricks, is knowing the current number of insects in a field, thus avoiding the "indiscriminate use" of pesticides.

Environment

Acid showers and damage to plants

In general, scientific studies so far have indicated that acid rain does not appear to damage or reduce the yield of most agricultural crops (SN: 7/18/87, p.36). "However," says botanist Denis T. DuBay of North Carolina State University (NCSU) in Raleigh, "there are certain crops and certain situations that are a cause for concern, and that are the subject of continuing investigation." To get a sense of how serious the problem may be, NCSU researchers recently conducted several laboratory studies designed to evaluate acid rain effects at times when plants are likely to be most sensitive.

One group of experiments focused on acid rain's effect on reproduction in corn plants. The experiments showed that corn plants subjected to acid rain showers immediately after pollination develop fewer kernels than do plants that are showered with unpolluted rain. "The more acidic the rain," says DuBay, who headed the project, "the fewer the kernels." Acid rain showers before pollination have no noticeable effect on kernel formation.

"Whether that means anything for the farmer is hard to say," says DuBay, "because it was a very artificial experiment. We don't have any idea that this will happen in the field." In the field, pollination occurs over a period of days instead of all at once, as in the experiment. Because the effect of acid rain on kernel formation appears to depend strongly on the timing, duration and frequency of acid rain showers, the chances of seeing an effect in the field are likely to be small.

In another study, NCSU researchers identified which species among 18 agricultural crops and 11 ornamental plants appear to be sensitive to acid rain during early growth. Working with seedlings that had just produced their first set of true leaves, the scientists showered the plants with acid rain for one hour, then examined the plants two days later for leaf damage. Acid rain, if it causes damage, leaves tiny white spots where plant material has dried out and died.

Of 247 species tested, the researchers detected leaf damage among plants such as tomatoes, soybeans, snap beans, tobacco, eggplant, sunflowers and cotton. Winter wheat, corn, lettuce, alfalfa, fescue and clover were among the least sensitive. Other experiments have shown that the extent of leaf injury at this early stage seems to be a good indicator of how well the plants grow if acid rain showers continue.

The overall picture is encouraging. "We saw very little injury among most of the crops we looked at," says DuBay. "Because we set the experiments up to get the plants at the most sensitive time, we expected to see more effects than we ended up seeing."

From sulfur dioxide to sulfuric acid

The chemical paths leading from sulfur dioxide (SO_2) molecules to sulfate ($SO_4^{=}$) ions, a key component of acid rain, are many and varied. One possible path is the oxidation of sulfur dioxide in cloud and fog water droplets. Although that reaction has been studied for nearly a century, its mechanism is still not completely understood. Researchers at the Lawrence Berkeley (Calif.) Laboratory have now identified a previously undetected intermediate chemical species that may play an important role in the formation of sulfate ions.

Reporting in the Aug. 14 SCIENCE, S.G. Chang, D. Littlejohn and K.Y. Hu suggest that the reaction between bisulfite (HSO_3^-) ions and oxygen produces disulfate ($S_2O_7^{=}$) ions, which then combine with water and decay into sulfate and hydrogen ions. Their conclusion is based on the spectroscopic study of a rapidly mixed flow system at a pressure high enough to ensure a sufficiently large dissolved oxygen concentration. That technique allows researchers to monitor all chemical species present during the reaction.