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Pollution in Solution

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ENVIRONMENT

DRUG-RESISTANCE DNA AS THE LATEST FRESHWATER THREAT

DNA that makes germs resistant against medicines may increasingly be polluting water, from rivers all the way to the faucet. Scientists caution these contaminants, if not cleansed, could exacerbate the growing problem of drug resistance among potentially harmful microbes. The genes join a long list of contaminants being found in water, posing a challenge for devising an effective means of treatment.

Currently the World Health Organization reports that drug-resistant germs infect more than two million people in the U.S. every year and that 14,000 die as a result. The rise of drug resistance among germs is tied to the widespread use of pharmaceuticals in humans and animals. Up to 95 percent of antibiotics are excreted unaltered, seeping into the environment and possibly encouraging antibiotic resistance there.

Instead of focusing on the presence of antibiotics in the surroundings, environmental engineer Amy Pruden of Colorado State University searched for the presence of genes that help to confer drug resistance to germs in the first place. Microbes regularly swap DNA with one another, and the fear is that antibiotic-resistance genes can persist and spread long after the drugs they target have dissipated.

Pruden and her colleagues looked for genes bestowing resistance against tetracycline and sulfonamide, two antibiotics linked to urban and farm activity, in northern Colorado waters. They analyzed DNA extracted from bacteria collected from relatively pristine river sediments and drinking water from treatment plants to effluents from a wastewater recycling plant and samples from irrigation ditches and dairy lagoons, where microbes decompose cow excrement.

The levels of antibiotic-resistance genes ran hundreds to thousands of times higher in waters directly affected by urban or farm activity than in relatively pristine bodies. Still, the researchers found the genes everywhere they

investigated, including drinking water. "It is very important to emphasize that although this study was conducted in Colorado, by no means are antibiotic-resistance genes localized to this region," says Pruden, whose findings appear in a special December 1 issue of Environmental Science & Technology Briefs.

These genes have become the latest in an increasing menagerie of pollutants not yet commonly monitored in the environment. These emerging contaminants include antibiotics and other pharmaceuticals, hormones, detergent by-products, fragrances and other personal care products. "A lot of times these contaminants may actually have been in the environment for years, but we only now have the analytical tools to detect them well," explains research hydrologist Dana Kolpin, coordinator of the U.S. Geological Survey emerging contaminants project.

Conventionally, water treatment plants go after pollutants such as bacteria and toxic metals as well as nutrients such as nitrates and phosphates, which can create algal blooms deadly to other aquatic life. Emerging contaminants such as DNA, however, slip through "because water treatment plants are generally designed to inactivate bacteria, not to destroy the DNA inside them," Pruden explains.

Designing treatment systems against emerging contaminants is tricky. "You have to make sure that by removing one compound through, say, chlorination or ozonation, you're not generating by-products you're not seeing that could have an impact. You don't want to swap one problem for another," Kolpin says.

Still, researchers are seeking a good solution. For instance, activated sludge systems containing high concentrations of bacteria can remove 60 to 70 percent of at least 100 trace contaminants from liquid streams, notes wastewater treatment specialist Beverley Stinson of the Laurel, Md., office of environmental engineering firm Metcalf & Eddy. "Many municipalities are now going through very expensive upgrades to such systems-not to target those contaminants but primarily to remove nutrients from wastewater. So these systems will have a nice double benefit," she states.

Meanwhile Pruden is working with her colleagues on experimental water treatment systems that degrade genes using ultraviolet light, perhaps in combination with peroxide. They plan to test pilot systems within the year. "Those should almost certainly disrupt DNA sequences," Stinson says.

PHOTO (COLOR): COW FARMS could promote the spread of antibiotic-resistance genes if farmers dose the bovines with the bacteria-beating compounds.

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By Charles Q. Choi

Charles Q. Choi is a frequent contributor.

NEW AND LASTING THREATS

Emerging contaminants can exert a wide range of effects. For instance, alkylphenols, which are surfactants found in many detergents, wreak havoc on the balance of hormones in animals. Any number of emerging contaminants could act as such endocrine disruptors, explains U.S. Geological Survey fish pathologist Vicki Blazer. With her colleagues, she has discovered that more than half the male smallmouth bass sampled at several sites in the Potomac and Shenandoah rivers are "intersex"--that is, males bearing immature eggs.

What is more, these new pollutants could persist. Scientists at the Europa University of Applied Sciences Fresenius in Idstein, Germany, found significant concentrations of barbiturate drugs in a tributary of the river Elbe near a landfill, even though Valium and other modern tranquilizers replaced barbiturates 30 years ago.
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