

Final report of the post-doctoral project “Effects of urbanization on the behaviour of wild animals towards humans” (PD-134985)

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In September 2020, I prepared the aviaries at the animal facility of the Veszprém campus of University of Pannonia for housing great tits (*Parus major*) and performing Aviary Experiment 1. After a brief pilot study on 4 birds in October, I captured 36 individual birds from differently urbanized locations between November 2020 and February 2021, and tested whether they can use humans as a source of information in a foraging situation. Contrary to my prediction, the preliminary analyses of the data collected in this study revealed no significant difference in the performance of urban and non-urban great tits in this study. However, I found that urban birds acclimatized faster to the experimental conditions. Barna Denking, student of Bioengineering at the University of Pannonia, participated in the studies and wrote his Bachelor’s thesis based on the preliminary results, titled “Humans as source of information in the foraging behavior of urban and non-urban great tits”. He defended his thesis with a Good (4) grade on the 10th of June, 2021. Blood samples were collected from all birds participating in the experiments and sent to Dr. Zsolt Rónai at Semmelweis University, who genotyped all of them for dopamine receptor (DRD4) and serotonin transporter (SERT) genes. Analysis of the data are to be expected later this year. Further analyses, controlling for the birds’ activity, stress response, body condition and DRD4 and SERT genotypes are in progress. Following these more elaborate analyses, I plan to submit a manuscript based on the results to a scientific journal.

Additionally, over the course 2021, with the help of my co-author Bálint Kovács, I performed literature screening, data collection and meta-analysis to test whether urban animals have better cognitive abilities than their non-urban conspecifics (*Vincze & Kovács, 2022. Urbanization’s effects on problem solving abilities: a meta-analysis*. *Frontiers in Ecology and Evolution* 10:834436). The results indicate a marginally non-significant trend that urban animals are better problem solvers, but also a heterogeneity significantly higher than what one would expect from random distribution, indicating some sort of underlying biological or methodological phenomenon. Furthermore, the literature screening revealed a number of major knowledge gaps: there were only 12 studies comparing the problem-solving abilities of urban and rural animals, the majority of which were performed on the Northern hemisphere, on avian species, and on captive animals captured from urban and rural habitats, whereas little is known about species from the Southern hemisphere, other taxonomic groups like mammals and reptiles, and studies performed on non-captive animals. Beside the aforementioned publication, I also presented these results at a Hungarian national conference talk (Hungarian Ethology Congress, November 26 – 27, 2021, online), an international conference talk (Frontlines in Urban Conservation, March 22, 2023, Budapest, Hungary), as well as two international conference posters (European Conference of Behavioral Biology, July 20 – 23, 2022, Groningen, The Netherlands; International Conference of Behavioral Ecology, July 28 – August 2, 2022, Stockholm, Sweden).

In February 2021, I won the “MSCA EF Seal of Excellence” post-doctoral grant from Vinnova, the Swedish Governmental Agency for Innovation Systems, which started in August 2021. As I prioritized my new project, I put this project on hold for two years before terminating it. Therefore, I did not perform the two behavioral experiments scheduled for the second and third years of the project. However, there is a significant overlap between the topic of my NKFI and

Vinnova post-doctoral projects: both study behavioral differences between urban and rural great tits, but the Vinnova project focuses on various cognitive abilities rather than behavior toward humans. In the study I performed as part of the first year of my Vinnova grant, I found no significant difference between the success of great tits captured from urban and rural habitats in either of two problem-solving tasks, but the solving success differed largely between the batches of birds that got slightly different experimental protocols in both tasks. This result was presented in one Swedish national conference talk (Swedish Oikos Meeting, January 31 – February 1, 2023, Gothenburg, Sweden) and one international conference poster (European Ornithologists' Union Congress, August 21-25, 2023, Lund, Sweden).

I also got five additional research papers published over the grant period which were loosely connected to the research topic of my grant, focusing primarily on the breeding biology rather than the behavior of urban and rural great tits. One of them (*Vincze et al. 2021. Consistency and plasticity of risk-taking behavior towards humans at the nest in urban and forest great tits, *Parus major**. *Animal Behaviour* 179: 161-172) showed on a six-year dataset that urban great tits alarm-call at humans more than their forest conspecifics and urban females stay on the nest upon human disturbance more often than forest birds, and the latter behavior is highly repeatable within individual. The second paper (*Seress et al. 2021. Contrasting effects of the COVID-19 lockdown on urban birds' reproductive success in two cities*. *Scientific Reports* 11: 17649) revealed that during the COVID-19 lockdown of 2020, the number of humans in urban parks increased in Budapest, leading to lower reproductive success of great tits compared to 2019, whereas in Veszprém, the number of humans in urban parks decreased, but this did not lead to higher reproductive success. The third one (*Sinkovics et al. 2021. Great tits feed their nestlings with more but smaller prey items and fewer caterpillars in cities than in forests*. *Scientific Reports* 11:24161) showed that it is not the amount of prey, but rather the size of prey items and the lower proportion of high-quality prey items (i.e. caterpillars) that lead to the weaker condition of urban great tit nestlings compared to their forest-dwelling conspecifics, but in certain “good years” the diet of urban nestlings can get close in quality to rural nestlings. The fourth paper (*Pipoly et al. 2022. Extreme Hot Weather Has Stronger Impacts on Avian Reproduction in Forests Than in Cities*. *Frontiers in Ecology and Evolution* 10:825410) showed on a data set from 6 years that the number of extremely hot days in the breeding period has a negative effect on the body size and survival of great tit nestlings, but birds from forest habitats are more vulnerable to this effect than urban nestlings. Finally, the fifth paper (*Bukor et al. 2022. Double-brooding and annual breeding success of great tits in urban and forest habitats*. *Current Zoology*, 68: 517–525) revealed a statistically non-significant trend of urban great tits starting a second breeding attempt within a year more often than their forest-dwelling conspecifics, and that urban great tits fledge fewer nestlings both in their first and their second broods, with double-brooding urban birds fledging about the same amount of nestlings as single-brooding forest birds.

Additionally, at the 22nd Congress of the Hungarian Ethological Society (December 4-5, 2020, online), I presented a talk entitled “Is there a relationship between DRD4 genotypes and risk-taking behavior of female great tits in urban and forest habitats?”, and was included as co-author in another talk entitled “The influence of habitat and female traits on the probability of double-brooding and annual breeding success in great tits” (related to the fifth paper mentioned in the above paragraph). I also published a book review under the title “Bird Conservation in Human-Made Habitats” (Vincze 2022, *Conservation Biology*, 36: e13999).