

Listening in on lignin light

Lignin is the natural cement that binds cellulose fibers in plant stems and prevents enzymes from digesting cellulose. Although lignin is the second most abundant organic material (after cellulose), it remains an enigma. Researchers at the U.S. Department of Agriculture laboratory in Peoria, Ill., are attempting to learn more about the natural state of this material by shining light on the subject and listening for the results using a technique called photoacoustic spectroscopy (SN: 6/19/76, p. 392). The research could lead to more effective methods for removing lignin from wood or crop residues like corn stalks, which would make more cellulose available as fodder, or for processing into ethyl alcohol and other industrial raw materials (SN: 5/3/80, p. 282; 5/31/80, p. 344).

USDA chemist J. Michael Gould's studies are the first application of photoacoustic spectroscopy to natural lignin. Light of a particular wavelength from a xenon lamp flashes onto a sample in a sealed metal chamber. If the sample absorbs light, it heats up during the period the light is on and cools when the light is off. Because the light flashes at a given frequency, the air inside the chamber expands and contracts periodically, creating sound-like waves that are detected by a microphone in the chamber. In a typical experiment, with samples of a few milligrams of powder or centimeter-long scraps of paper, Gould records the intensity of the microphone's output as the instrument scans across the lamp's spectrum. The result is an absorption spectrum for an opaque material.

"The advantage of the system is that the sample doesn't have to be transparent," Gould says. "The sample itself is functioning as a detector." Previous research had been done with lignin mechanically or chemically broken into fragments, which become soluble in organic solvents. Gould says, "It's not representative of real lignin." He predicts that in 10 years photoacoustic spectroscopy will be a commonly used technique for investigating the chemistry of complex biomaterials like lignin.

So far, Gould has shown that a lot of chemical degradation occurs from the time lignin is originally deposited in a plant. "We are able to demonstrate pretty convincingly now that it's a photochemical reaction with a single oxygen-type intermediate that's involved," Gould says. "That is probably what's responsible for the yellowing that occurs in paper, so we're trying to identify what parts of the molecule are responsible for these reactions." Now Gould and his colleagues are looking into photoacoustic spectroscopy with infrared light.

Cleaner wastewater for synfuel plants

Many proposed designs for coal gasification and liquefaction plants include schemes for recycling wastewater with the goal of achieving "zero discharge." However, there are few data on the performance of advanced water treatment processes necessary to remove the complex mixture of contaminants left in the wastewater after coal is processed. Researchers from the Oak Ridge National Laboratory are now testing a prototype treatment unit at the H-Coal Pilot Plant in Catlettsburg, Ky. Richard K. Genung of Oak Ridge says their portable unit has successfully treated actual process wastewater at a rate of 1 gallon per minute under plant conditions on a scale that provides some credible design and cost data.

In the process, pretreated wastewater is first bathed in ozone to break down organic chemicals into compounds more readily absorbed by powdered activated carbon in the second treatment stage. Finally, a reverse osmosis process removes and concentrates dissolved salts. Genung says further work is needed to refine the process and to test it on wastewaters from different coal conversion processes and from different types of coal.

Bald eagle may lose some protection

When President Reagan declared June 20, 1982 "National Bald Eagle Day" he stated that, although the eagle's "extinction has become a disheartening possibility in recent years," efforts of federal and state governments have resulted in a "subtle but definite population increase." These efforts, he said, include passage of the Bald and Golden Eagle Protection Act. Ten days later, William Coldiron, Solicitor of the U.S. Department of Interior, issued a legal opinion stating that restrictions in that act should no longer apply to activities of the federal government. Among federal activities that may harm eagles and their habitat are: coal and mineral leasing by the Bureau of Land Management, timber cutting by the Forest Service and livestock predator control — setting out traps and poisons, for example — by the Fish and Wildlife Service.

This ruling, say some environmentalists, will bring new threats to our national bird. Phil Million, an information officer at Interior, argues that "there is ample protection for bald eagles under other legislation," namely the Endangered Species Act. That may be true in states where the bald eagle is listed as endangered, says Michael Bean, an attorney at the Environmental Defense Fund. But in the five states where they are threatened, regulations only provide the restrictions included in the eagle act and the Migratory Bird Treaty Act. While the latter could be a "potential additional source of authority" for prohibiting harmful actions, he says it has never been used for this, and if it were it would be "vulnerable to the same kind of analysis" as the eagle legislation. In addition, the opinion "eliminates all protection from federal activities for bald eagles in Alaska and golden eagles everywhere," says Bean. Protecting golden eagles is important to bald eagle conservation because the young of the two species are almost indistinguishable.

While the Solicitor's opinion does not state why the ruling was necessary, Bean suggests it probably stemmed from a recent gift of two bald eagles to President Reagan from West German Chancellor Helmut Schmidt and fears that importing the birds would be a violation of the act. Million told SCIENCE NEWS that the opinion "might have been tied to the eagle gift, but to the best of my knowledge it was an internal, not White House, request." Fewer restrictions on the government may help eagles, he adds, because federal scientists could then import them more easily for captive breeding programs. But, notes Bean, those kinds of activities are already possible through special permits and do not justify this broad exemption from the law.

Probing pollution with more mussel

The tendency of shellfish to concentrate natural and man-made toxins in their bodies—and the resulting hazard to human health — is well known. But mollusks also accumulate substances in their shells and, according to one U.S. Fish and Wildlife Service biologist, this characteristic may help scientists monitor pollution levels over time. Marc J. Imlay of the National Fisheries Research Laboratory in Columbia, Mo., writes in the 1982 MALACOLOGICAL REVIEW that freshwater mussels incorporate dissolved heavy metals from surrounding water into their shells—including copper, cadmium, mercury, lead and zinc. Because annual shell growth increments can be separated in the laboratory and metal concentrations in each layer measured and compared, mussels are ideal for monitoring metals over time at a specific site, says Imlay. Mussels rarely move far from a particular spot throughout their adult lives. Imlay reviews 20 species known to accumulate heavy metals that could be used as pollution monitors. He notes, however, that the exact relationship between shell concentration and that of the surrounding environment must still be worked out.