Monitoring insect pathogens across urbanization gradients as a tool to help planning insect-friendly urban parks

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Monitoring the status of insect populations in urban environments is a strategic, relevant activity which gives suggestions on effective urban biodiversity conservation. However, while monitoring is often carried out through community-level sampling of species, phenotypic intra-specific variations are rarely considered.

Here, we propose internal pathogens (virus, microsporidians and protozoans) as a novel tool to assess insect health status within urban areas. This approach can serve as a monitoring framework to evaluate how the characteristics of urban parks influence insect population health to inform better green management strategies.

We used the metropolitan city of Milan as model city, and five hymenopteran species (bees, wasps and ants) spanning different body sizes, foraging habits and social behaviours as model organisms. Overall, the relative presence/abundance of the pathogens were found to be species specific, as were the responses to urbanization. In more urbanized areas, two solitary bee species had a higher occurrence probability of the protozoan *Apicystis bombi*, but a lower infection load of the deformed wing virus (DWV). In social bees and social wasps, higher levels of urbanization increased the likelihood of occurrence of DWV and chronic bee paralysis virus (CBPV). In ants, the occurrence probability of DWV decreased, and that of the *Lasius negletus* virus 3 (LNV3) increased, in more urbanized areas.

Although transmission pathways remain to be studied in detail, we suggest internal pathogens to be included in novel monitoring programs. By identifying landscape characteristics that minimize infections, effective management strategies of urban green areas could be put in place. This would ultimately protect insects from potentially harmful pathogens, supporting population functioning and the ecosystem services provided by bees, wasps and ants.