WATER POLLUTION

Caffeine in Wastewater Is a Tracer for Human Fecal Contamination

Using caffeine as a tracer to monitor fecal contamination in waterways could be a useful tool in protecting public water supplies.

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Sewage contamination of surface waters can be a serious problem, exposing people to waterborne pathogens such as *Cryptosporidium*, *Giardia,* and norovirus via recreational waters[1,2] and drinking water supplies.[3] Contaminants can run off into waterways from many different sources—domestic, agricultural, and industrial—and it is not always easy to identify where contamination is coming from. A new study indicates that measuring caffeine in municipal water systems provides a good estimate of fecal contamination caused solely by humans.[4]

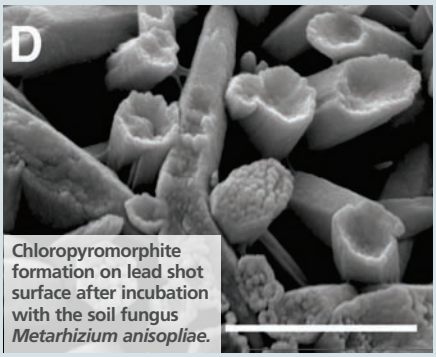
Researchers led by Sébastien Sauvé, an associate professor in the Department of Chemistry at the Université de Montréal, Québec, discovered that caffeine levels correlate strongly with levels of fecal coliform bacteria. Caffeine is a particularly good marker for human fecal contamination because agricultural and industrial sources of fecal coliforms generally do not release caffeine into the environment. Plus, the ubiquity of caffeine consumption means that where there is human sewage, there almost certainly will be caffeine as well.[4]

Sauvé's team analyzed water samples collected from streams, stormwater collection pipes, and stormwater discharge points in Montréal City. They measured caffeine, fecal coliforms, and the antiseizure medication carbamazepine, another candidate chemical indicator of human sewage contamination.[5] Of 120 samples collected, 93 exceeded 200 colony-forming units (cfu) fecal coliforms per 100 mL water.

The Beat | by Erin E. Dooley

Soil Fungi May Help in Lead Remediation

Lead contaminates soil in many urban areas. Investigators have discovered that lead can be transformed by multiple soil fungi into a stable form known as chloropyromorphite, suggesting a potential new tool for cleaning up soil lead contamination.[1] This ability of the fungi may help them to survive in contaminated locations. The authors write that "fungal metabolites, particularly organic acids, [may play] an important role in the liberation of mobile lead species," a discovery that "may be important in other environmental contexts outside those reported in this paper."[1]



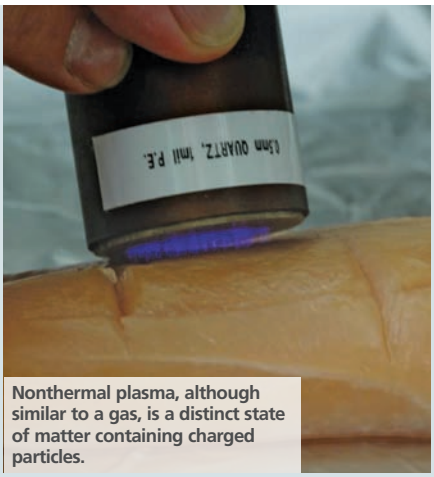
Chloropyromorphite formation on lead shot surface after incubation with the soil fungus *Metarhizium anisopliae*.

Triple A Test for Fewer Asthma Attacks

The nonprofit Asthma UK has developed a new online test to help asthma sufferers over the age of 12 predict their risk of a serious attack.[2] The Triple A ("Avoid Asthma Attacks") Test asks 13 questions about factors such as prior hospital admissions, allergies, and inhaler use, and explains why this information is useful in assessing the risk for an asthma attack. The Triple A website also offers guidelines for minimizing risk of asthma attacks. Asthma UK estimates that, in the United Kingdom, 75% ofhospital admissions for asthma and 90% of asthma deaths are preventable.

Plasma Approach to Foodborne Pathogens

Campylobacter and *Salmonella* cause hundreds of thousands of cases of foodborne illness in the United States each year.[3] A new proof-of-concept study shows that nonthermal plasma can be used to kill these pathogens on raw chicken without altering the texture or appearance of the meat.[4] The study builds on earlier research that showed plasma was effective at reducing pathogens on the surfaces of fruits and vegetables. Plasma technology is not yet developed for wide use in the meat-processing industry; challenges involve devising an efficient way to fully expose all the surfaces of a piece of meat.



Nonthermal plasma, although similar to a gas, is a distinct state of matter containing charged particles.

Left to right: Current Biology/Elsevier, Brian Dirks/Drexel.edu

Caffeine, but not carbamazepine, was strongly correlated with fecal coliform counts.[4] All the water samples with more than 400 ng/L caffeine—an arbitrary threshold selected by the authors—were contaminated with fecal coliforms at concentrations exceeding 200 cfu/100 mL. The U.S. Environmental Protection Agency set a standard for safe swimming and recreational waters of 235 cfu/100 mL fecal coliforms,[6] and the Canadian limit is 200 cfu/100 mL.[7]

Sauvé makes this practical comparison of his data: "Any water sample containing more than the equivalent of ten cups of coffee diluted in an Olympic-size swimming pool is definitely contaminated with fecal coliforms." He adds that ELISA kits that detect caffeine potentially could be calibrated for fieldwork.

Environmental chemist Piero Gardinali of Florida International University in North Miami says that Sauvé's results clearly indicate the correlation is relevant, and that a threshold of 400 ng/L caffeine could be used for environmental assessment. "Finding this link was extremely important," says Gardinali.

People regularly consume caffeine in coffee, tea, soft drinks, chocolate, and medications,[8] and after excretion, caffeine degrades slowly in the environment.[5] Caffeine offers several advantages as a tracer of environmental fecal contamination. For one, it's faster than time-consuming bacterial cultures now used to measure fecal coliforms. The presence of caffeine indicates exclusively human fecal pollution, whereas fecal coliform cultures usually cannot differentiate human excrement from that of pets, wildlife, and livestock. The discovery also offers public works officials a potential tool for locating sewage leaks. "If there's no caffeine upstream but there's caffeine downstream, then the sewage leak lies in between," Sauvé says.

Sauvé's study also showed that parts of Montréal's stormwater collection system, which combines rain and domestic sewers, causes sewage contamination of surface waters. Ideally, uncontaminated stormwater should flow into a river, while sewage is delivered to wastewater treatment plants. But in Montréal and many other cities, stormwater runoff and sanitary sewage both run into so-called combined sewer systems that can overflow during heavy rainfalls.[9] "Any big city where sewers and runoff combine have cross-contamination problems," Sauvé says.

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Growing Counterfeit Pesticide Trade in Europe

The European Union's law enforcement agency, Europol, estimates that as much as 25% of the pesticides used in some EU member states may originate in an illegal and counterfeit pesticide market worth billions of dollars.[5] These cut-rate fakes may contain banned hazardous substances that make them harmful not only to human health but to crops as well.[6] Europol and national experts have outlined a set of overarching recommendations in this area, including assessment of existing relevant legislation, coordinated cross-border investigations, adoption of a wide-ranging response to address the many potential health threats posed by counterfeit pesticides, and research on the traceability of hazardous chemicals used in these products.

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The port of Hamburg, Germany, where 28 metric tons of counterfeit pesticides were seized in 2010.

Use of Treated Wastewater to Meet Drinking Water Demands

Amidst continued population growth, communities are searching for new ways to meet their water needs. A report by the National Research Council outlines how treated wastewater can be used to meet many of those needs, including that for drinking water.[7] In many cases, treated wastewater is fully as safe for consumption as existing drinking water sources, or even safer. Wastewater reclamation programs are already in use in many areas, but potable applications account for only a small fraction of these programs' activities; however, many drinking water treatment plants draw on water supplies fed by wastewater discharged by upstream communities.

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