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Mechanistic understanding of an ecosystem service: efficiency of emergent pollutant biodegradation in the hyporheic zone

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Water is considered to be the most indispensable natural resource yet pollution of aquatic environments, particularly of freshwater urban systems, is widespread. In recent years a vast array of emerging micro-pollutants (MP) have provoked increasing concern due to their presence in wastewater treatment plants (WWTPs) effluents. WWTPs are generally not equipped to deal with complex MPs and, paradoxically, they are considered the main transport pathway of these compounds into the environment. Bacterial biofilms in streambed sediments may degrade several of these MPs as water exchanges between the surface stream and the hyporheic zone. Although, this biologically active interface beneath the open channel has been recognised as a water-purifying bioreactor (hyporheic bioreactor), the ecological mechanisms behind its functioning are unknown. We experimentally assessed how Glucose availability (a model dissolved organic carbon compound) and the consequences of predator-prey interactions drive the hyporheic bioreactor and determine how efficient it is at processing a model MP (ibuprofen). Glucose had a significant positive effect on bacterial population growth. Bacteria used glucose as a carbon source in preference to ibuprofen, thus, when Glucose was present, ibuprofen removal efficiency was reduced. Moreover, low and medium levels of predation by a ciliate protozoan, stimulated bacterial population growth and MP removal whereas high levels of predation resulted in lower bacterial growth and less MP removal. This hormesis-like effect of predation interacted synergistically with glucose availability resulting in a notable increase in bacterial population growth and MP removal. These findings emphasise the importance of preserving natural predator-prey interactions in order to maintain and sustain the ecosystem services.