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The global land surface covered by cities is expected to triple between 2000 and 2030. Urbanisation is associated with visible environmental change relative to undisturbed habitats, such as the reduction in tree cover and the increase in light and noise levels. It is also associated with "invisible" pollution caused by the increase of chemical pollutants such as trace metals. Nonetheless, cities are also inhabited by plant and animal species, which have great ecological importance and social value. How does urbanisation affect wildlife in cities? Although timely, this question remains largely unanswered. The great tit Parus major is a flagship "wild" animal that is now becoming a reference species to study the ecological and evolutionary effects of urbanisation. I will investigate this key research question by working on great tit populations established along a gradient of urbanisation in the city of Warsaw in Poland. 500 great tit nestboxes will be studied in a continuum of urban to rural conditions, where tree cover as well as sound, light, and traffic levels will be determined for each nestbox. In particular, I will study the effects of "invisible pollution" on the physiology and reproductive success of great tits living in a gradient of urbanisation.

First, I will investigate the link between oxidative stress, a physiological index of organismal health, and urbanisation level (objective 1). Oxidative stress occurs when there is an imbalance between the production of aggressive oxygen compounds that lead to the damage of tissues and organs, and the body's ability to counteract or detoxify these harmful substances. It will be measured in springtime in adults and offspring, in nestboxes scattered along a gradient of urbanisation ranging from dense forest habitat outside of Warsaw to green areas in Warsaw city centre.

I will then test whether trace metals such as cadmium, lead, zinc and copper are associated with urbanisation-linked oxidative stress (objective 2). Trace metals are emitted by human activities such as the combustion of fossil energies by traffic and heating systems or metallurgic industries and are absorbed and accumulated in animals. They are likely to cause variation in oxidative stress levels because of their chemical properties, yet knowledge of their influence on oxidative stress is very limited. Therefore, I will estimate the extent to which trace metals are linked to urbanisation-induced oxidative stress in great tit populations (objective 2).

Oxidative stress and trace metals are likely to affect great tits in many ways. I will estimate their impact on great tit health by measuring great tit body corpulence, telomere length (telomeres protect the end of a chromosome from deterioration, and their length has been associated with the rate of ageing in animals), reproductive success and survival (objective 3).

Published studies report that urban and rural birds of the same species sometimes differ in their morphology or timing of breeding, but the nature of these differences – acclimatisation or genetic change - is rarely tested. By analysing genomic data available for the 5 study populations, I will ask whether urbanisation-induced physiological changes identified in this study have a genetic basis, which would thus be heritable (objective 4). Understanding the nature of these processes (acclimatisation vs. genetic based) is of fundamental interest in evolutionary biology and conservation biology alike. Such knowledge will also be of great value to make accurate forecasts about which animals may settle and prosper in cities.

Great tits is one species among many others inhabiting cities. Several studies investigated the effects of urbanisation on a variety of vertebrates, and it is essential to compare these studies in order to identify whether there is a trend in how urbanisation affects urban fauna. Identifying general trends are also needed to allow practitioners to devise effective conservation plans reducing the human footprint on biodiversity loss. With this in mind, I will use published scientific studies to quantify the effect of urbanisation on biological traits (morphology, physiology, life-history) in vertebrates (objective 5).