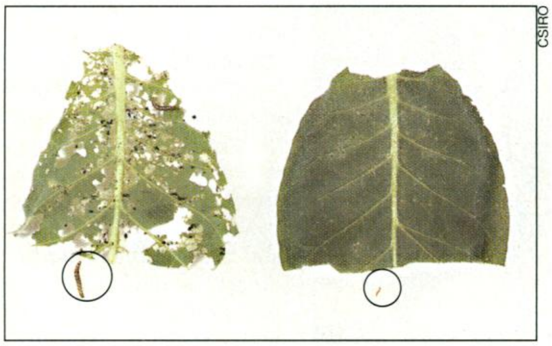
MEETING BRIEFS

Pacific Basin Gathering in Hawaii Fills With Chemists

From December 17 to 22, chemists from around the Pacific Rim converged on Honolulu, Hawaii, for the International Chemical Congress of Pacific Basin Societies, a meeting held every 6 years. Japan produced the highest turnout, sending over 3000 researchers, while the United States was second with nearly 2000; other delegations were smaller (Korea sent about 60, for instance). Chemists heard reports of many advances, including square molecules with twists and plants engineered to make insect-killing viruses.

Arming Plants With a Virus

In their ongoing war against crop pests, agricultural researchers have begun to appropriate weapons from nature itself. They've genetically engineered plants to produce a bacterial toxin, for instance, which kills crop-damaging insects. At the Honolulu meeting, a group of Australian researchers reported taking this strategy one step further: engineering a plant to express an entire insect-killing virus.



CSIRO

Defensive plants. An ordinary tobacco leaf *(left)* is ravaged by a bollworm, while one armed with a virus *(right)* fared better. The virus stunts and kills the pests *(circled)*.

Terry Hanzlik, Karl Gordon, and Phil Larkin of the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Canberra armed a tobacco plant with the HaSV virus, which infects and kills a costly agricultural pest, the cotton bollworm (*Helicoverpa armigera*), and its equally pernicious relatives, the tobacco budworms. Bollworm and budworm larvae attack plants such as cotton, corn, and tobacco, and rank among the five most economically destructive insect pests in the United States. But in initial tests, the virally armed plants remained all but unharmed by bollworm larvae, while normal plants were ravaged.

The use of a virus has drawn both praise and concern. "It's an imaginative and novel strategy" for controlling pests without using synthetic chemicals, says Brian Federici, a professor of entomology at the University of California, Riverside, who has worked on turning bacterial toxins into pesticides. "This looked like it worked pretty well." A viral defense may improve on one based on bacterial toxins, because small RNA viruses, such as HaSV, mutate readily, producing new insect-killing strains should resistance to the current one crop up.

But Alvin Smith, a professor of veterinary medicine at Oregon State University in Corvallis, who has studied how other small RNA viruses known as caliciviruses can adapt to new animal hosts, says he's concerned that HaSV's tendency to mutate might allow it to jump to a new host. "I get a little spooked if you talk about a plant expressing an infectious virion," he says.

In creating their transgenic plants, however, the Australian team chose HaSV because of its apparent specificity: The virus infects only bollworm and budworm larvae, and kills them by binding to cells in their guts. The insects then try to shed infected cells. As this process is repeated, the gut breaks down, and the insects die.

To transfer the viral genes into the tobacco, the researchers first transcribed the viral RNA into DNA. They then used gene-splicing methods to insert this DNA, along with genetic "on switches" known as promoters, into the chromosomes of cultured tobacco plant cells. When the cultured cells were grown into adult plants, each cell transcribed the viral genes, producing HaSV particles that were harmless to the plant, but deadly to munching insects.

Hanzlik and Gordon also doubt that HaSV will acquire the ability to infect other organisms. "These viruses have been around for a long time," says Gordon. "And this virus has never managed to enter other hosts." Federici adds that although it's possible that other insects could be susceptible, "I consider it unlikely that it would jump to other organisms," as the virus is specialized to attack bollworm gut cells. It's particularly unlikely that it could infect mammals, he adds, because unlike insects, mammals have a very acidic gut that quickly breaks down HaSV's protein coat.

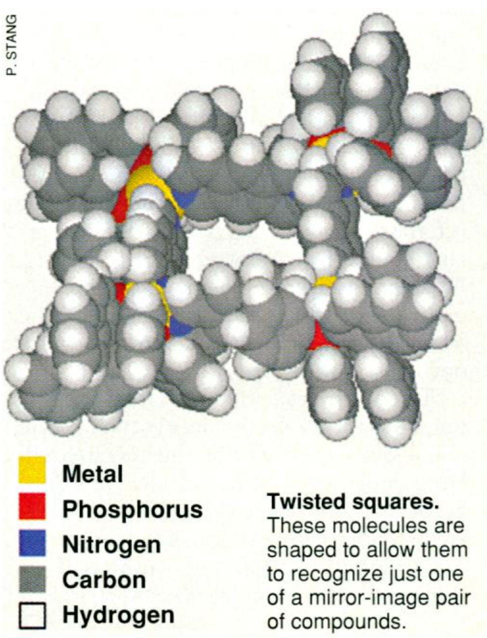
Smith, however, notes that caliciviruses are now recognized to infect more hosts than originally thought, and that HaSV could also hold surprises for scientists. All the researchers do agree that before any virally armed plants make it to commercial fields, researchers will have to present a crop of lab and field studies showing that the viruses will not affect beneficial insects and other organisms such as birds. If these trials are successful, farmers may be growing more heavily armed plants.

Not-So-Square Molecules

A square should look the same no matter which way you turn it. But a group of chemists at the University of Utah, Salt Lake City, have created squares that look different—on a molecular level. These assemblages of chemical groups have the overall architecture of a square, but the "handedness" of a right- or left-handed glove.

The compounds are the first squares with the property of "chirality," which might make them sought-after chemical catalysts. Chiral molecules, such as amino acids and sugars, come in pairs whose architectures are mirror opposites. The twins often differ in their behavior—only one might be an active form of a drug, for example—and researchers believe chiral squares will have the ability to interact only with the desired twin. That should allow such squares to act as traps for singling out and transforming other chiral molecules.

The new twist has turned a few heads. "It's wonderful work, and something that has real practical promise," says George Olah, the 1994 Nobel laureate in chemistry, who is at the University of Southern California in Los Angeles. "There is a great interest in catalysis where the products would be chiral." Such squares could add cyclic groups to chiral compounds, an important synthetic step in making precursor compounds for drug synthesis,



P. STANG

Twisted squares. These molecules are shaped to allow them to recognize just one of a mirror-image pair of compounds.

says Peter Stang, who led the research effort. The Utah team has yet to test the squares' unique recognition abilities, but their architecture bodes well, Olah says.

These chiral forms are not the first squares out of the box for the Utah team. The researchers have already made a variety of nonchiral squares in hopes that their unique cavities and configurations of atomic components will allow them to act as catalysts, filters, or traps for molecules that only fit in square corners. The earlier models were formed by creating two different sets of building blocks: corners and straight connecting arms. A metal atom such as platinum, which has four possible binding sites extending out like the arms of a cross, often serves to create the corners. The researchers block off two adjacent sites with chemical groups known as phosphines, leaving the other pair—which forms a right angle—free.

To connect these 90-degree corners, the researchers use arms made from organic compounds, such as bipyridine, which have a pair of nitrogen atoms on each end. When the scientists add the corners and arms to an organic solvent, the squares spontaneously assemble as the electron-rich nitrogen atoms in the arms bond to the electron-hungry metals in the corners.

But while these squares can trap molecules, they cannot distinguish between the mirror-image structures of chiral twins. To give their squares this extra ability, the group replaced the bipyridine arms with compounds such as 2,6-diazaanthracene-9,10-dione (DAAD). The nitrogen atoms at the ends of these molecules are slightly offset from the molecules' long axis. As a result, the DAAD arms have to twist when they bind to the corners, giving an overall asymmetrical twist to the square (see photo).

To ensure that all of the squares twist in the same way—essential if they are to find just one chiral species in a sea of molecular variety—the researchers replaced the phosphine units at the corners with bulky chiral compounds commonly abbreviated as BINAPs. The BINAPs hem in the attachment sites for the DAAD arms, leaving only one way for the DAADs to fit into the corners. The result is formation of just one consistent chiral architecture, or enantiomer, explains Stang. "We don't fully understand why we get one particular enantiomer," says Stang. But, he adds, that enantiomer should only recognize one molecular species.

The Utah team now plans to test the squares for this selective recognition. If the chiral squares pass the test, the next step will be to design squares that catalyze reactions between chiral molecules, such as unsaturated amines, and hydrogen to create products which are used in drug synthesis. That could make it very hip to make squares.

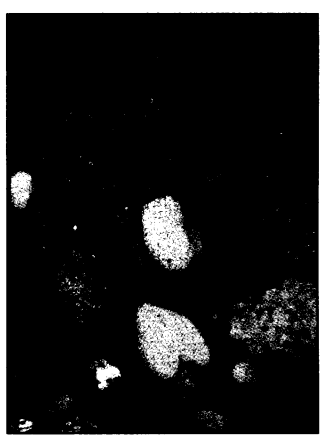
–**Robert F. Service**

CLIMATE

Millennial Climate Oscillation Spied

For climate researchers, figuring out how much Earth's climate is being warmed by the release of greenhouse gases has become a major growth industry. But from studies of past climates comes a reminder that the greenhouse effect isn't the only thing determining global climate. By analyzing climate records stored in sediments and glacial ice, researchers have detected a slow climate oscillation that has alternately warmed and cooled the world every couple of thousand years for the past hundred thousand years, and perhaps for hundreds of millions of years.

Such millennial-scale oscillations had been spotted before, in the last ice age and even earlier in Earth's history. But the latest work firmly establishes them in the Holocene Epoch, the 10,000 years since the end of the last ice age. The climate oscillations in the Holocene are "not quite as wild as [in] the ice age," says ice core specialist Richard Alley of Pennsylvania State University, "but [the epoch] is certainly not boring."


G. BOND

Marking the climate beat. Ice-borne grit records an extra chill.

Indeed, the oscillation's latest dip to the cold side may have been the Little Ice Age of 300 years ago. "Because this oscillation runs through the Holocene, it means that it is operating independent of glacial ice and that it is running now," says paleoceanographer Gerard Bond of Columbia University's Lamont-Doherty Earth Observatory, whose lab is contributing to the work. Understanding what drives the oscillation—still a mystery—might help predict how much—or if—natural warming will boost greenhouse warming.

Bond originally spotted a millennial climate oscillation during the last ice age by analyzing the rock grains in marine sediments older than 10,000 years. When icebergs that split off from the ice sheets on North America and Iceland began to melt, they dropped sand- and pebble-size rocks to the bottom of the deep North Atlantic that are so large and angular that they could not have washed there from rivers. And as Hartmut Heinrich of Germany's Federal Office for Marine Navigation and Hydrography in Hamburg had reported in 1988, the abundance of this ice-rafted debris in sediment cores jumps every 7000 to 10,000 years, reflecting gushes of bergs from the ice sheets that sailed across the North Atlantic. But when Bond and his Lamont colleague Rusty Lotti looked more closely at the sediment cores, they also found smaller but more frequent surges in ice-rafted debris every 2000 to 3000 years.

Early on, all these North Atlantic iceberg surges were assumed to be driven by processes intrinsic to the ice sheets. The idea was that the North American ice sheet periodically grew until it collapsed under its own weight, spewing out an iceberg armada. But a year ago, Bond and Lotti seemed to rule out that idea, at least for the ice sheets around the northwestern North Atlantic, when they showed that the little Icelandic ice sheet was discharging icebergs on roughly the same schedule as its larger neighbor. If the internal dynamics of the ice sheets were responsible for the surges, the two ice sheets should have been following quite different schedules (*Science*, 6 January 1995, p. 27). Some oscillation in global climate, not the internal dynamics of the ice sheets, seemed to be driving the iceberg surges.

If so, the oscillations would also be expected in the Holocene, after the great ice sheets had largely melted. Indeed, Suzanne O'Brien of the University of New Hampshire and her colleagues had already found a clue that the oscillations didn't end with the ice age in an analysis of sea salt in Greenland ice during the Holocene. In results just published in the 22 December issue of *Science*, these researchers found that, starting 11,300 years ago, the flux of fine particles of sea salt falling on the core site of the Greenland Ice Sheet Project jumped five times at intervals averaging 2600 years. Apparently, more intensely winterlike, stormy weather was periodically lofting more than the usual amount of seawater droplets off the Atlantic and onto Greenland.

O'Brien had passed her unpublished results on to Bond, who decided to look for a matching oscillation in a Holocene-age sediment core drilled between Greenland and Iceland. There, as Bond reported at last month's meeting of the American Geophysical Union, he found increases in ice-rafted debris—albeit a tenth the size of ice-age ones—at 1000- to 2400-year intervals. These surges tended to coincide with the sea-salt peaks on Greenland, suggesting that periodic spells of unusual cold were creating more icebergs or letting ice travel farther than usual before dropping its load of debris.

What the ultimate driver of this millennial climate oscillation is, no one can say, but Bond, O'Brien, and some others are