**////Title: Exploring the Impact of Urbanisation on Soil Microbes**

**////Standfirst:**

Beneath our feet lies one of the most biodiverse habitats imaginable – the soil. These highly active underground microbial communities are vital to ecosystem health; they cycle nutrients, form soil structure, and decompose organic matter, among many other functions. The type of microbes that colonise soil is determined by the local plant community and climatic variables, both of which are rapidly changing due to human activity. In a recent study, Dr Carl Rosier of the University of Delaware has explored how urban development disturbs the environmental cycles that influence the types of microbes found in various soil habitats.

**////Main text:**

Though it may not look like much, the soil is teeming with microbial life. These microbes provide essential services that maintain soil health and quality, such as organic matter decomposition and nutrient cycling. In turn, healthy soil directly affects plant life, creating cascading effects on entire ecosystems.

The network of interactions between soil microbes and plant communities works both ways. Just as soil microbes influence which plants grow well, plants can also shape the structure and function of microbial communities. This trend is most notable in forests, where tree leaf litter, shade offered by the canopy, and root uptake of nutrients can alter soil chemistry and indirectly affect the composition of microbial populations in the soil. Trees also directly attract microbes through sugary substances they excrete through their roots – called ‘root exudates’. It is common for a particular tree species to be associated with a unique group of microbes that differs from that of a neighbouring tree.

Trees are not the only significant factor impacting soil chemistry in forests. Human activities such as urban development and agriculture can dramatically shift soil chemistry in ways that can override the slower plant-powered processes. Increased chemical and nutrient deposition, higher temperatures, and decreased soil moisture can be all attributed to deforestation and urbanisation.

Given the importance of trees and the environment in determining microbe composition, Dr Carl Rosier of the University of Delaware wondered how the two interact to affect the composition of soil microbial communities. In particular, he wanted to assess whether trees near urban areas still influenced microbe composition, or if the urban effect overrode any plant-specific influences on soil composition.

In a unique study published in *Scientific Reports*, Dr Rosier and his colleagues demonstrate that urbanisation has a particularly strong impact on forest edges – a finding with broad implications for the sustainability of urban forests.

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Small, urban forests embedded within developed landscapes are prevalent in much of Europe and America. These forests are influenced by their proximity to non-forest areas, such as farmland or suburban housing. Although the interiors of fragmented forests can be well buffered from any negative impacts, forest edges do not fare as well. This recurring pattern has been named the ‘edge effect’. In the case of urban forests, edges are exposed to more solar radiation and wind, decreasing soil moisture.

For their study, Dr Rosier and his colleagues made use of a local urban forest network set up by researchers at the United States Department of Agriculture for long-term research. In this network, woodland plots had been established on the periphery of local hardwood forests so that edge effects could be studied. The network extends from the urban town of Newark to nearby rural landscapes, creating an ideal urban-to-rural gradient.

Dr Rosier and his team chose plots in the urban, suburban, and rural parts of the forest network. In each woodland plot, they selected three American beech and yellow poplar trees within 10 meters of the edge. For comparison, they also studied the same species in the interior of each plot too – at least 100 meters from the forest edge.

The team took samples around each tree to analyse the soil chemistry and microbe diversity. By doing so, they could correlate these properties with whether the tree was at the edge of a plot or within the interior, and whether the plot was in an urban, suburban, or rural environment. The researchers could also assess soil differences between the two species they chose to study: beech and poplar. They then ran statistical analysis to test whether the location or species of the trees better predicted the composition of their soil microbes.

If urban pressure strongly manipulates environmental factors, the researchers expected that soil microbes would be similar across all plots within the urban zone, regardless of the tree species or whether they were located at the edge or interior. Since suburban and rural areas may be more buffered from the environmental effects of urbanisation, microbial communities in these areas may be more affected by tree species.

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Overall, the team found that forest edges differed from interiors in critical environmental factors, including soil temperature, light availability, and wind. Furthermore, edges were subject to nutrient and pollutant deposition and had different pH, calcium concentrations, and amounts of organic matter, particularly in the urban zone. With demonstrated edge effects on soil characteristics that impact microbial communities, the researchers expected edge soil communities to differ from interior communities. While this expectation was met for edges in rural and suburban forests, urban forests showed similar microbial compositions along the edge and within the interior.

Additionally, the team found that tree species is a better predictor of microbial composition in the interiors of suburban and rural plots. This shows that as environmental pressure from urbanisation is reduced within forest interiors in suburban and rural plots, the tree species influence on soil microbes is more significant. However, in the case of urban areas, the environmental signal is strong enough to drown out tree species effects in both forest edges and interiors.

Interestingly, urban areas did not differ from suburban or rural areas in two important diversity metrics: species richness and species evenness. Species richness describes the number of unique species, while species evenness refers to the relative abundance of each species. These metrics indicate that the microbial communities present were diverse enough to resist many stressors. These results suggest that although urbanisation seems to influence the types of microbes present in the soil, it does not reduce their overall biodiversity.

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This study is the first to explicitly demonstrate that shifts in the structure of soil microbial communities in urban areas may be linked to urbanisation effects on soil pH, calcium, and organic matter content. Dr Rosier suggests that future research should identify the functions of these communities to determine whether the shifts in composition that come with urbanisation also change vital ecosystem services. For instance, if urbanisation decreases the number of microbes responsible for decomposition and nutrient cycling, the sustainability of urban forests will undoubtedly be in question.

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This SciPod is a summary of the paper ‘Urbanization pressures alter tree rhizosphere microbiomes’ from *Scientific Reports*. <https://doi.org/10.1038/s41598-021-88839-8>

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