Multi-omics spatio-temporal monitoring of the effect of anthropic pressures on the host-microbiome interactions within the freshwater sponge Spongilla lacustris.

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Abstract

Through their tight interactions with their microbiome, marine and freshwater sponges are known for their ability to efficiently filter large volumes of water, participating to the recycling of the DOM in their environment. *Spongilla lacustris* is one of the most abundant freshwater sponges in Europe, with a wide distribution in the city canals and surrounding lakes of the Netherlands. Through their filter-feeding activities, the *S. lacustris* holobiont could constitute a promising model as a bioindicator of the water quality of Dutch urbanized freshwater ecosystems. The objective of this study aims to investigate to which extent this model can **reflect environmental pressures**, as we hypothesize that such factors can highly influence the host-microbiome interactions dynamics.
A spatio-temporal monitoring was conducted every two weeks in 2021, on three sampling sites in the Netherlands (Warmond lake, the Oegstgeest suburb, and Leiden city center), each corresponding to three different levels of increasing urbanization. Sponge samples were collected for morphological and **multi-omics analyses**, combining 16S rRNA **metabarcoding** and untargeted UHPLC-MS **metabolomics** approaches. Results from both microbiome and metabolomics studies confirmed that the *S. lacustris* holobiont is **highly impacted by eutrophic conditions**, and especially by high **ammonium** concentrations. The microbiome was also found to be **less stable** and more dispersed over time, especially during the senescence period of the tissues, when the sponges were **bleached** after the loss of the microalgal photosymbionts (*Chlorella* spp.). Results from the metabolomics studies also indicated a change of the metabolome linked to this senescence, especially with chemical markers associated to the symbiont loss and oxidative stresses.

This study provides the first insight into the evaluation of freshwater sponges under biomonitoring perspectives. Through the high diversity and complexity of interactions with their microbiome, results suggest that *S. lacustris* can offer an important source of information for aquatic biomonitoring. Especially, further research on this holobiont model could be considered to develop methods aiming to target the potential xenobiotics filtered and bioaccumulated by the sponge.

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