Science for Environment Policy

Wastewater treatment plant discharges can promote the development of antibiotic resistance in streams

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Widespread use of antibiotics has led to pollution of waterways, potentially creating resistance among freshwater bacterial communities. A new study looked for antibiotic resistance genes in a river basin in Spain, revealing that wastewater discharges can promote the spread of antibiotic resistance in streams and small rivers.

Antibiotics are a cornerstone of modern medicine and have saved millions of lives. However, their extensive use has led to the development of widespread resistance, rendering them ineffective against some infections. Microorganisms resistant to commonly prescribed antibiotics are increasingly being found, leading the World Health Organization to declare antibiotic resistance a 'major threat to public health'. Already, approximately 25 000 European citizens die every year from infections caused by bacteria resistant to antibiotics[1].

Although some bacteria are intrinsically resistant to antibiotics, and resistant strains evolve naturally, the overuse of antibiotics accelerates this process. Drug-resistant bacteria can pass on resistance to other bacteria, via a process called 'horizontal gene transfer', which is thought to be the major cause of the spread of resistance among bacteria.

While the clinical side of this problem has been studied extensively, there is a less-studied environmental aspect. Antibiotics are not fully metabolised by animals (including humans), which means that residues can enter the aquatic environment via wastewater discharges. Recent studies have shown that concentrations of antibiotics found in aquatic environments could aid selection of resistant bacteria. Inputs from urban wastewater treatment plants (WWTPs) can also include antibiotic-resistant bacteria and resistance genes.

This study is one of very few to assess antibiotic resistance in river biofilms: the layer of slime composed of microbial organisms that is found on rocks, plants and other surfaces in rivers. Antibiotic-resistant bacteria can integrate into these biofilms, which may provide an optimal environment for the exchange of genetic material, including genes encoding resistance to antibiotics.

The researchers, who were part-funded by the European Regional Development Fund, evaluated the abundance of antibiotic resistance genes in the Tordera River Basin in northern Spain, which receives input from domestic WWTPs. They looked for genes conferring resistance to major families of antibiotics in biofilm samples collected upstream and downstream of WWTP discharge points in four streams.

The monitored genes confer resistance to antibiotics commonly used in hospitals and communities (such as fluoroquinolones, macrolides and sulfonamides). Previous studies have shown a high prevalence of these genes in water samples collected from Mediterranean rivers.

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1. European Centre for Disease Prevention and Control (2009) The Bacterial Challenge: Time to React. http://ecdc.europa.eu/en/publications/Publications/0909_TER_The_Bacterial_Challenge_Time_to_React.pdf

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WWTPs are necessary to minimise, *inter alia*, organic pollution from wastewater generated by human settlements, which would otherwise affect water bodies and the wider environment. Despite the overall positive role of WWTPs, the results of the study showed that WWTP discharges can strongly affect the hydrology and physical, chemical and biological characteristics of receiving streams.

In the study, WWTPs increased stream flow, water conductivity and nitrogen/phosphorus content. They also significantly increased the abundance of antibiotic resistance genes downstream. For example, the *ermB* gene (which confers resistance to erythromycin, an antibiotic used to treat respiratory infections) occurred four times more frequently in biofilms collected downstream of WWTPs than in those collected upstream. The extent of the changes was influenced by the relative contribution of each WWTP. The authors say their findings suggest WWTP discharges support the spread of antibiotic resistance in streams.

The researchers found antibiotic resistance genes as far as 1 km downstream of the WWTPs, which suggests resistance genes can persist in the environment even in the absence of an additional pollution source, perhaps due to the 'drift' of antibiotic-resistant bacteria or resistance genes in the water flow. Alternatively, resistant bacteria or resistance genes could have entered the river from unknown sources located between the WWTP discharge site and the site 1 km downstream.

The authors say further studies are needed to determine the reason for the increase in antibiotic resistance in biofilms downstream of the WWTPs. It could have resulted from the release of resistant bacteria from the WWTPs, or from indigenous bacteria becoming resistant in response to the presence of antibiotic residues discharged into the streams. Overall, the researchers say river biofilms could be useful as indicators of anthropogenic pollution with pharmaceutical residues.

If wastewater discharges negatively affect the quality of a water body, for example by increasing the level of an antibiotic above an established environmental quality standard (EQS), measures must be taken by Member States to improve the water quality. At present, EQS for pollutants are set in relation to their toxic (or similar) effects on organisms. For antibiotics, account may also need to be taken of their role in triggering the development of resistance in bacteria, and of the significance of that resistance.