Phylloplane of trees under stress in the city

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Phylloplane or the microbial habitat on leaf surfaces is an integrated part of green infrastructure, with the potential to stimulate plant community productivity, affect plant fitness, and release of ecosystem services. Anthropogenic pressure, among which urbanization and related stressors was shown to affect the phylloplane microbial community composition and diversity. However, taxonomic characterization of the phylloplane with the aim to link it to the ecosystem functioning is not sufficient because it considers the microbial pool as a whole, not distinguishing between active, potentially active, dormant, and dead units. Meanwhile, only active microorganisms drive biochemical processes and determine the microbial community functioning. Determination of ecologically relevant microorganisms is linked to characterization the active microbial states but little is known on the phylloplane activity and its variation with the quality of the environment.

In this study, we attempted to verify how a change in environmental quality affects the phylloplane composition and activity. For this purpose, leaves of Betula pendula were sampled in Moscow (Russian Federation) along the three transects established starting from the road with heavy traffic and increasing gradually the distance from this pollution source. For determination of phylloplane activity and functional diversity a Microresp™ tool, used generally for characterization of the soil microbiome, was adopted. The diversity of phylloplane microbiome was determined by its cultivation on nutrient media. Additionally, total genomic DNA was extracted from the leaf surface. Environmental quality was assessed by collecting the dust deposited on the leaf surface and analyzing its chemical composition on ICP-OES.

Activity of the phylloplane close to the road was 1.6 higher than far from it. Functional diversity or the ability to metabolize different substrates was on the contrary lower here. The amount of DNA was used to quantify the metabolic quotient (activity per DNA unit) which substantially increased in trees adjacent to the road. It could serve as an indication of the stress conditions or inefficiency of microbial community functioning with increase of contaminants concentrations. Elements that
affected microbial activity were Ca and Zn. The amount of DNA declined with increase of Cu in leaf dust. While the total DNA and microbial functional diversity declined closer to the road, the amount of cultivable microorganisms, especially saprotrophic and enterobacteria, as well as the fungi species richness, increased on the leaf surface. This study showed that the distribution patterns under stress for phylloplane activity and functional diversity don't correspond to those for species richness of cultivable fungi. The activity of phylloplane could be considered as an additional tool for bioindication of environmental quality.

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