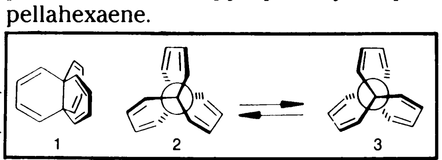
Putting a spin into chemistry

Chemists have found a way to build a molecular propeller. The recently synthesized molecule, consisting of three six-membered rings made up of carbon atoms radiating from a central axis (diagram 1), looks like a three-bladed propeller. Its name, appropriately, is propellahexaene.



Paquette/JACS

"It's a very attractive molecule," says chemist Leo A. Paquette of Ohio State University in Columbus. "It's nicely symmetric and has all the features one would expect if one were to describe a molecular propeller." Paquette and Liladhar Waykole report their successful synthesis in the May 13 JOURNAL OF THE AMERICAN CHEMICAL SOCIETY.

Achieving the synthesis was no simple matter. It took about 20 steps and many years of work to end up with the correct ring structure. Locking three rings together was relatively easy. The trick was to strip away any unnecessary molecular appendages hanging from the rings without causing a major rearrangement of the molecular structure.

The new compound turns out to be remarkably stable in air. It appears in the form of fine, colorless, needle-like crystals, which melt at 48°C.

Paquette and his colleagues are hoping to produce larger quantities of the hexaene to study its crystal structure and its chemical reactivity. In terms of its chemistry, he says, "we don't know what to expect — except complications."

Propellahexaene is also of interest to chemists because it comes in two forms: a right-handed and a left-handed conformation. The rings are strongly curved, and the whole system rapidly flips back and forth between one form and the other (diagrams 2 and 3). Chemists are interested in the factors that determine how easily this switching occurs and how much energy is involved.

It may be possible to lock such a molecular propeller in one position, says Paquette, perhaps by making the rings heavier. That could be done by using double instead of single rings for each blade. Paquette says he can also imagine stacking hexaene molecules to create a molecular screw, "but I wouldn't want to come to grips yet with the task of making them." *— I. Peterson*

Volcanic history in the Aleutian arc

Benjamin Franklin was probably the first to suggest a correlation between volcanic eruptions and changes in the global climate when he proposed that a 1783 volcanic eruption on Iceland had induced abnormally cold temperatures later that year. More recently, scientists have accused volcanic eruptions of causing the yearly depletions of polar ozone and even the extinction of the dinosaurs. However, to support volcano-climate theories, scientists must rely on an incomplete and often sketchy list of the major eruptions in the earth's history, says Thomas P. Miller of the U.S. Geological Survey (USGS) in Anchorage, Alaska.

M. Woodbridge Williams/NPS

View of Alaska's Aniakchak caldera, formed by the collapse of a volcanic cone during an eruption about 3,400 years ago.

In the May GEOLOGY, Miller and Robert L. Smith, a USGS colleague from Sacramento, Calif., report results that fill in some of the gaps in the eruption chronology. Their study will help climatologists confirm or deny that volcanoes had caused certain prehistoric climate changes, says Miller. He and Smith have identified and dated 12 large eruptions — 11 of them previously undated or poorly documented — in the eastern Aleutian arc, a volcanically active boundary between the Pacific plate and the North American plate.

Using carbon-14 dating, the researchers pinpointed the age of organic material either charred by the eruptions or buried under the debris. From these dates, they determined that most of these eruptions occurred relatively recently, within the last 10,000 years. Eight of those eruptions and two earlier ones were large enough "that they must be considered in hypotheses linking large eruptions and climate changes in the late Quaternary [last 100,000 years] time," write the USGS researchers.

Volcanic eruptions influence global climate by ejecting sulfur dioxide into the stratosphere. When this combines with water, it forms small, stable droplets of sulfuric acid, which interact with solar radiation and radiation from the earth, thereby affecting global temperatures.

This study of the Aleutian volcanic history, says Thomas Simkin, a geologist with the Smithsonian Institution in Washington, D.C., will also aid those who assess the potential hazard from future volcanic eruptions. *— R. Monastersky*

Plant hormone: Key to ozone toxicity?

Ozone, a photochemical oxidant in smog, is considered by the government's National Crop Loss Assessment Network to account for about 90 percent of U.S. crop losses from air pollution. According to Walter W. Heck, a scientist with the Agricultural Research Service in Raleigh, N.C., which oversees the network, the pollutant's economic toll on U.S. corn, soybean, wheat and cotton producers is estimated at between $1 billion and $5 billion annually. What has remained a mystery is how the pollutant exacts its toll on plants.

Now a pair of biologists in England report stumbling onto what may be an important clue: that dramatically increased production of a hormone, in response to stress, appears to increase a plant's ozone vulnerability. Moreover, the hormone-triggering stress in this case was a one-shot dose of ozone; long-term ozone exposure actually had the opposite effect on young seedlings, reducing hormone levels.

The researchers found that pea seedlings exposed to between 50 and 150 parts per billion of ozone for seven hours daily throughout their first three weeks of growth showed no visible leaf injury. However, when seedlings grown in the absence of ozone for three weeks were given just one similar seven-hour exposure on day 21, they immediately developed severe leaf-tissue death.

The researchers, Horst Mehlhorn and Alan R. Wellburn of the University of Lancaster, wondered why the two sets of plants were responding so differently. They measured the plants' production of the hormone ethylene and discovered that the single-exposure group produced double the amount of ethylene produced by unstressed (control) plants. Plants in the three-week-exposure group, on the other hand, seemed to combat the ozone by producing 92 percent *less* ethylene than the controls.

"These two quite different responses to ozone suggest that the rate of ethylene production may have an influence on and modify the extent of visible leaf injury caused by ozone," the researchers write in the June 6 NATURE. As a further test of ethylene's role, they pretreated plants with an ethylene inhibitor on the day before the 21-day-old seedlings' single seven-hour ozone exposure. Not only did the treatment reduce by 85 percent the plants' ethylene production during ozone treatment, but it "also almost abolished the visible leaf injury normally caused by this short ozone fumigation," they report.

Mehlhorn says it's not clear how or why the seedlings exposed to three weeks of ozone reduce their ethylene production. But from the study, he says, this accom-