MEETING ECOLOGICAL SOCIETY OF AMERICA

Superweeds, and a Sinking Feeling on Carbon Sinks

MADISON, WISCONSIN—More than 3000 ecologists gathered here from 5 to 10 August for the 86th annual meeting of the Ecological Society of America (ESA). Hot topics included trees and global warming, the risks of transgenic crops, and vanishing tropical mammals.

Forests: No Greenhouse Antidote?

Some experts claim that the world's forests can absorb enough carbon dioxide to reduce the impact of further global warming. But at least one type of hardwood forest may not be up to the job. Rather than storing extra carbon in long-lasting trunks and branches, an experimental sweetgum stand in Tennessee socks most of the CO_2 in tiny roots that rapidly die and decompose. That process sends the gas right back into the atmosphere.

CREDIT: ORNL

Leaky sponge. Sweetgum forests like this one may not do much to curb greenhouse warming.

Researchers have long wrangled over the ability of forests to serve as carbon sinks for excess greenhouse gases. It's clear that saplings in open-top enclosures respond to high CO_2 with growth spurts, stepping up photosynthesis and making more leaves and wood than would trees sucking unadulterated air. But what's true for a stand of saplings may not be true for a mature forest, says ecologist Rich Norby of Oak Ridge National Laboratory in Tennessee. That's because leaf coverage maxes out as a tree matures—putting limits on photosynthesis and, thus, on its capacity to soak up excess CO_2.

To find out how much CO_2 mature trees can absorb, Norby and colleagues built towers 4 years ago to pump CO_2 into the canopies of four stands of young sweetgums. As Norby reported at the meeting, during the first year most of the extra carbon went into wood, with the gassed-up sweetgums accumulating 35% more carbon than control trees grown in unsupplemented air. But 2 years later, that wood differential had narrowed to 7%. More than twice as much carbon as in the controls ended up in the fine roots—thin structures that fall off and die each year. Soil organisms quickly consume the detritus, releasing CO_2 that diffuses out into the air.

Forest ecologist Adrien Finzi of Boston University calls the results "really interesting" but cautions that they may not hold true in other forests. The mechanism of carbon storage certainly differs in an experimental pine stand he studies in North Carolina. Although the loblolly pines there exposed to extra CO_2 also store less extra carbon in wood after a few years as they run short on nutrients such as nitrogen (*Science*, 6 April, p. 36), the carbon ends up primarily in leaf litter, not the fine roots. That suggests to Finzi that researchers must check more than a couple of stands to understand how different forest types respond to high CO_2 levels.

The bottom line for sweetgum and loblolly pine, anyway, is that neither leaf litter nor fine roots offer long-term carbon storage. For that reason, says biogeochemist William Schlesinger of Duke University, planners shouldn't count on forests as CO_2 saviors. "These terrestrial sinks," he contends, "are just not adding up to much."

–DAN FERBER

Breeding a Hardier Weed

In the vitriolic debate over the potential risks of transgenic crops, one big concern is that wild relatives may commandeer valuable traits and turn into "superweeds" that spread, unchecked, across the land. Two new studies add hard data to what has been mostly a theoretical discussion. One finds that genes from a crop can persist in a weed for many generations, while a second supports the idea that if genes that protect against viral infection slip into wild plants, there could be serious consequences.

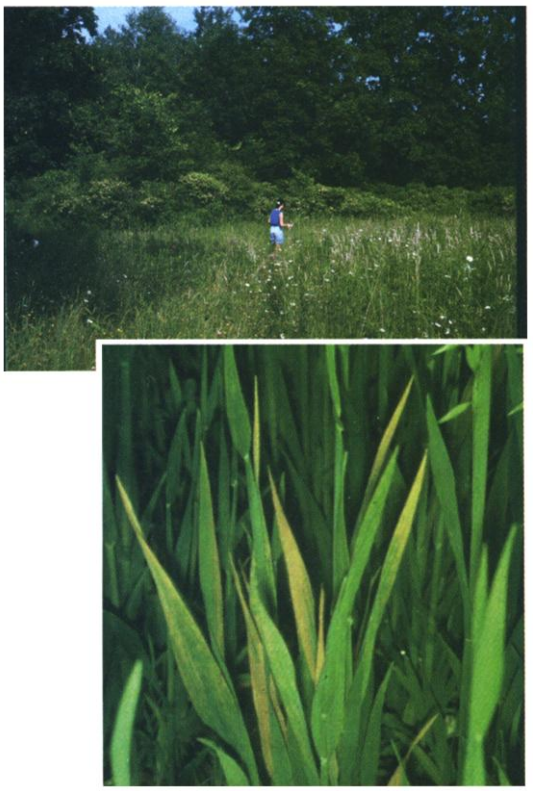
Although neither finding pins down the risks, these and other studies have convinced some ecologists that genetically modified (GM) crops are being rolled out too hastily. "We really need a lot more data before we make assumptions" about safety, says Alison Power of Cornell University in Ithaca, New York, who presented her work on viruses.

Conventional wisdom says that crop traits are unlikely to persist in the wild in part because crossbreeding crops and weeds yields hybrids that tend to reproduce poorly. "In the crop-breeding and weed science world, there's always been a feeling that crop genes would not persist," says Allison Snow of Ohio State University in Columbus, who described a 6-year experiment on half-wild, half-crop radishes planted next to wild radishes in Michigan. Snow's group found that crop genes had no trouble sneaking into the weeds—and staying there.

While the first cross between these relatives (the F1 generation) had low fertility—as few as 60% made seeds—several traits, including white flowers and variants of two enzymes, showed up in subsequent generations of wild radishes. And second-generation hybrids—crosses between F1 and wild plants—grew almost as well as the wild radish. Although it's not a big surprise that traits showed up in the wild radishes, "it's important to quantify persistence," says plant scientist Neal Stewart of the University of North Carolina, Greensboro. Radish, he notes, "is a very nasty weed."

But whiter flowers and a more croplike metabolism are hardly the makings of superweeds. What might help weeds outlast the competition, however, is if a jumping gene they acquired were able to help them fend off viral attack, says Power.

Her test case is crops modified to resist the barley yellow dwarf virus. To find out whether the trait could give a leg up to wild plants, Power first looked at whether the virus shows up much in nonagricultural ecosystems. The team tested for virus in wild grasses near Ithaca. Surprisingly, up to 60% of samples of 16 grasses, including



Sowing wilder wild oats? Wild grasses (*top*) are often infected with barley yellow dwarf virus (*bottom*, infected crop oats). If wild oats were to steal a viral-resistance gene from transgenic crops, they could benefit immensely.

yellow foxtail and wild oats, were infected. "To me, that's mind-boggling," Power says, because it has been assumed that wild plants had evolved resistance to the virus.

Wild oats, not surprisingly, often grow in the same areas as crop oats, a variety of which has been equipped to withstand the virus. (Although companies have developed at least 18 virus-resistant crops, the only ones now being planted commercially are potato, papaya, and squash.) Hypothetically, the trait could slip into the wild oats. To see if this might make the weed hardier, the team grew cultivated oats and wild oats side by side in a greenhouse. Some plants were inoculated with the virus; others were disease-free. Compared to infected plants, healthy wild oats grew much better than healthy crop oats, producing about 25% more biomass; meanwhile, crop oat biomass actually dropped 13%. "If you remove the virus," Power says, "it gives a huge advantage to wild oats because they're no longer suppressed." The result could be a weed that aggressively invades croplands.

Although other meeting attendees found the results intriguing, they caution that only field tests of virus-free wild oats will determine the actual risks. Power expects to complete those studies this summer.

–JOCELYN KAISER

CREDITS: (FIELD AND OATS) A. G. POWER/CORNELL UNIVERSITY; (TAPIR) TOM BRAKEFIELD/CORBIS

Case of the Missing Mammals

As primates, tapirs, and other large mammals in the tropics get picked off by poachers, the harm could extend far beyond the devastation to the species themselves. Because these herbivores influence the makeup of plant communities by eating leaves and seeds, their loss could transform the overall structure of tropical forests, ecologists have argued. Experiments described here at the meeting suggest that this scenario is now playing out in Mexico.

Three decades ago, ecologists posited that herbivores and seed-eating animals might help maintain the remarkable diversity of tropical forests by thinning abundant seedlings to make room for less prolific species. Nobody tested this hypothesis on a large scale, however, until an alarming report on Mexico's fragile ecosystems appeared in 1991.

That's when ecologist Rodolfo Dirzo of the Universidad Nacional Autónoma de México (UNAM) noticed a striking contrast in the appearance of two forests in southern Mexico: Montes Azules in Chiapas, a largely intact forest with its original 40 or so species of nonflying mammals; and the smaller Los Tuxtlas, Veracruz, in which about 46% of the same suite of species—including jaguars, tapirs, deer, and monkeys—had in the last 3 decades been hunted down or captured for the pet trade. Los Tuxtlas's understory was carpeted with dense patches of seedlings from trees such as *Nectandra ambigens* and *Brosiumum alicastrum*—far fewer species, but far thicker growth, than the understory at Montes Azules.

Factors other than browsing, such as a heavier-than-normal seed production one year for certain tree species, might have explained the strangely uniform and thick understory in Los Tuxtlas. But the findings inspired Dirzo and other ecologists to examine what happens when mammals are absent. At the meeting, Dirzo and graduate student Eduardo Mendoza described recent experiments that firm up a role for mammals in fostering diversity in Los Tuxtlas and Montes Azules.

First, Dirzo's team set up fences to exclude all mammals from 2-square-meter plots located near five canopy trees at each of the two sites. After 2 years, the number of species of understory plants in fenced and control plots in Los Tuxtlas were, as expected, exactly the same. But in Montes Azules, which still has its mammals, the scientists counted a total of only 91 species in fenced plots compared to 112 in plots visited by animals.

The UNAM team is also exploring a possible mechanism for why large-seeded plants may be favored when large and medium-sized mammals are missing. Dirzo and Mendoza suspect that mice—which may be more abundant with their predators gone—are eating mainly small seeds in Los Tuxtlas. The two have found that caged mice seem to eat mostly small seeds in the lab, and they're now testing preferences in the field with cages that only small animals can enter.

Although these results appear to support a role for herbivores in promoting forest diversity, Dirzo cautions that he can't predict the long-term fate of Los Tuxtlas's species-poor understory or whether the findings apply to other forests. Indeed, researchers reported at the meeting that in much larger, 35-meter-by-40-meter exclosures at Barro Colorado Island in Panama, plant diversity is going up—not down—after 8 years. A similar 3-year study in Australia has gotten mixed results: more species, but certain species are flourishing and may be crowding out others. "It may take longer to see differences" at a larger scale, notes investigator Catherine Gehring of Northern Arizona University in Flagstaff.

Disappearing act. Losing large mammals such as the Baird's tapir may be altering diversity in a Mexican forest.

No matter how their role in forests plays out, Dirzo says, the plight of tropical mammals demands action: "We need to view defaunation as another major environmental change." **–J.K.**