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Updating European lichen bioindication scales to improve urban air quality assessment in the current pollution context: a meta-analysis

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Air pollution is a major threat for both human and ecosystem health, especially in urban areas where more than half of the world's population lives. Accurate assessment of air pollution is thus crucial for evaluating population exposure and mitigating its adverse effects. Bioindication (i.e., the use of sensitive organisms to assess environmental quality) offers a complementary approach to physico-chemical sensors by improving spatial resolution at low cost. Epiphytic lichens (i.e., symbiotic association of fungi and algae) are widely used as bioindicators in terrestrial environments because of their widespread distribution and capacity to directly absorb air pollutants. Due to specific pollution sensitivity of each lichen species, we can identify the main pollutants affecting a given environment through lichen communities. However, the dominant pollutants changed over the past few decades and the existing lichen bioindication scales need to be recalibrated. In this context, the development of updated sensitivity scales is required to enable a more in-depth interpretation of lichen data. To achieve this goal, we are conducting a meta-analysis coupling lichen surveys carried out in different European urban areas with air pollution data (i.e., including both modelled and bioaccumulation data). Factors beyond air pollution, such as climate, land use, and tree-related data, will also be considered as potential influencing variables. We already found more than 100 datasets across Europe (i.e., from Portugal to Sweden). Using a multi-varied statistical analysis, we assess the response of each lichen species to different pollutants to update the existing bioindication scales (e.g., SO_2 and NH_3) or propose some new ones (e.g., NO_2, O_3, metals, PAH, etc.). Thanks to the wide range of climate conditions considered in the database, we also investigate the influence of climate change. By providing updated interpretation tools, these findings will improve the urban environmental assessment by lichen bioindication for scientific studies or within the framework of citizen science programs involving simplified protocols (such as Lichens GO or OPAL).