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ARE YOUR MEDICINES AFFECTING FISH?
AU researcher seeking to improve wastewater treatment

AUBURN - Synthetic chemicals designed to help human health may be having unintended consequences downstream from wastewater treatment plants, according to an Auburn University researcher. The problems can include fish with both male and female characteristics and the creation of antimicrobial-resistant microorganisms.

Willie Harper, assistant professor of civil and environmental engineering, is looking into how synthetic, or manmade, chemicals are broken down by wastewater treatment plants and the possible effects on the environment.

He says pharmaceutical and personal care products, such as aspirin, antibiotics and birth control pills, contain chemicals that can pass through treatment plants either unaltered or only slightly degraded.

"These chemicals serve their intended purposes and then are passed through the human body into the wastewater," said Harper, who has been studying wastewater treatment for 15 years, the last five at AU. "We are studying how well they are broken down by bacteria at the treatment plant and we want to create new technology for use in wastewater treatment. We want to prevent problems downstream."

Chemicals that act as endocrine disruptors are designed to affect hormonal stability, such as in birth control pills to prevent pregnancy. However, after the chemicals pass through the body, a residue can remain intact even after going through a wastewater treatment plant.

"These chemicals can affect fish by disrupting their endocrine system. If this happens, then they develop abnormally," Harper said. "Some synthetic chemicals can 'feminize' a male fish, giving it female characteristics. Some male fish have been found with ovaries."

In September, fish were found in the Potomac River near Washington, D.C., that had both male and female attributes. While scientists are concerned about this situation and others, Harper says the first step is to learn the fate of chemicals as they pass through the treatment process.

"The treatment plants are doing a good job to clean the water based on current regulations, but they not designed to remove certain chemicals to even safer levels," he said. "We want to help treatment plants address these concerns."

Using National Science Foundation grants, Harper has set up three small-scale treatment plants in his laboratory where he can control the treatment process and the kind and amount

of chemicals being treated. His lab, like large plants, removes chemicals through a process called activated sludge treatment in which biomass, or biological material, is used to remove harmful pollutants.

Harper's AU research group was one of the first in the world to show that the biomass particle size is a critical factor in the adsorptive removal of steroidal compounds. As these clumps of microorganisms get smaller, he says, they have more surface area and thus they provide more sites for removal of synthetic chemicals.

"Biomass particle size can be controlled by practitioners both at the design stage and at the operating stage," Harper said. "The information we have provided will be of interest to water pollution control facilities that are concerned about pharmaceutical compounds.

"We were also one of the first groups to show the specific degradation mechanism of how the active ingredient in birth control pills is broken down."

Ultimately, these kinds of results hold great promise for long-term impact. For example, these research results may be useful to chemical engineers and pharmacologists in the design of synthetic chemicals that degrade well during treatment, or for identifying chemicals that will be persistent. The results also should help regulators development water quality criteria.

Another problem that Harper's group is addressing is the possibility that antibiotic residues help create antimicrobial-resistant microorganisms. Along with Mark Liles of AU Biological Sciences, Harper is investigating the idea that biological wastewater treatment plants are an important source of antibiotic-resistant microorganisms.

"We want to learn more about the reservoir of antibiotic-resistant mechanisms available to the activated sludge microorganisms," he said.

This is a major public health issue, he says, and it has become more important as water quality surveys have revealed the broad range of antibiotics present in water after it goes through wastewater treatment plants.

"Antibiotics are designed to kill infections, however, if they get into the environment, they can cause naturally occurring microorganisms to develop antibiotic resistance. We would then have a microorganism that is much more difficult to kill," he said. "We have already found evidence that some activated sludge microorganisms are extremely resistance to a broad variety of common antibiotics. We need to direct more research into this issue."

Water research at Auburn University will be highlighted June 14-15 during AU's 2007 Water Resources Conference hosted by the newly created Water Resources Center. The center, part of AU's Natural Resources Management & Development Institute, has an interdisciplinary team of more than 50 faculty who specialize in various types of water research.

Harper holds a bachelor's degree in civil engineering from UCLA, a master's degree in environmental engineering from Cornell University and a doctorate from the University of California, Berkeley. He is a recent recipient of the 2007 AU College of Engineering Junior Faculty Research Award, and the highly competitive National Science Foundation Early Faculty Career Award, one of the most prestigious research awards granted to junior faculty in engineering.

His research group consists of two Ph.D. students in AU civil engineering, two master's degree students and two undergraduates in biological sciences. He is also collaborating with two Ph.D. students at Virginia Tech University and the University of Buffalo and a professor at Technical University of Denmark.

(Contributed by Charles Martin.)

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