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REVIEW

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A review of diversity of bees, the attractiveness of host plants and the effects of landscape variables on bees in urban gardens

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Abstract

Background: The world's growing population and growing need for food have increased attention to urban agriculture around the world. Most crops grown in urban environments need bees for pollination. However, little is known about bee populations in urban areas and little attention has been paid to the function of these pollinators in cities. Therefore, studying the ecology of pollinating bees in urban gardens and green roofs contributes greatly to urban agriculture. In this study, the results of 87 articles related to the presence of bees in gardens and urban farms were summarized in three general sections. The first part deals with issues, such as the diversity of bees in urban gardens, dominant species in these areas, their nesting type, origin, specialty, and sociality. The second part examines the attractiveness of host plants in urban gardens and farms and their origin for bees. The third section examines the effects of landscape and local variables effects on the presence of bees in urban farms and gardens.

Results: Our data showed that urban environments, especially urban gardens, contain a high diversity of bees, which honeybees and bumblebees are the most dominant species in these environments. The results of the second part showed that native plants were more attractive to bees than non-native plants. In the third section, most studies have shown the negative role of urbanization on the presence of bees. On the other hand, many studies have shown that the presence of green spaces or other farms and gardens around the studied gardens have a positive effect on the presence of pollinators.

Conclusion: Urban environments have a high diversity of plants and bees that provides a good opportunity to increase agricultural production in these environments. Planting native plants and creating artificial nests for solitary bees and bumblebees can help attract more bees to urban environments. Converting lawns into floral resources or carrying out agricultural activities around green spaces can also effectively help to increase agricultural production in the city.

Keywords: Urban agriculture, Urban gardens, Green roofs, Bees, Pollination

Introduction

Urban areas now account for more than half of the world's population [80]. The United Nations estimates that by 2050, 68 percent of the world's population will live in cities, with rapid urbanization growing in low-income countries [70]. The expansion of cities threatens biodiversity and reduces agricultural lands [52]. The world's growing population and growing need for food have increased attention to urban agriculture around the world [69]. In recent years, attention to urban gardens, urban agriculture, and roof agriculture has increased. Urban agriculture does not have a specific definition and includes a wide range of agricultural activities within cities. Types

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of urban agriculture include home gardens, allotment growing, community gardens, commercial, vertical agriculture, rooftop gardening [71]. The crops grown in these gardens contribute to urban sustainability and food security [13]. Urban agriculture positively affects the local environment, including improving air quality, increasing carbon stabilization rates, reducing urban heat islands, and reducing runoff-related water pollution [53]. Reducing the food supply chain as a result of urban agriculture is another advantage of this type of agriculture [86].

Many crops are grown in the city, such as cucumbers, tomatoes, watermelons, strawberries, peppers, and eggplants that require a pollination process to produce the crop [65]. Pollination is a vital ecosystem service not only in natural ecosystems but also in cities [94]. However, little is known about bee populations in urban areas and little attention has been paid to the function of these pollinators in cities. With the growth of urban agriculture, the role of bees in helping to produce food in cities has become more prominent. Some studies claim that urban farms and gardens are short of pollinators, and to increase agricultural production on urban farms, we need to increase the supply of pollination services in cities by creating new flowering sources around urban farms. for example, To increase the supply of pollination to support urban farms in Chicago, Davis et al. [14] propose two scenarios based on the conversion of turf-grass flora resources. (1) If the goal is to improve the pollination supply for home gardens, the best strategy is to convert the turf-grass throughout the urban landscape into floral sources. (2) If the goal is to increase the pollination supply for urban farms, the best strategy is to convert turf-grass to floral resources that are located within a radius of 250 m from urban farms.

Others suggest a companion planting strategy to attract pollinators to farms and urban gardens. Companion planting is a traditional method of planting different flowering plants in the proximity of cultivating crops to attract pollinators [37]. For example, Griffiths-Lee et al. [37] planted a borage plant next to a strawberry crop based on a companion planting strategy. They used the borage plant to attract pollinators to the strawberry farms. This increased the production of strawberries by 32%. Someone Pereira-Peixoto et al. [77] also examined the behavior of bees in isolated urban gardens and gardens adjacent to rapeseed crops. They found that the bees' abundance in gardens adjacent to the rapeseed plant was higher than in isolated gardens in the city. In the gardens bordering the rapeseed crop, during the mass flowering of the rapeseed crop, a spillover from the gardens to the rapeseed was observed, which could increase the yield of the rapeseed crop. Langellotto et al. [49] also claim that in farms near urban gardens, 30 to 50 percent of the bees in the gardens go to the farms for pollination. However, Matsuoka et al. [63] cultivated several plant species with sodium plants and did not observe any positive effect of the companion planting strategy in attracting pollinators.

Bees are thought to be moving between gardens and farms, helping to increase crop production. However, many studies have shown that the relationship between urban agriculture and bees is more complex than we think because, bees are unable to fly long distances, and reports indicate that they usually fly less than 1,000 Meters. For example, Hofmann et al. [41] examined flight distances of four specialist species and two general species of *Osmiini* bees (*Megachilidae*). They found that females flew an average of 73 to 121 m and males 59 to 100 m. In addition, even if farms and urban gardens are adjacent, we should not expect bees to visit all of these farms. For example, based on the mark-recapture method of *Bombus impatiens* species, Matteson and Langellotto [65] found that 45% of these species were found in the same gardens that were marked, implying that the bumblebees did not move between the gardens and remained inside the original garden. O'Connell et al. [74] showed that although many crops were grown around ornamental plants, *B. vosnesenskii* visited ornamental plants more than the crops. Therefore, bee food preferences affect their role in the pollination of agricultural products in and around gardens.

These studies show that the strategy of adding flowering plants to urban gardens or around farms is not always a good solution, because if the added flowers provide bees with better quality resources, agricultural products will receive fewer visits. It seems that better management of gardens and urban farms is needed to understand the relationships between bees and these areas. In this regard, the following questions should be answered (1) What is the diversity of bees in urban areas, especially in gardens and urban farms. We need to know in detail about the dominant species in the urban gardens, in particular, their nesting type, and determine whether they are native, general, and social. (2) What is the relationship between host plants and pollinating bees? In particular, their attractiveness to bees according to origin. (3) How do landscape and local variables around urban gardens affect the presence of bees? Answering these questions can help us determine the best strategy to increase the pollination supply in gardens and urban farms. We believe that to answer these questions, the relevant studies that have been published so far need to be reviewed and their results summarized. Then, based on the insights that these studies give us, we will be able to guess the optimal strategy to increase the urban agricultural products by bees.

Methods

We searched for published studies using the ISI Web of Science. We conducted our search from 1990 to 2021 using the following search string: (pollinator* OR pollination* OR bee*) AND (urban garden* OR urban agriculture* OR city garden* OR city agriculture* OR green roofs*). The final data set included studies from 1990 to 2021. Nearly 900 articles were obtained, leaving 280 unique articles after the duplicate articles were removed. We were only looking for articles that examined the relationship between bees and urban agriculture. Therefore, we selected studies that would help our knowledge to increase the production of agricultural products (edible or ornamental) by bees (native or non-native). After reviewing the titles and abstracts of the articles, 87 articles remained that were related to our goals, and we recorded the most important results of these articles. We divided the results of these studies into three general sections. The first part deals with issues, such as the diversity of bees in urban gardens, the dominant species in these areas, their nesting type, origin, specialty, and sociality. The second part examines the diversity of host plants in urban gardens and farms, their origin, and attractiveness for bees. The third section examines the effects of landscape and local variables on the presence of bees in urban farms and gardens (Table 1).

Bee diversity in urban gardens

To better management of urban gardens, we need to have an overview of pollinators within these areas. Although the presence of bees in urban gardens depends on various factors such as location and climate of the city, the landscape around the gardens, the type, and origin of host plants, the use of pesticides, identifying bees in urban gardens can be a great help in managing these gardens. Various studies have investigated the diversity and species richness of bees in urban, suburban, and natural environments that the details of their results are beyond the scope of this study. However, many of these studies have shown that the diversity of bees within cities is in some cases greater than in natural areas, and generally emphasize the high diversity of bees and their population composition within cities, and sometimes cities, especially city gardens, are referred to as bee hotspots [4, 94].

Table 2 shows the number and family details of bees recorded in urban gardens and green roofs. This table details 45 studies, most of which were conducted in the United States (60%). Most of these studies have focused on urban gardens, and only six studies (13%) have examined the diversity of bees on green roofs. The number of bees recorded in urban gardens is between 10 to 200 species and on green roofs between 5 to 326 species. Most of the recorded species belong to 5 families of *Andrenidae, Apidae, Colletidae, Halictidae, Megachilidae*, so that 53% of the studies have reported these families in their investigations.

Dominant bees in urban gardens

Identifying the dominant species in urban environments, especially in urban gardens, helps us in managing these gardens, because by creating artificial nests, we can attract more populations of these species to the gardens. Some studies have identified dominant species in their studied gardens. Details of these studies are provided in Table 2. This table shows the nesting type, origin, sociality, generality, and the scientific name of the most dominant species recorded in urban environments. This table presents 31 studies, most of which were conducted in the United States (51%). These studies show that bees that live in urban environments are mostly above-ground nesting and a small percentage (12%) of these species nest in the soil. Non-native species are also found to a significant extent (29%) in urban environments, most of which are composed of honeybees.

Bumblebees, honeybees, and stingless bees are social. Therefore, studies that have reported the predominance of these species in their studies have also shown a high proportion of social bees in urban gardens. According to Table 2, the most dominant species in urban environments is the honeybees (38%) followed by bumblebees (19%). Although some studies have shown that honeybees negatively affect the presence of wild bees due to the competitive process and do not recommend beekeeping in the cities [82], other studies have shown that the number of honeybees is positively correlated to bumblebees [39] and does not appear to compete with bumblebees or other wild bees [32, 47].

The attractiveness of the host plant for bees

Numerous studies have focused on the attractiveness of different plants in attracting pollinators, and the results of these studies are provided in different lists. Looking at these lists, we find that a large number of native and non-native plant species have been introduced to attract pollinators. However, there are many criticisms of these lists. For example, Garbuzov and Ratnieks [31] examined the strengths and weaknesses of the 15 list of introduced plants for attracting pollinators, stating that these lists have little overlap in terms of the different plants they introduce. Contrary to popular belief, limited species are effective in attracting pollinators, and there are several studies to support this claim. For example, Garbuzov and Ratnieks [33] tested 228 varieties of the *Aster* plant to measure their attractiveness for bees. They showed that only a small fraction of the varieties of this genus were highly attractive to pollinators. Table 3 shows a list of

Table 1 Number and family details of recorded bees in urban gardens and green roofs

References	Country	Garden	No. Species	Family
[27]	USA	Urban garden	76	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*), 23 genera
[101]	USA	Urban garden	32	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*), 17 genera
[21]	USA	Urban garden	110	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[64]	USA	Urban garden	54	–
[25]	USA	Urban garden	82	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*), 28 genera
[26]	USA	Urban garden	68	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*), 26 genera
[97]	USA	Green roof	63	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*), 23 genera
[66]	USA	Urban garden	45	–
[85]	Sweden	Urban garden	28	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*), 8 genera
[56]	USA	Urban garden	37	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[9]	Switzerland	Green roof	126	–
[77]	Germany	Urban garden	20	2 families (*Colletidae*, *Megachilidae*)
[75]	USA	Urban garden	66	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[67]	Argentina	Urban garden	66	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*), 32 genera
[58]	Canada	Green roof	17	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[54]	USA	Urban garden	20	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[96]	Australia	Urban garden	19	4 families *(Apidae, Colletidae, Halictidae and Megachilidae)*
[59]	Canada	Green roof	11	2 families (*Colletidae*, *Megachilidae*), 5 genera
[6]	Poland	Urban garden	104	–
[81]	USA	Urban garden	55	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[51]	USA	Urban garden	96	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[36]	USA	Urban garden	10	*Bombus* spp.
[60]	Australia	Urban garden	21	4 families (*Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[23]	USA	Urban garden	18	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[78]	USA	Urban garden	43	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[73]	Canada	Urban garden	200	6 bee families (*Andrenidae, Apidae, Colletidae, Halictidae, Megachilidae and Melittidae*)
[42]	Asia, Europe, and North America	Green roof	326	*Apidae*
[87]	Philippine	Urban garden	14	2 families (*Apidae* and *Halictidae*), 6 genera
[57]	USA	Urban garden	29	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*), 23 genera
[91]	USA	Urban garden	98	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[47]	Austria	Green roof	90	19 genera
[2]	USA	Urban garden	17	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*), 13 genera
[22]	USA	Urban garden	14	4 families (*Andrenidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[38]	Ghana	Urban garden	167	4 families (*Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[7]	USA	Urban garden	75	3 families (*Apidae*, *Halictidae*, *Megachilidae*)
[11]	USA	Urban garden	57	19 genera
[5]	USA	Urban garden	172	6 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*, *Melittidae*), 44 genera
[76]	Switzerland	Green roof	5	*Halictidae*
[20]	USA	Urban garden	49	4 families (*Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*),
[8]	USA	Urban–rural	81	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*), 23 genera
[50]	Austria	Urban garden	113	22 genera
[15]	Argentina	Urban garden	73	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*)
[92]	Germany	Urban garden	117	-
[88]	India	Urban garden	39	3 families (*Apidae*, *Halictidae*, *Megachilidae*),
[3]	USA	Urban garden	20	5 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*, *Megachilidae*), 17 genera
[12]	USA	Urban garden	15	4 families (*Andrenidae*, *Apidae*, *Colletidae*, *Halictidae*), 14 genera

Table 2 Nesting type, origin, sociality, generality, and the scientific name of the most dominant species recorded in urban environments

References	Country	Nesting	Origin	Sociality	Generality	Species
[27]	USA	Above-ground	Native	Solitary	General	*Apidae*
[21]	USA	Soil	Native	Social	General	*Halictidae*
[64]	USA	Above-ground	Non-native	Social	General	*Hylaeus leptocephalus*
[65]	USA	Above-ground	Native	Social	General	Bumblebees
[25]	USA	Above-ground	Non-native	Social	General	Honeybees
[26]	USA	Above-ground	Native	Solitary	General	*Megachilidae*
[97]	USA	Above-ground	Native	Social	General	*Halictus virescens*
[72]	Egypt	Above-ground	Non-native	Social	General	Honeybees
[58]	Canada	Above-ground	Native	Social	General	Bumblebees
[96]	Australia	Above-ground	Non-native	Social	General	Honeybees
[54]	USA	Above-ground	Native	Social	General	*Bombus impatiens*
[67]	Argentina	Above-ground	Native	Social	General	*Plebeia droryana*
[34]	UK	Above-ground	Native	Social	General	Honeybees
[33]	UK	Above-ground	Native	Social	General	Honeybees
[95]	Germany	Above-ground	Native	Social	General	Bumblebees
[51]	USA	Soil	Native	Solitary	General	*Lasioglossum illinoensis*
[29]	UK	Above-ground	Non-native	Social	General	Honeybees
[78]	USA	Above-ground	Non-native	Social	General	Honeybees
[73]	Canada	Soil	Native	Social	General	*Halictidae*
[87]	Philippine	Above-ground	Non-native	Social	General	*Apis cerana*
[2]	USA	Above-ground	Native	Social	General	*Bombus griseocollis*
[7]	USA	Above-ground	Native	Social	General	Bumblebees
[83]	UK	Above-ground	Native	Social	General	Honeybees
[22]	USA	Above-ground	Non-native	Social	General	Honeybees
[5]	USA	Soil	Native	Social	General	*Lasioglossum coactum*
[4]	UK	Above-ground	Native	Social	General	Bumblebees
[35]	Canada	Above-ground	Non-native	Social	General	Honeybees
[62]	Germany	Above-ground	Native	Social	General	Bumblebees
[8]	USA	Above-ground	Native	Social	General	*Halictus tripartitus*
[92]	Germany	Above-ground	Native	Social	General	Honeybees
[99]	USA	Above-ground	Native	Social	General	Honeybees

attractive plants for bees in urban gardens. These plants have been suggested by 23 studies, most of which have been done in the United States (39%).

Native vs. non-native host plants

It is claimed that the presence of native and non-native bees in gardens is primarily related to the host plant [6]. One of the factors that affect the attraction of bees in urban gardens is the origin of the host plant, which some studies have found that native plants are more effective in attracting pollinators than non-native ones. However, some studies claim that non-native plants attract more bees and others claim that the simultaneous presence of native and non-native plants in urban gardens attracts more bumblebees than those whose non-native species are predominant [84]. Staab et al. [92] state that the visit of bees to native and non-native plants depends on their flowering season. After the flowering season in non-native plants, bees' visits decrease and they will shift to native plants. Regardless of the origin of the studied plants, plant height also has a positive effect on bees' visiting rate [17].

Table 4 shows the attractiveness of the plants in urban gardens for bees according to plant origin. This table presents 16 studies, 44% of which found that bees are more attracted to native plants. Others have found that non-native plants are more attractive to bees than native plants (38%). Few studies have shown that there is no difference in the attractiveness of native and non-native plants for bees (18%).

Table 3 Attractive plant species for bees in urban environments

References	Country	Garden	Attractive species
[25]	USA	Urban garden	*Asteraceae*, and *Lamiaceae*
[66]	USA	Urban garden	Ornamental plants
[72]	Egypt	Urban garden	*Achillea santolina, Chenopodium album, Beta vulgaris, Foeniculum vulgare*
[30]	UK	Urban garden	*Borago officinalis, Lavandula * intermedia 'Grosso'*
[34]	UK	Urban garden	*Sedum, Origanum*
[33]	UK	Urban garden	*Aster*
[29]	UK	Urban garden	*Iberis, Alstromeria, Tradescantia*
[2]	USA	Urban garden	*Asclepias tuberosa and A. fascicularis*
[91]	USA	Urban garden	Harvestable crops and ornamental flowers
[87]	Philippine	Urban garden	*Bidens pilosa (Asteraceae) and Brassica rapa (Brassicaceae)*
[4]	UK	Urban garden	*Cirsium arvense, Taraxacum agg, Rubus fruticosus agg, Ranunculus repens*
[83]	UK	Urban garden	*Calamintha nepeta, Helenium autumnale*, and *Geranium rozanne*
[55]	USA	Urban garden	Non-native, perennial, ornamental
[45]	Poland	Urban garden	*Lonicera*
[19]	France	Urban garden	*H. maximum, C. jacea, L. corniculatus*
[17]	USA	Urban garden	*Borago, Phacelia, milkweed*
[99]	USA	Urban garden	*Ascelpias curassavica*
[43]	Ukraine	Urban garden	*Rhinanthus vernalis, Echium vulgare, Cirsium arvense, Trifolium pratensis,*
[90]	Poland	Urban garden	*Asteraceae, Fabaceae*, and *Lamiaceae*
[93]	Australia	Urban garden	*Brassica rapa* and *Ocimum basilicum*
[100]	USA	Urban garden	Ruderal plant
[62]	Germany	Urban garden	*Bidens ssp., Coreopsis ssp.* and *Euphorbia hypericifolia*
[3]	USA	Urban garden	*A. incarnate, A. tuberosa*

Table 4 The attractiveness of the plants in urban gardens for bees according to plant origin

References	Country	Garden	Origin
[27]	USA	Urban garden	Native
[40]	Australia	Urban garden	Neutral
[25]	USA	Urban garden	Non-native
[97]	USA	Green roof	Native
[66]	USA	Urban garden	Non-native
[75]	USA	Urban garden	Native
[84]	UK	Urban garden	Native
[28]	Canada	Urban garden	Native
[89]	Poland	Urban garden	Non-native
[46]	Japan	Urban garden	Non-native
[57]	USA	Urban garden	Neutral
[55]	USA	Urban garden	Native
[83]	UK	Urban garden	Neutral
[10]	Germany	Urban garden	Non-native
[17]	USA	Urban garden	Native
[35]	Canada	Urban garden	Non-native

Landscape and Local features effects

Many studies have examined the effect of landscape features on the presence of bees at both the local and landscape levels. Local variables include garden size, variety, and density of host plants, plant origin, type of agricultural products, roof height, etc. Some studies suggest that only local variables affect the presence of bees in the gardens and that the variables of the landscape or the features around these gardens have no effect. Some studies have found that increasing the richness and density of floral resources inside the gardens attracts pollinators to the gardens. At the landscape level, variables such as the percentage of impervious surfaces, traffic, the presence of other gardens, parks, forest patches, the density of buildings are usually measured. Most of the studies have focused on the role of the percentage of impervious surfaces as an indicator of urbanization.

Table 5 shows a list of studies that have examined the effects of local and landscape features and on the presence of bees in urban gardens and green roofs. The results of these studies have been obtained at distances of 50 to 1000 m from the gardens. This table presents 44 studies, most of which have been conducted in the United States (47%). The urbanization column shows the type of impact of impervious surfaces around the gardens. Studies that have not examined the effects of urbanization are shown by "-" and those that have not found a relationship between bee presence and urbanization were considered

Table 5 The effects of urbanization and local variables on the presence of bees in urban gardens and green roofs

References	Country	Garden	Urbanization	Key result
[1]	Sweden	Urban garden	Negative	Local variables were more important than landscape variables
[66]	USA	Urban garden	–	Adding wild native species to the garden did not attract pollinators
[85]	Sweden	Urban garden	Negative	Seed set for *C. persicifolia* decreased with urbanization
[97]	USA	Green roof	Negative	Green spaces around green roofs increased bee abundance
[102]	USA	Urban garden	Negative	*Bombus* and *Megachile* were affected by local variables
[9]	Switzerland	Green roof	Negative	Green roof size has no effects on bee populations
[39]	Sweden	Urban garden	–	Garden size does not affect pollinator populations
[98]	Belgium	Urban garden	Negative	Bumblebee visiting rate decreased with the increasing amount of green space around gardens
[84]	UK	Urban garden	–	Regardless of the origin, the increase in flowers attracts bumblebees
[54]	USA	Urban garden	–	In-garden flowers have a positive effect on coneflower pollination
[30]	UK	Urban garden	–	Garden size does not affect pollinator populations
[33]	UK	Urban garden	–	Garden size does not affect pollinator populations
[79]	USA	Urban garden	Neutral	Garden size does not affect pollinator populations
[96]	Australia	Urban garden	Negative	*Colletidae* were almost absent from residential landscapes
[59]	Canada	Green roof	Negative	Roof height reduced brood cells
[81]	USA	Urban garden	Negative	Garden size positively affected small bees
[28]	Canada	Urban garden	–	Garden size does not affect pollinator populations
[16]	USA	Urban garden	Negative	Urbanization is associated with reduced flower visitor richness
[6]	Poland	Urban garden	Negative	The presence of a large green patch around the gardens has a positive effect on bee presence
[95]	Germany	Urban garden	Positive	Local variables were strongly related to flower visitation rates
[60]	Australia	Urban garden	Neutral	Local and landscape variables were not associated with bees' populations
[24]	UK	Urban garden	Neutral	Bumblebees were negatively correlated with areas cultivated for vegetables
[36]	USA	Urban garden	Negative	Diversity and abundance of *Bombus* spp. Decreased with urbanization
[48]	USA	Urban garden	Negative	Bees were positively associated with distance to the city center
[23]	USA	Urban garden	Neutral	Visits to one species increased with urbanization but visits to others decreased
[78]	USA	Urban garden	Negative	The diversity of bees decrease with increasing flower abundance
[47]	Austria	Green roof	–	Roof height did not affect bee communities
[87]	Philippine	Urban garden	Negative	Home gardens surrounded by woody habitats showed higher bee richness
[91]	USA	Urban garden	Positive	The presence of green spaces around the gardens positively affected bees
[11]	USA	Urban garden	Negative	Canopy cover within gardens negatively affected bee abundance
[7]	USA	Urban garden	Neutral	Garden size positively affected small bees
[44]	China	Urban garden	Negative	Urbanization negatively affected *Gentiana dahurica*
[38]	Ghana	Urban garden	Neutral	Fewer cavity-nesting bees were found in urban than in rural areas
[52]	France	Urban garden	Negative	Gardens surrounded by other gardens showed higher bee richness
[22]	USA	Urban garden	Neutral	Positive effect on non-native species but negative on native species
[5]	USA	Urban garden	Negative	Natural cover around gardens increases bee richness
[68]	USA	Urban garden	Negative	Suburban landscapes are suboptimal for B. impatiens
[50]	Austria	Urban garden	Neutral	Flower abundance was the most important factor as a local variable
[18]	Argentina	Green roof	Negative	Street cover in the landscape negatively affected total richness
[8]	USA	Urban–rural	Negative	Urban areas negatively impact bee communities
[61]	Mexico	Urban garden	Neutral	Floral visitor abundance was influenced by habitat type and season
[20]	USA	Urban garden	Positive	Barren lands around gardens negatively affected bee populations
[12]	USA	Urban garden	Neutral	Bee abundance and richness did not change with increasing floral resources
[74]	USA	Urban garden	Positive	The percent urban cover positively affected *B. vosnesenskii*

neutral. Half of these studies have reported the negative effects of urbanization on the presence of bees. Few of these studies (9%) have found positive effects and 22% have found no relationship between urbanization and the presence of bees in urban gardens and green roofs.

Conclusion

In this study, the results of 87 articles related to the presence of bees in gardens and urban farms were summarized in three general sections. In the first part of the results, our data showed that urban environments, and especially urban gardens, contain a high diversity of bees, which provides a good opportunity for urban agriculture. Most studies have emphasized the greater abundance and diversity of bees in ground-level gardens than green roofs. This result may be due to the cultivation of Sedum monoculture or the high height of buildings that are more prone to wind than short buildings. Therefore, planting native plants with greater diversity for green roofs than sedum monoculture is recommended to attract bees [97].

One important result was that bumblebees and honeybees have been identified as the dominant species in urban gardens by most studies. This result can help a lot in managing urban gardens and increasing the pollination supply, because by recognizing the habitat needs of these species, a significant percentage of pollinating bees can be attracted to farms and urban gardens. Most studies showed that native bees make up a larger population than non-native bees in urban gardens. Since few studies have examined the competition between honeybees as a non-native species (for example in North America) and native bees, we are not able to reach a definite conclusion in this regard. Therefore, the strategy of increasing the bee population in urban environments by establishing beehives is facing major challenges, and more studies are needed in this field.

Most studies claimed that the identified bees were of general and social species. Urban environments are different from natural environments and provide difficult conditions for the presence of specialist species. Air and noise pollution, the effects of urban heat islands, urban microclimate, traffic, and the lack of suitable host plants for specialist species have caused cities to accommodate general species that one of the most important of which is honeybees. Therefore, in the strategy of increasing floral resources in gardens, it is necessary to avoid planting flower species that need specialist bees for pollination. Honeybees and bumblebees, previously mentioned as common species in urban gardens, are part of the above-ground nesting [7]. On the other hand, about 70% of solitary bees nest in the ground [25], which are less present in urban environments. Therefore, to attract bees, more attention should be focused on the habitat and nesting needs of above-ground nesting. Our data showed that the diversity of host plants had a significant effect on the presence of pollinators in farms and urban gardens so that native plants were more attractive to bees than non-native plants.

Related studies on the effect of landscape and local variables on the presence of bees in farms and urban gardens showed that urbanization negatively affects the presence of bees in urban gardens. Some studies have shown that the presence of green spaces or other farms and gardens around the studied gardens have a positive effect on the presence of pollinators. Therefore, the strategy of converting lawns into floral resources or carrying out agricultural activities around green spaces can effectively help to increase agricultural production in the city.

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ER has written the paper and has presented the articles in summary form in tables. ShB has reviewed the paper, helped to write, and interpreted the results. PD has reviewed the paper, edited grammar, and helped to interpret the results. All authors read and approved the final manuscript.

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