they came up empty-handed. Neither virulence genes nor acid-tolerance genes were up-regulated. But unexpectedly, several genes involved in helping the microbes head toward or away from chemical targets were silenced. As a result, "they don't have directional motility," Camilli predicts.

Camilli suspects that this lack might help the bacteria invade the gut. Those that can sense where to go are guided by chemical signals to the lower part of the small intestine, where for unknown reasons they like to settle. But he has shown that mutant strains that are not directional "colonize everywhere in the intestinal tract," and the same might be true of stool-derived *Vibrio*. This widespread colonization might mean that more bacteria find space to start multiplying, thereby speeding the development of symptoms.

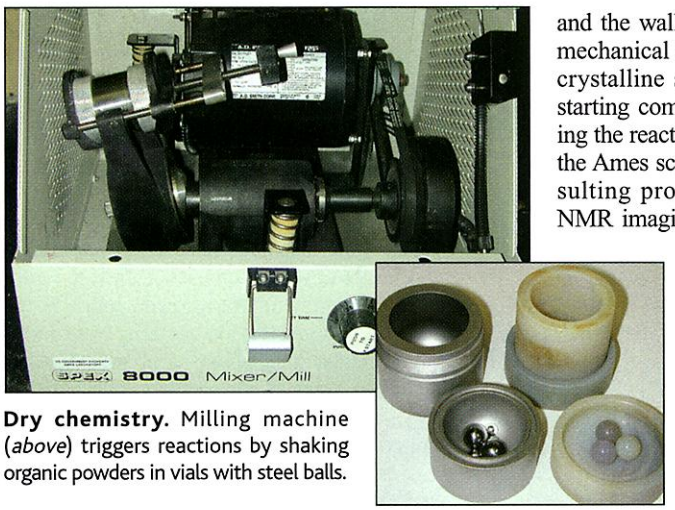
The finding could influence the current way that vaccines are developed. For one, "it may change the way we think about trials," says DiRita; perhaps tests must be done in which people are exposed to *Vibrio* prevalent during epidemics, rather than the current practice of exposing healthy volunteers to hobbled lab strains. And the proteins up-regulated by exposure to the human gut "might be good vaccine targets," Camilli speculates. But Harvard microbiologist John Mekalanos cautions that even though the data look convincing, the experiments need to be replicated. And well-controlled tests demonstrating that stool-derived *Vibrio* is more infectious in humans as well as mice will be difficult if not impossible to do for ethical reasons. **–ELIZABETH PENNISI**

ORGANIC CHEMISTRY

New-Model Reactions Skip the Drip

If you think organic chemistry is a dry subject now, just wait. Researchers at the Department of Energy's Ames Laboratory in Iowa are trying to make it literally as dry as dust. In the latest issue of the *Journal of the American Chemical Society*, a team led by Vitalij Pecharsky—a materials scientist with a joint appointment at the Ames lab and Iowa State University, Ames—reports that it has carried out a battery of common organic chemistry reactions using solid compounds, without first dissolving them in the usual liquid solvents. If this new "dry chemistry" approach works for other reactions, it could light a fire under attempts to make everyday compounds without using toxic organic solvents.

"It's an encouraging result," says Lawrence Scott, a synthetic organic chemist at Boston College in Massachusetts. The vast majority of organic reactions today require organic solvents, many of which are environmentally hazardous and costly to dispose of. "This new method gets around that



Dry chemistry. Milling machine (*above*) triggers reactions by shaking organic powders in vials with steel balls.

completely, because there isn't any solvent present," Scott says. Dry chemistry, says Kim Janda, a chemist at the Scripps Research Institute in La Jolla, California, "could be a new branch of green chemistry and open up new avenues to simplify a variety of chemical reactions."

Until now, few researchers suspected that scrapping solvents altogether was even possible. For most reactions to occur, precursor compounds must be free to come into contact with one another. That's easy in liquids, where ions and molecules move about freely. "But in solids, things are pretty much frozen," Scott says. As a result, solids normally make poor reactants for synthesizing new compounds.

To get around that problem, Pecharsky and his colleagues—organic chemist Viktor Balema and nuclear magnetic resonance (NMR) spectroscopists Jerzy Wiench and Marek Pruski—used a mechanical mill to break up organic crystalline solids, hoping to bring molecules into contact with one another long enough to form new compounds. According to Pecharsky, other groups in Japan and Russia had previously carried out related attempts at such solvent-free chemistry. But in those cases the groups had either melted the materials with heat or added small amounts of solvent, making it impossible to be certain that the reactions were taking place among the solids themselves. This work, Pecharsky says, is the first example that conclusively proves that all the reactions take place in the solid state.

For their experiment, the Ames researchers started with powdery organic compounds such as phosphonium salts, solid aldehydes or ketones, and anhydrous potassium carbonate. They placed them into 10-centimeter-long hardened steel vials loaded with steel balls the size of marbles and BBs. Then they flipped the switch on the mill, which shook each vial for between 3 and 20 hours. "The balls fly all around the vial and [crush] the powder as they hit one another and the walls," Pecharsky says. The mechanical energy broke down the crystalline solids and churned the starting compounds together, allowing the reactions to take place. When the Ames scientists examined the resulting products with solid state NMR imaging and other tools, they found that between 70% and 99% of the starting compounds had transformed into the final products.

Pecharsky says the novel method won't work for all reactions, and it would still require solvents to separate reaction products from unwanted byproducts. "It's no magic wand that will cover the entire field of organic chemistry," he says. But it might be enough to stir things up a bit. **–ROBERT F. SERVICE**

ECOLOGY

Signs of Stress Seen in Snowmobile Season

As biologists, recreationists, and policymakers debate whether snowmobiles should be allowed in U.S. national parks, a new study of animal feces suggests that the noisy machines raise the stress hormone levels of elk and wolves.

In April 2000 the National Park Service announced plans to ban snowmobiles in national parks, but it later reversed itself following a lawsuit by the snowmobile industry. A ban is now being debated again—and the machines' impact on wildlife is at the heart of the issue.

Earlier studies demonstrated that mammals and birds move to avoid areas of snowmobile use and that their heart rates increase in the presence of the machines. To look for more direct signs of stress, Scott Creel of Montana State University, Bozeman, and colleagues measured levels of glucocorticoid stress hormones in the feces of elk and gray

Peace and quiet? Elk might be stressed by the drone of snowmobiles.

CREDITS: (TOP TO BOTTOM) AMES LAB; GERALD AND BUFF CORSI/CALIFORNIA ACADEMY OF SCIENCES