Chemistry

Janet Raloff reports from Anaheim, Calif., at the American Chemical Society's 192nd national meeting

Making roach control a gut reaction

Agriculture Department scientists are studying chemicals that control contractions in the cockroach's hind gut for clues to a new class of roach control agents. So far, they have chemically characterized 11 of these neuropeptides — amino-acid-chain molecules released from the roach's brain. These chemicals help control digestion, blood flow and water excretion, according to work at the agency's Veterinary Toxicology and Entomology Research Laboratory in College Station, Tex., and Western Regional Research Center in Albany, Calif. To date, most of the work has focused on the Madeira cockroach, a large roach infesting many major U.S. cities. According to G. Mark Holman at the Texas facility, however, similar studies with the American cockroach indicate the same chemical control strategy should work with other roaches, including the German (SN:6/14/86,p.378).

These bioregulators are active in extremely small amounts, Holman says, probably less than 0.05 to 0.15 nanograms, depending on the chemical. To isolate the most abundant of them in a quantity matching just the 100 micrograms typical of an ordinary crystal of table sugar, Holman notes, would require an extract from the heads of 78,000 roaches; more than 2 million heads would be needed for the same amount of the least abundant.

"These neuropeptides themselves cannot be used as insect control agents," says organic chemist Ronald J. Nachman of the Albany center. "They're just too expensive to produce and are quickly broken down by the insect's digestive tract." So he's developing chemical mimics of the endogenous neuropeptides, ones that share much of the active portion of the original chemicals' structure but lack their unstable chemical bonds. And by replacing some of the originals' amino acids, the chemists will tailor functionally similar neuropeptides that can no longer be degraded by enzymes that break down the originals, he says. Alternatively, the researchers might design antipeptides that, once in the roach's body, would attach to and effectively remove the roach's natural peptides. Nachman is considering use of recombinant-DNA technology to introduce one or more antipeptides into viruses that infect the insect.

Among the attractions of these new agents, Nachman says, is that they should lead to more selective toxicity — affecting roaches and little else. As a result, he says, "we expect that these specific agents may be more compatible with use in tenement housing." In addition, he says, "we believe the cockroaches will be less likely to build resistance to mimics of their own regulators."

Low-cost way to help keep radon out

According to the Environmental Protection Agency (EPA), indoor exposures to radioactive radon and its decay products may cause 5,000 to 20,000 cases of lung cancer in the United States each year. "These estimates would make radon the second-greatest cause, after smoking, of America's total lung cancer death rate," the agency notes. But preliminary field studies, sponsored by the Palo Alto, Calif.-based Electric Power Research Institute (EPRI), indicate there may be a simple, inexpensive way to prevent most radon from entering the home.

Radon gas is a naturally occurring decay product of radium that can seep into homes from soil, rocks and groundwater. Where high indoor levels of radon have been recorded, most infiltration occurs from the soil into the ground floor of a home through the cement slab over the soil or through basement walls. This radon infiltration "is basically a pressure-mediated effect," according to Jerome Harper, manager of the Tennessee Valley Authority's indoor-air-quality program in Chattanooga and an EPRI consultant. "So if you can control the factors that relate to the pressure differential between the soil and the home," he says, "you can control radon's entry."

And that is the principle behind the subslab depressurization concept now being studied in EPRI experiments at highly instrumented homes in Gaithersburg, Md. Holes were drilled through each cement basement floor and then sealed with a cover containing a connection for a 4-inch polyvinyl chloride (PVC) pipe. A small, 30-cubic-feet-per-minute fan and enough PVC piping were connected to continuously vent outdoors the subfloor air pulled through the piping. Air flow drawn from under the home while the fan operates creates a lower air pressure beneath the basement than in it, Harper explains.

As a result, radon will attempt to leave the house rather than enter it. The reduction being measured in homes with starting radon concentrations of 2 to 4 picocuries per liter (pCi/l) in air "is very significant," Harper told SCIENCE NEWS — "on the order of 95 percent." While the approach also appears to work at significantly higher radon concentrations than were present in Gaithersburg, Harper says, even a 95 percent reduction may be insufficient. EPA has said that some cancer risk may exist at indoor radon concentrations of 4 pCi/l. Where starting indoor-radon levels exceed 100 pCi/l — and some do by quite a lot, Harper notes — treated homes might still exceed 4 pCi/l.

Diet, metals and hidden heart disease

People concerned about heart disease should worry about more than cholesterol intake and smoking, according to research findings from the Institute of Environmental Health at the University of Cincinnati Medical Center. Studies conducted there over the past 12 years are showing that the body's intake of and ability to use trace metals — especially copper and zinc — appears to be important in preventing both cardiomyopathy, a degenerative disease of heart muscle that can eventually lead to heart failure, and angiopathy, a degenerative disease of the smaller arteries that can lead to the formation of enough scar tissue to entirely block blood flow. That's important because the diets of many in the United States are deficient in one or both of these essential trace metals (SN:6/8/85,p.357).

Studies by others have shown that coronary heart disease can be initiated in laboratory animals by copper deficiency (SN:5/3/86,p.279). According to work by Klaus Stemmer, a clinical and research pathologist at the Cincinnati center, severe cardiomyopathy and angiopathy can be induced not only by dietary deficiencies of copper or zinc but also by exposure to drugs or environmental pollutants that chelate out (remove) these essential minerals or block their availability to the body. For example, his laboratory animal experiments have shown that the metal chelator disulfiram, a drug used for treating alcoholics, causes severe angiopathy in animals on a zinc-sufficient diet. Similarly, animals given doxorubicin, a chemotherapy drug and known copper chelator, developed severe cardiomyopathy on a balanced diet. And animals on the metal chelator isonicotinic acid hydrazile, a tuberculosis drug, developed both cardiomyopathy and angiopathy.

Similarly, when rats were exposed to copper- and zinc-sufficient diets and were also fed cadmium or lead — toxic heavy metals that compete with or block the activity of zinc and, to a lesser extent, copper — they too developed serious cardiomyopathy, Stemmer reports. He says studies are now under way looking at the effects of dietary deficiencies of iron, another trace metal that appears to play a role similar to that of copper in protecting heart tissue.

Based in part on his autopsies of humans, Stemmer says, "there appears to be a growing increase in cardiomyopathy" — one that is going largely unrecognized. Helping to mask the disease, he says, is the fact that heart biopsy is the only way to detect it before its effects become evident.