Chemistry

Janet Raloff reports from Miami Beach at the American Chemical Society's fall national meeting

Spanish fly's lure: Ardor or armor?

The infamous aphrodisiac "Spanish fly" derives not from flies but from the dried bodies of meloid beetles. Poisonous to humans, its active ingredient — a terpene known as cantharidin — occasionally attracts other insects, especially male pyrochroid beetles, which feast compulsively on meloid carcasses. Though some researchers have suspected cantharidin might lure male insects by mimicking their females' sex pheromone, new studies dispel that notion and point to quite another explanation. For pyrochroid beetles, "cantharidin really does seem to function as an aphrodisiac," says chemist Jerrold Meinwald of Cornell University in Ithaca, N.Y. Females actively reject advances by males who have *not* fed upon it, he reports.

Seduction might not even be the chemical's primary function in these bugs, suggest Meinwald, Thomas Eisner and their co-workers, noting that the toxic cantharidin deters predators from dining on beetles that have ingested it.

The researchers observed that as the mating ritual begins, the pyrochroid male secretes a gooey substance from a groove-like structure in his forehead. The female tastes it. Only if she detects cantharidin does she readily agree to mate.

"We now suspect cantharidin functions as a prenuptial offering," Meinwald says. When a group of males approaches a female, she "asks" each what he has to offer. Those who can promise her and her offspring cantharidin protection against predators — as evidenced by the chemical-laced forehead goo — are welcomed. Meinwald's analyses show that females not only get a hefty dose of the male-harvested toxin during mating but also pass on the chemical defense in their eggs. The team's studies with ladybugs — pyrochroid-egg consumers — confirm cantharidin's legacy: It reduces egg predation.

Crab-shell derivative retards rancidity

Researchers have spent decades seeking uses for chitin, Earth's second most abundant natural polymer (long-chain molecule). The shellfish industry discards huge amounts of this strong, biodegradable and nonallergenic material, the main constituent of crustacean shells. Last year, Canadian scientists reported plans to fashion chitin-based coatings to extend the shelf life of fruits (SN: 6/25/88, p.410). Now, chemists at the USDA's Southern Regional Research Center in New Orleans have developed another shelf-life-extending chitin derivative. This one binds with the iron in meats to slow chemical reactions that cause rancidity and flavor loss.

In meats, iron activates oxygen in the air to produce highly reactive free radicals that attack fatty substances called lipids. The oxidative breakdown of polyunsaturated fatty acids causes much of the flavor breakdown associated with rancidity, explains chemist John R. Vercellotti. The chitin-based compound he's working with — N-carboxymethylchitosan, or NCMC — essentially ties up meat's iron atoms. This greatly retards the atoms' ability to generate lipid-damaging free radicals, report Vercellotti and Allen J. St. Angelo, who together developed NCMC's newly patented antioxidant application.

Dilute solutions of NCMC can be injected into meats, from steaks to top round roasts — probably at the slaughterhouse, Vercellotti says. Alternatively, cooks can mix the antioxidant into raw ground beef or sprinkle it into stews and gravies. A 500-parts-per-million concentration of NCMC prevented oxidative rancidity in cooked ground beef throughout a week of refrigeration — generally the maximum useful life of leftovers. In fact, Vercellotti says, scant oxidation occurred in treated, cooked meat over the course of a month. NCMC might also protect fish, poultry and even dairy products.

Vercellotti says an industrial consortium has sprung up to make NCMC for a range of such applications.

Environment

Ozone needles loblolly pines . . .

Wood merchants love the long-needled loblolly for its ability to reach timber size in 25 to 30 years. This pine represents the major commercial wood species of the South, a region producing half of the United States' wood fiber. But in the past two decades, loblolly growth rates in the South have decreased by 10 to 15 percent. Most experts have blamed air pollution, fingering rising levels of ozone — a pollutant already held responsible for about 90 percent of U.S. crop losses from air pollution (SN: 6/6/87, p.357).

Supporting that theory, Duke University researchers have found that high levels of ozone diminish long-term photosynthesis rates in the loblolly pine. Duke ecologist Curtis J. Richardson calls the research the "first large-scale field study to look at levels of ozone in the Southeast that are significantly affecting photosynthesis and tree growth" of loblolly pines.

Richardson and his colleagues studied trees in a 50-acre experimental forest site near the university in Durham, N.C. They exposed trees in 54 chambers to five different levels of ozone and three of acid rain. At ozone levels triple those normally found in forest air, loblollies experienced an 80 percent reduction in photosynthesis compared with trees exposed to ambient ozone levels, the researchers reported in Toronto last month at the meeting of the American Institute of Biological Sciences. Similar ozone levels now exist in such large cities as Atlanta and Houston. At slightly lower ozone levels, loblolly needles — which normally stay on the tree for 14 to 18 months — dropped off in the first year, Richardson says. New needles showed an unexplained increase in their photosynthetic rate, which leveled off as cumulative ozone exposure increased. Duke scientists next hope to determine whether the trees will produce enough new needles to offset the early loss of old ones.

In another study, described in the June PLANT PHYSIOLOGY, Richardson and Duke toxicologist Richard T. Di Giulio determined that loblolly pines, red spruce and scotch pines exposed to similarly high ozone levels produced increased levels of enzymes and other compounds called antioxidants. Plants produce antioxidants to prevent the formation of hydroxyl radicals, highly reactive molecules that usually kill cells. Richardson says the increased antioxidant levels reflect the trees' attempt to overcome oxygen stress. Scientists could look for increased antioxidant levels in needles as a biomarker of air pollution stress, he told SCIENCE NEWS.

. . . and saps sequoia seedlings

High ozone levels also reduce photosynthesis and increase loss of carbon dioxide in giant sequoia seedlings, report Nancy E. Grulke and Paul R. Miller of the U.S. Forest Service's Pacific Southwest Forest and Range Experiment Station in Riverside, Calif. They found that sequoia seedlings exposed to increased ozone levels lost carbon, indicating reduced photosynthesis and possible cell damage.

Ozone-fumigated seedlings required more light to retain the same amount of carbon as seedlings grown at ambient ozone levels, Grulke says. Although the test plants had yellowed needles, those needles did not show the bands of dead tissue typical of plant injury, Miller says.

The team's findings, presented at the meeting of the American Institute of Biological Sciences, suggest that if ozone levels increase, sequoia seedlings will need more light for longer periods to survive, Grulke adds. Seedlings on forest floors typically get only about two hours of sunlight per day and have a relatively high mortality rate, with only 10 to 15 of 100 surviving their first year. Grulke is now looking into whether ozone affects adult sequoias, which show no visible symptoms of ozone injury.