Buzzing in the Concrete Jungle: Unraveling Bumblebee Adaptation to Urban Living through Multi-omics Analysis

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Abstract:
Pollinator insects are closely related to human wellbeing; indeed they are involved both in ensuring ecosystem functionality and food security. Worldwide, the expansion of urban areas is affecting pollinators biodiversity, favoring those species that better adapt to this anthropic habitat. In this framework our aim is to understand how two species of bumblebee widely distributed in Italian cities, namely *Bombus terrestris* (Linnaeus, 1758) and *Bombus pascuorum* (Scopoli, 1763), are adapting to the urban habitat conditions through a multi-omics strategy, including transcriptomic, genomic, and metabolomic approaches. This integrative approach will eventually allow us to assess how urban related stressors, namely habitat loss, high temperature and air pollution, affect pollinators' population responses to urban contexts.
To reach this goal, we planned a workflow including an initial sampling campaign during which we collected 200 bumblebee individuals in 24 sampling sites located in four Italian metropolitan cities: Milan, Rome, Turin, and Florence. Sampling sites were equally selected in urban and semi-natural areas to allow the comparison among individuals from contrasting conditions.
Transcriptome data will be obtained through mRNA sequencing, to assess differential gene expression between urban and semi-natural populations. Genome data will be obtained through a whole genome sequencing approach, and the obtained single nucleotide polymorphisms will be used to detect genomic regions under selection and to explore any possible genetic structure in the sampled localities. Finally, metabolome data will be obtained through LC-MS analysis and will allow us to investigate how urbanization influences the production of stress-related molecules such as octopamine and malondialdehyde.
Furthermore, the “-omics” data will be integrated with other analyses able to define a proxy of individual general health state. Assaying enzymatic activity involved in oxidative stress, known to have a detrimental effect on bees survival, together with a screening for pathogens and dysbiosis in microbial communities will allow us to define the mentioned proxy.
In the end, by combining the results of different analyses, we will be able to define a solid and complete picture of bumblebees adaptation able to guide policy-makers in managing urbanization processes.