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Author for correspondence:
Monika Egerer,
E-mail: monika.egerer@tum.de

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Bee discovery suggests the importance of urban gardens in a changing world

Monika Egerer[1,2]

[1]Department of Life Science Systems, TUM School of Life Sciences, Technical University of Munich, Hans Carl-von-Carlowitz-Platz 2, 85354 Freising, Germany and [2]Department of Ecology, Technische Universität Berlin, Rothenburgstr. 12, 12165 Berlin, Germany

Abstract

The diversity and distribution of wild bees are dramatically changing due to habitat fragmentation, agricultural intensification and climate change. In cities, urban gardens are proposed 'island' habitats for bees offering floral and nesting resources. Yet, it is largely unclear how gardens play a role in changes in species diversity and distribution. This paper reports on the discovery of a bee species to our knowledge previously undocumented in the region of Berlin, Germany. We discovered *Lasioglossum limbellum* in a community garden created on concrete slabs of annual and perennial vegetation. As a cavity nester in soft rock cliffs—a natural habitat functionally not existent in urban areas—the life history of this species makes this discovery particularly interesting, and an opportunity to explore the role of urban gardens in biodiversity change. This report aims to spur future research, reporting and discussion on the changes in diversity and distribution of wild bees specifically in urban areas.

The loss of wild bee diversity is one of the most pressing contemporary challenges for biodiversity conservation due to the importance of wild pollinators for ecosystems (*via* wild plant pollination) and society (*via* crop pollination) (Zattara and Aizen, 2021). Agricultural intensification and urbanization push species to fragment vegetation remaining in the landscape, often loosing large habitat patches that can support wild bee populations (Kennedy *et al.*, 2013; Ferreira *et al.*, 2015). Climate change pushes species to northerly latitudes, creating new habitats for species to exploit, whereas the previous habitat may become too warm or dry (Marshall *et al.*, 2020).

The role of urban habitats such as gardens for supporting species conservation or migration is scarce in evidence though wide in speculation (Hall *et al.*, 2017; Banaszak-Cibicka *et al.*, 2018). Some work has documented how gardens can be hotspots for bee and plant diversity (Baldock *et al.*, 2019), with gardeners cultivating previously undocumented plant species within their yards (Taylor and Mione, 2019; Seitz *et al.*, 2022). Yet we have little evidence of how gardens may provide nectar, pollen and nesting resources for wild bees whose populations may be changing in diversity and distribution under land-use change. Furthermore, it is an open question as to whether gardens are rare resource patches in the cityscape that promote and sustain rare species populations, or whether gardens are ecological traps with rare species documented as remains of declining populations. Monitoring bee diversity in urban gardens can provide needed insight into species change (Baldock, 2011).

This article reports on the finding of a bee species previously undocumented in the city of Berlin, Germany to explore the role of urban gardens in species change. We investigated the species richness of wild bees (Clade: Anthophila) in 18 urban community garden sites distributed across Berlin, Germany's largest metropolitan region. Berlin's community gardens are an ever–popular novel urban ecosystem type situated on vacant lots, brownfields, wastelands, rooftops and parking lots (Kowarik, 2011).

We surveyed wild bees three times between May and August 2020 during good weather for bee activity (minimum 15°C, low wind, no rain and dry vegetation) (Bates *et al.*, 2011). We used standard passive trapping methods (15-cm-diameter plastic bowls, spray-painted in UV-bright yellow, white and blue placed 72 h) and netting methods (two observers walked through a 20 × 20 m observation plot for 60 min and identified species observed on flowers, netting individuals unidentified to species). We documented 102 wild bee species, and the comprehensive results of this research are presented in detail elsewhere (the authors, in review).

Discovery of *Lasioglossum limbellum*

This report provides initial evidence of a previously unrecorded wild bee species, *Lasioglossum limbellum* (Morawitz, 1876) in Berlin, documented within a very urban area in the city (84% impervious surface within 500 m of the garden). A female individual was found in a

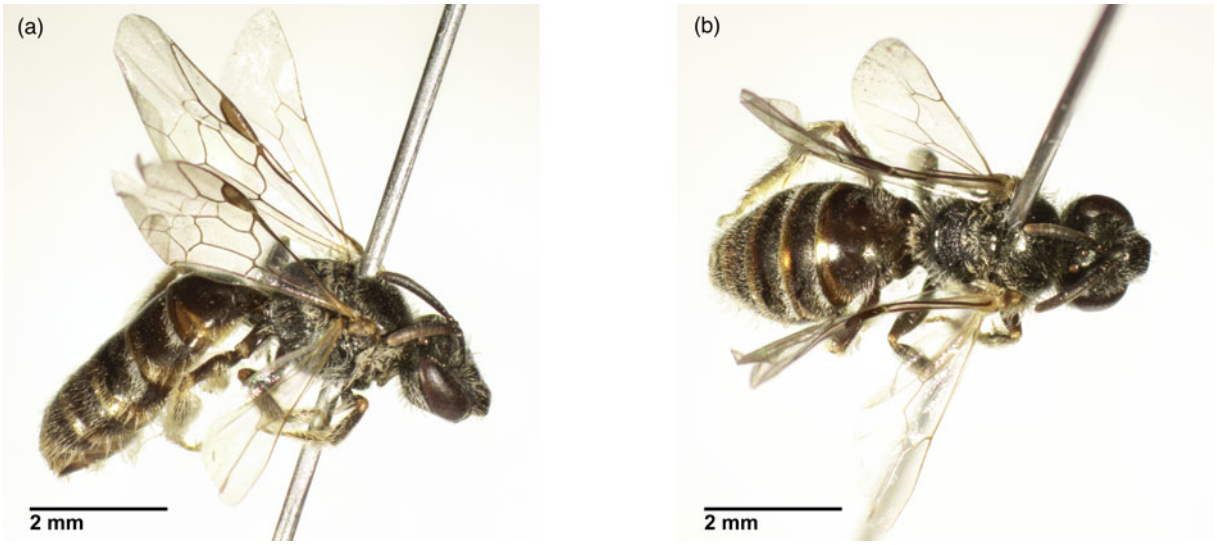

Fig. 1. Images of the bee specimen from the lateral (a) and dorsal (b) perspective. Images taken using a Motic SMZ-171 microscope (Motic Europe, Barcelona, Spain) with the Toupcam U3CMOS 16000KPA (ToupTek Photonics, Zhejiang, P. R. China), and processed using ToupView (Touptek) for photo acquisition with manual Focus stacking (16 Photos). The images where further processed using Lightroom (Adobe Inc., San José, California, USA) for images colour, brightness, sharpness, and control of chromatic aberations. The images were stacked in Photoshop (Adobe Inc.) and the scalebar (images shown to scale) was added from a measure slide. Imaging and processing by: Kenneth Kuba.

community garden in the Neukölln district in June 2020 using pan traps (Fig. 1). To our knowledge, this is the first documentation of this bee species in the Berlin region, and in northern Germany. The recorded distribution of the species spans warm localities in the Western Palearctic, from eastern Austria to China (Kansu), south to Israel, and north to Ukraine (Kiev); a subspecies is distributed from Morocco to Malta, from northwestern Spain to Austria, north to Guernsey and around Cologne, Germany (Ebmer, 1997; Pauly, 2016). In Germany, the species was previously restricted to Southern Germany (Pauly, 2016), is rare with a moderate decline, and was listed as endangered (level 3) on the 2007 Red List of bees in Germany (Westrich *et al.*, 2008). It is a small (8-10 mm), short-tongued solitary species belonging to the Halictidae, and can be identified by minute tranverse ridges usually at the sides of tergite 1, with translucent orange hind margins of tergites 1-4 that create a distinct banded appearance (Westrich, 2018). The top of the propodeum is smooth, especially along the hind margin. Females have a rounded face, while males have more oval faces and have short dark antennae. Females fly beginning in April, while males at the beginning of August (Westrich, 2018).

In the European habitats in which this species is found, it is strongly associated with soft rock cliffs and sandy and coastal grassland (Petanidou and Ellis, 1993; Sárospataki and Fazekas, 1995)—rare or functionally nonexistent in most urban areas. The bee colonizes sandy quarries, and constructs its nests in self-dug cavities in the steep walls from loam, sandy loam and sand material (Scheuchl and Willner, 2015; Westrich, 2018). As a polylectic species, it forages primarily on composites (e.g., *Taraxacum officinale*, *Picris Hieracioides*, *Chichorium intybus*), and pollen is collected on the hind legs and abdomen (Westrich, 2018).

Garden features suggest role in species conservation

The context of this garden raises interesting questions about how novel urban ecosystems that are created on concrete surfaces from natural elements could support biodiversity given their local vegetation and structural features. The garden (Vollguter Gemeinschaftsgarten) is a community project located in Berlin's Kindl Kiez, collectively managed by a group of citizens using ecological and permaculture practices. The garden community describes itself as a platform for experimentation, to explore the worlds of plants and herbs and where to build installations from recycled material (http://www.vgg.green). This civic engagement has produced an ecosystem of annual and perennial vegetation within raised beds in an area of otherwise concrete with little nearby vegetation (Fig. 2).

Despite being small, the garden is cultivated with many perennial and wild plant species that are high in pollinator attractiveness. We simultaneously documented 70 plant species within the garden using random sampling, including composite flowering species *Chichorium intybus* and the common *Taraxacum officinale* (Appendix 2), evidence that pollen and nectar resources associated with this species were available.

Of note, at the time of this research, an entire underground parking structure was being excavated right next to the garden. Previous studies have shown that demolition areas can provide nesting resources for ground-nesting bees (Seitz *et al.*, 2019). Perhaps the construction activity was providing materials to nest.

Urban landscape features suggest gardens are stepping stones

This finding opens up interesting questions in Island Biogeography and within the broader context of the 'SLOSS'-debate. In urban planning and ecology, an open question is what is the role of 'single large or several small' habitats in urban landscapes (Fattorini, 2016; Wintle *et al.*, 2019). Can small patches or 'urban islands' like gardens support populations as resource-providing 'stepping stones' in the landscape, or do we just need one large habitat as a 'source'? Are urban gardens ecological sinks or ecological traps, where species are attracted but the habitat cannot sustain the population? In

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Fig. 2. Community garden in Berlin, Germany where bee was discovered; the garden exists on concrete slabs (a) and is created out of annual and perennial flowering vegetation in makeshift beds and pots (b). Photos: the author.

cities, high amounts of imperviousness create a matrix that may be very difficult for species with low dispersal distances to traverse and maintain their populations. In this case, the garden is surrounded by high amounts of impervious surface. Yet it neighbors one of the largest habitats in central Berlin, Tempelhofer Feld (1000 m away), along with several other small green spaces including St.-Jakobi Kirchhof, St. Thomas-Kirchhof and Volkspark Hasenheide nearby (within 500 m). Tempelhofer Feld may be an important source habitat for many green space islands within this urban landscape. We cannot say whether the garden functions as purely a stepping stone across the urban landscape, or whether the garden can essentially function as the entire habitat for a bee species. The local context of the garden—small, raised beds on concrete, approximately 30 m^2 in size—may suggest that the garden is only as a stepping stone or even an ecological trap. Though for small species such as those of *Lasioglossum* with limited dispersal ability (couple hundred meters), this patch *could* serve as an entire habitat.

Open questions on the role of urban gardens in species conservation

Environmental change from land-use change is impacting species distribution and diversity worldwide. For wild bees, it is still largely unclear how urbanization may hinder (via densification) or support (via 'stepping stones') species conservation. This documentation provides preliminary evidence of how urban gardens may play a role in changes in bee species diversity. We cannot confirm any information on population numbers with this discovery, and the lack of historical collection records and wild bee monitoring across the regions and in diverse habitats means that we cannot confirm prior distributions or occurrences in the region. Nevertheless, it is critical to report such novel work to highlight the observations that we see occurring in urban ecosystems on changes in species diversity and distribution. This work opens the door to new investigations in urban environments to investigate, for example, whether species moving to new areas may be likely to use transformed novel ecosystems in cities. This discovery opens the question about the role of urban gardens in our city landscapes—even if only stepping stones—as important ecosystems for species ecology and conservation.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1742170522000199.

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