PROCEEDINGS OF SCIENCE

Trails of hidden life - Involving Citizen Scientists to show the biodiversity at Viennese cemeteries

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Death and mourning - that is probably the general population's predominant association with cemeteries. However, they equally provide a habitat for a diverse range of animal, plant, and fungal inhabitants. The cooperation of the Austrian Citizen Science projects Stadtwildtiere and Biodiversität am Friedhof (BaF) have been documenting species at native resting places since 2021. With a total of 57 cemeteries in the city of Vienna alone, the active research area spans an enormous and therefore significant distance for biodiversity research in urban environments. Thanks to the cooperation of the public, including citizen scientists, numerous reports are available that even document previously undiscovered creatures in the cemetery areas opening up a multitude of avenues for nature conservation measurements.

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1. Introduction

As culturally anchored places of remembrance, the 46 cemeteries managed by Wiener Friedhöfe GmbH fulfil an important holistic function as naturalistic places of rest, creating crucial habitats for a variety of living creatures as well as places of refuge in a rapidly growing urban environment. This makes cemeteries interesting objects of research in the increasing areal urbanization of Europe [1]. Cemeteries differ significantly from the surrounding areas, especially in density and abundance of biodiversity due to the imperative of quiet reverence and mostly being stable and professionally landscaped [2]. Most of them are publicly inaccessible outside of opening hours, allowing non-human residents necessary rest and protection. Furthermore, cemeteries are not threatened by sealing, as many urban areas are, and thus provide long-term refuges [2]. While initial studies on this exist in other countries (e.g.: Germany, [3]), in Austria/Vienna, these habitats are still sparsely researched (e.g. protected plants: [4]; vegetation and conservation value: [5]). They host diverse microhabitats such as gravestones, walls, trees, hedges, and meadows [2] as well as gravelled paths that serve as habitats for specialized species groups (e.g., Sand lizard (*Lacerta agilis*), European hamsters (*Cricetus cricetus*), various woodpeckers (*Picidae*), wild bees (Apiformes)). Cemeteries are important steppingstone biotopes serving as bridges especially for lower vertebrates, but also insects and molluscs, thus enabling the widespread colonization of urban areas through corridors [6].

Visitors to cemeteries have long enjoyed encounters with nature and sightings of rare animals in addition to visiting graves, but an inventory of actual diversity has not yet been carried out in Vienna. The knowledge of the pertaining biodiversity will add to the results of individual studies on vertebrates and insects [7] with a focus on birds, mammals, amphibians, and reptiles as well as the flora. The intention is to understand the actual species diversity including the total number of biological manifestations in a definable area [8]. Parts of this manuscript were compiled and presented as a pitch and a poster at the Austrian Citizen Science Conference in 2022.

1.1 Citizen Science Approach

Citizen Science has increasingly played a more serious role in science today, both enhancing research possibilities and reach as well as becoming becoming an outlet for science communication, for example through learning opportunities [9]. Our projects allow people to actively participate in biodiversity research making them not only Citizen Scientists but also actors in the SDGs for a better future [10]. Through scientific methods such as mapping, collecting, measuring, and photographing or documenting, people experience a scientific approach and become part of biological research, generating important data on natural diversity in Austria. At the same time, they are immersed in the process of science through research questions, individual projects, and their own analysis of the data.

2. Material & Methods

From January 2021 until May 2022 citizen scientists were able to document and report all found species on the 46 cemeteries of the Friedhöfe GmbH in Vienna, Austria. These documentations were sent in either through email to baf.pal@univie.ac.at, the application StadtWildTiere, or the website www.stadtwildtiere.at, including pictures, videos, date, time, GPS location, and type of observation (e.g. individual, call, remnants). All accounts were then verified by scientific staff

before being used for further data analysis. This data was compiled according to taxa, classes to gauge the abundance, and visualised in percentages.

3. Results

Around 2,000 sightings have been reported by Citizen Scientists, students, and staff in 2021 and 2022. The majority of sightings were birds with about 83% (compare Fig.1).

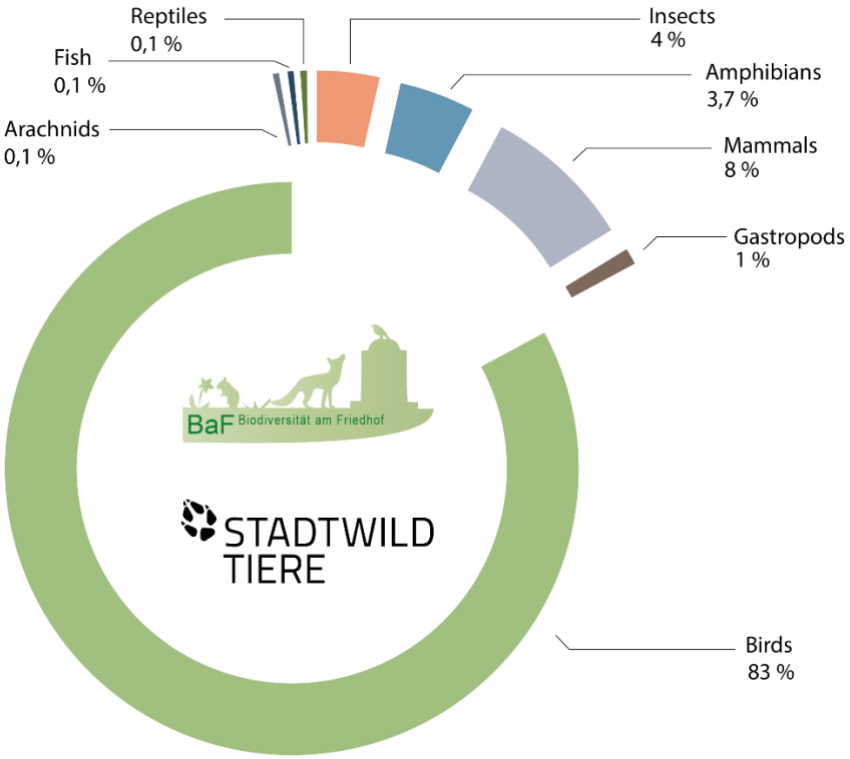

Figure 1: Percentages of determined species according to classes.

Biological rarities such as the Hoopoe (*Upupa epops*), Long-eared Owl (*Asio otus*), and Alpine Long-eared Buck (*Rosalia alpina*) were among the most significant documentations. Generalists and hemerophiles such as Hooded crows (*Corvus cornix*), Great tits (*Parus major*) and Wood pigeons (*Columba palumbus*) represented the bulk of these sightings. Mammals, such as the Roe deer (*Capreolus capreolus*) or Red squirrels (*Sciurus vulgaris*), are represented with 8% of the total sightings, followed by amphibians, insects, and snails. Reptiles, fish, and arachnids had the least amount of documentations by Citizen Scientist with only 0.1%.

4. Discussion

The 46 cemeteries managed by Friedhöfe Wien GmbH represent an immense space of over 497 ha, which could not be documented without the help of Citizen Scientists. The regular sightings including pictures by reports via app and email have become an important resource for biodiversity research in Vienna.

Most of the sightings included the expected hemerophile species such as hooded crows and red squirrels. Furthermore, species that were harder to detect and difficult to specify such as arachnids

naturally lacked in documentation while certainly not in their actual abundance in the area. Amphibians and fish were among the least detected species which is possibly due to lack of many pond or wetland areas in the Viennese cemeteries. However, the few documentations also showcased a large diversity highlighting the importance of these habitats and possibly opening up opportunities to expand these biotopes. Especially the number of knowledgeable birders in Vienna strongly influenced the documentations in comparison to other groups. This, however, also resulted in a broad picture of avian species, especially new and recurring sightings at various cemeteries.

The potential of the combined projects (Stadtwildtiere and BaF) has quickly found interest in the public eye. The Citizen Science Award brought the topic of biodiversity closer to schools and students, while targeted excursions created a relationship with nature. In the future, the documented data will be used for further projects to support scientific communication, publication, creation of shelters and encouragement of people to become part of species protection as well as science. Through sustained funding, further training and workshops with Citizen Scientist could be held to yield even better documentation results, especially in the field of species identification.

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