CO_2: An additional source of methane?

It's now well established that methane levels in the atmosphere are rising, and doing so at a rate faster than that of another "greenhouse" gas, carbon dioxide (CO_2). Carbon dioxide is released into the atmosphere by the burning of fossil fuels, but where is all this methane coming from? Scientists have fingered a number of causes, from growing populations of cows to the decreasing levels of certain atmospheric chemicals that destroy methane. A new paper, soon to be published in the JOURNAL OF GEOPHYSICAL RESEARCH, proposes another possibility: that rising levels of carbon dioxide itself are an indirect source of methane.

Paul Guthrie, an atmospheric scientist at NASA Goddard Space Flight Center in Greenbelt, Md., suggests that additional methane is being produced by the anaerobic (oxygenless) decay of plants whose growth has been enhanced by the increasing atmospheric concentrations of carbon dioxide. Using the results of other studies, he estimates that this CO_2-to-methane pathway may account for 2 to 30 percent of the observed increase in atmospheric methane.

"Although some of us like to think we know why methane is increasing at a rate of over 1 percent per year, I think what Guthrie is showing is that not all the possibilities have been considered at all, let alone very well," comments Ralph Cicerone, director of the atmospheric chemistry division at the National Center for Atmospheric Research in Boulder, Colo. He says that with the current state of knowledge, one could theoretically account for the methane increases — a 35 percent rise in the last 40 years and a 100 percent increase over the last 150 years — by considering how rice agriculture, numbers of ruminating animals (whose digestion produces methane), natural-gas and mineral exploration and the burning of forests have increased over time. "So Guthrie has made the puzzle more complicated," he says.

In terms of the projected greenhouse warming of the planet, Guthrie's theory is worrisome because, at the present gas levels, any methane molecule added to the atmosphere is more effective than an added carbon dioxide molecule at harvesting energy escaping from the earth, and therefore at warming the planet (SN:5/18/85, p.308). Guthrie's calculations indicate that this CO_2-derived source of methane could accelerate greenhouse warming by 1 to 15 percent.

One link in Guthrie's CO_2-to-methane chain is a process called carbon dioxide fertilization: Because CO_2 is a key ingredient in photosynthesis, increased levels of it stimulate plant growth. Horticulturists routinely exploit this effect by adding carbon dioxide to commercial greenhouses. A December 1985 Department of Energy report on carbon dioxide's effects on vegetation estimates that a doubling of atmospheric carbon dioxide could result in a 30 to 50 percent increase in the growth and productivity of some agricultural plants. And Boyd Strain, a botanist at Duke University in Durham, N.C., and editor of that report, says that since the beginning of the industrial revolution, increased agricultural yield "is likely to have come from CO_2 fertilization rather than the things we've been attributing it to, such as pesticides or irrigation."

But while the notion of carbon dioxide fertilization has been fairly well demonstrated in small experimental studies, scientists say more work is needed to quantitatively measure its effects, especially the long-term effects on large-scale, complex ecosystems. According to Strain, work is now progressing to explore the effects of increased carbon dioxide in mathematical models of ecosystems. Another step toward demonstrating carbon dioxide fertilization in large areas is being taken by Donald Graybill and his co-workers at the University of Arizona in Tucson. Two weeks ago, at a Tarrytown, N.Y., symposium on tree analysis, they reported the preliminary results of a study of more than 500 bristlecone pines spread over North America. They suggested that carbon dioxide has been responsible for increasing the widths of rings in these trees since the 1840s.

Ironically, carbon dioxide fertilization has been used by agriculture experts and others to play down possible deleterious effects of future greenhouse warming, according to Cicerone. "Some people who are rather sanguine say that the earth will surprise us, that there is nothing to worry about because the biosphere will pull CO_2 down faster into green plants and ocean waters than it does now — so that future rates of CO_2 increase will not be as great as they would have been otherwise," he says. Guthrie adds that ice core data show that carbon dioxide levels have risen and fallen many times in the earth's history, suggesting that there is some biological process that can reverse greenhouse warming. "I was looking for such a process," he says. "I found this one instead." *— S. Weisburd*

Tying up proteins for drug delivery

A group of Ohio researchers has devised a way to wrap protein drugs in a protective coating so that the proteins can be taken orally rather than by injection. The wrap has potential as a way to free diabetics from daily insulin shots, and may also prove useful for other proteins, including painkillers, certain vaccines and new contraceptives, the researchers say.

What the digestive system does to proteins is good for digestion, but not good for protein drugs. Enzymes and high acid levels in the stomach followed by alkalinity in the small intestine break proteins down into their constituent amino acids, which are absorbed into the blood for use in the body. Protein drugs will be broken down by the same process, losing their activity before they get into the blood. As a result, therapeutic proteins such as insulin must be injected in order to sidestep the protein-destroying gut.

Researchers from the Medical College of Ohio in Toledo and Bowling Green State University noticed that nonprotein drugs used to treat diseases of the large intestine contain chemical bonds called azoaromatic bonds, which enable them to reach their target organ intact. The bond is a double link between nitrogen atoms, each of which is hooked to ring-containing hydrocarbon chains. Azoaromatic bonds are also found in many yellow, orange and red food colorings.

The researchers selected an azoaromatic polymer to coat insulin pellets and capsules containing another protein hormone involved in urine production. The coated compounds carried the drugs safely through the stomach and small intestine and into the large intestine of rats, where the coating was broken down by bacteria normally present in the gut. Insulin is known to be able to cross the wall of the large intestine into the blood in both nondiabetic and diabetic people.

The drugs caused the intended physiological responses — lowered blood sugar and decreased urine production — but not in a highly uniform fashion, the researchers report in the Sept. 5 SCIENCE. The responses began from one to nine hours following ingestion, an irregularity that will have to be ironed out if the process is to be useful.

"I think we can control this by engineering the polymer," says Douglas C. Neckers, a Bowling Green chemist who is working on the project. While some researchers have suggested that the body could develop antibodies to the insulin, other studies indicate that it won't be a problem, Neckers says.

Before azoaromatic coatings can be used in the treatment of diabetes or any other protein-requiring condition in humans, animal trials will have to be done. "In two or three years," says Neckers, "we'll know a little more about its potential." *— J. Silberner*