 LIST OF BEE SPECIES (HYMENOPTERA, APOIDEA) OF LVIV CITY (UKRAINE).
PART II: FAMILIES COLLETIDAE LEPELETIER, 1841; HALICTIDAE THOMSON, 1869; MEGACHILIDAE LATREILLE, 1802 AND MELITTIDAE MICHENER, 2000

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Skyrpan I.P., Pytel S.R. List of bee species (Hymenoptera, Apoidea) of Lviv city (Ukraine). Part II: Families Colletidae Lepeletier, 1841; Halictidae Thomson, 1869; Megachilidae Latreille, 1802 and Melittidae Michener, 2000. Studia Biologica, 2020: 14(4); 59–68 • DOI: https://doi.org/10.30970/sbi.1404.637

Background. The article presents the results of the research on bees (Hymenoptera, Apoidea) that occur in the city of Lviv. Bees are one of the most important pollinators of many species of angiosperm plants. Research on species diversity of bees is very important not only on the wild nature territories, but also on the urbanized areas. Cities have a significant impact on bee species diversity, their biology and conservation. A comprehensive study of all Apoidea on the whole territory of the city of Lviv has been conducted for the first time in more than 80 years and we hope that the presented materials will lay the foundation for further more detailed studies in this area.

Materials and Methods. Lviv is the largest city in Western Ukraine located on the eastern edge of the Roztochia Upland. The material was collected during the warm period of 2017–2019. The Moericke (yellow) pan traps and the entomological nets were used. Besides, we collected dead bees (killed by traffic) along the roads. W have analyzed the entomological collection of the Zoological Museum of the Ivan Franko National University [ZMD] (Lviv). The stereoscopic microscope and a variety of specialized keys for bee species identification were used. We used the Shannon’s diversity index to assess species diversity. We also calculated the Shannon evenness measure to facilitate the interpretation of the results.

Results. We analyzed 960 specimens of bees that belong to 106 species, 25 genera and 6 families.

The current (second) part of our study deals with review of the Colletidae (3 species), Halictidae (22 species), Megachilidae (11 species) and Melittidae (5 species) families. Species diversity of the bees from Andrenidae and Apidae families was analyzed in (first) the part of our research [27].

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Conclusions. All species from the six families are native for the territory of Europe. The majority of them are polylectic (≈ 61 %), while the number of oligolectic species (≈ 23 %), or species that do not need to collect pollen (≈ 16 %) is much smaller. The Shannon’s diversity index is approx. 3.718 and the Shannon evenness measure is 0.799 (the honeybee Apis mellifera was excluded in both calculations). Analysis of the impact of urbanization and various environmental factors on the species diversity of bees requires further detailed studies.

Keywords: bees, species diversity, Lviv, Ukraine

INTRODUCTION

Bees are one of the most important pollinators of many species of wild angiosperm plants, so they are an integral component of many ecosystems. However, apart from wild plants, bees are also effective pollinators of many crops, orchards and ornamental flower beds on the farmlands and cities.

Research on species diversity of bees is very important not only for the wild nature territories, but also for urbanized areas. Research of wild bees in urban context started recently [3]. Over the past two decades, numerous contributions on the implications of urbanization for biodiversity conservation have been published [5, 12].

Cities have a significant impact on bee species diversity, their biology and conservation. For example, the effects of pesticides, emerging pathogens from managed bees, climate change and land-use change are negatively correlated with bee species richness [6, 7, 9, 10, 11]. Higher diversity of flowering plants due to domestic orchards and ornamental flowers attract many polylectic species, but the abundance of oligolectic species could decrease at the same time. Urbanization often degrades nesting habitats for ground-nesting bees, but various structures like buildings and fences, can lead to an increase in abundance of cavity-nesters in urban habitats [6]. Despite a large number of investigations, many urbanization factors that influence biodiversity and pollination remain unstudied [13]. We are only beginning to understand the possible effects of habitat fragmentation on bees [4].

Significant research on bees on the territory of Western Ukraine was conducted by Maximilian Nowicki, Antoni Wierzejski (19th century), Jan Noskiewicz (the beginning of 20th century) and by Hanna Osychnyuk (the second half of the 20th century) [27]. A comprehensive study of all Apoidea on the whole territory of the city of Lviv has been conducted for the first time in more than 80 years and we hope that the presented materials will lay the foundation for further more detailed studies in this area.

MATERIALS AND METHODS

A brief description of the territory of Lviv City is given in the first part of the study [27]. The objects of our research were bees (Hymenoptera, Apoidea) that occur on the territory of the city of Lviv. We collected the specimens during the warm period of 2017–2019. We used the Moericke (yellow) pan traps and the entomological nets. Moericke yellow trap is a type of attraction traps (insects are attracted by colour) [17]. We used pans of 18 cm in diameter and 7 cm in depth as the most affordable. Traps were filled with water and a few drops of detergent were added.

Also, we collected dead bees (mostly killed by traffic) along the roads. Besides, we analyzed the entomological collection of Zoological Museum of Ivan Franko National University of Lviv (ZMD), collected during 2001–2016 by students and faculty staff.
We used MBS-2 stereoscopic microscope and a variety of specialized keys for bee species identification [1, 2, 8, 16, 19–26]. Higher level classification of bees follows Ch. D. Michener [15]. Information about belonging to the IUCN Red List Categories was obtained from the “European Red List of bees” [18]. Information about species biology was taken from the relevant literature [1, 2, 8, 16, 19, 23–26].

We used the Shannon’s diversity index (H) to assess species diversity. We also calculated the Shannon evenness measure (J) (the ratio of the observed diversity to maximum possible diversity of a given number of taxa) to facilitate the interpretation of the result [14]:

$$J = \frac{H}{\ln S} = \frac{-\sum_{i} \frac{n_i}{N} \ln \frac{n_i}{N}}{\ln S},$$

where $S$ is the total number of species; $N$ is the total number of specimens and $n_i$ is the number of specimens in species $i$.

Statistical analysis of the data was performed by the PAST (PAleontological STAtistics, Version 2.17c) program.

RESULTS AND DISCUSSION

During the research, 960 specimens of bees that belong to 106 species, 25 genera and 6 families (Apidae, Andrenidae, Colletidae, Halictidae, Megachilidae and Melittidae) were examined. Species diversity of bees of Andrenidae and Apidae families was presented in the first part of our research [27]. In this part of our study, we have reviewed Colletidae Lepidoptera, 1841 (10 examined specimens), Halictidae Thomson, 1869 (73 specimens), Megachilidae Latreille, 1802 (86 specimens) and Melittidae Michener, 2000 (32 specimens) families.

In our collection, the Colletidae family is presented only by 3 species from a single genus – *Colletes* Latreille, 1802 (Table 1).

| No | Species | Species biology | Conservation |
|----|---------|-----------------|-------------|
| 1. | *Colletes cunicularius* (Linnaeus, 1761) | Solitary. Univoltine (April–June). Polyleptic. Nest in soil | LC |
| 2. | C. daviesanus Smith, 1846 | Solitary. Univoltine (June–September). Oligolectic on Asteraceae. Nest in soil | LC |
| 3. | C. similis Schenck, 1853 | Solitary. Univoltine (June–September). Oligolectic on Asteraceae. Nest in soil | LC |

Comments: Species conservation (IUCN Red List Categories): LC – Least concern

Prимітки: Охорона видів (категорії Червоного списку МСОП): LC – “Найменший ризик”

Colletidae is the poorest family in the number of species in our collection. All three species are native for the territory of Europe, solitary and nesting in soil. These species are listed in the category “Least concern” of the IUCN Red List. One species is polyleptic and two other species are oligolectic.

In our collection, the Halictidae family is presented by 22 species from 5 genera – *Halictus* Latreille, 1804, *Lasioglossum* Curtis, 1833, *Rophites* Spinola, 1808, *Sphecodes* Latreille, 1804 and *Systropha* Illiger, 1806 (Table 2).
Table 2. Bees of the Halictidae family occurring on the territory of the city of Lviv
Таблиця 2. Бджолині родини Halictidae, поширені на території міста Львова

| No | Species | Species biology | Conservation |
|----|---------|----------------|--------------|
| 1  | Halictus rubicundus (Christ,1791) | Primitively eusocial. Flight from April to October. Polylectic. Nest in soil | LC |
| 2  | H. subauratus Rossius, 1792 | Primitively eusocial. Flight from May to October. Oligolectic on Asteraceae. Nest in soil | LC |
| 3  | H. tumulorum (Linnaeus,1758) | Primitively eusocial. Flight from April to October. Polylectic. Nest in soil | LC |
| 4  | Lasioglossum albipes (Fabricius,1781) | Primitively eusocial. Flight from April to October. Polylectic, with preference to Ranunculus L. (Ranunculaceae). Nest in soil | LC |
| 5  | L. fulvicorne (Kirby, 1802) | Solitary. Univoltine (April–October). Polylectic. Nest in soil | LC |
| 6  | L. laevigatum (Kirby, 1802) | Solitary. Univoltine (April–September). Polylectic. Nesting unknown | NT |
| 7  | L. laticeps (Schenck, 1870) | Primitively eusocial. Flight from April to September. Polylectic. Nest in soil | LC |
| 8  | L. lativentre (Schenck, 1853) | Solitary. Probably univoltine (March–October). Polylectic. Nesting unknown | LC |
| 9  | L. leucozonium (Schrank,1871) | Solitary. Univoltine (April–October). Polylectic, with preference to Asteraceae. Nest in soil | LC |
| 10 | L. majus (Nylander, 1852) | Solitary. Univoltine (April–October). Polylectic. Nest in soil | NT |
| 11 | L. morio (Fabricius, 1793) | Primitively eusocial. Flight from April to September. Polylectic. Nest in soil | LC |
| 12 | L. nigripes (Lepeletier, 1841) | Primitively eusocial. Flight from April to October. Polylectic. Nest in soil | LC |
| 13 | L. pauxillum (Schenck,1853) | Primitively eusocial. Flight from April to October. Polylectic. Nest in soil | LC |
| 14 | L. politum (Schenck, 1853) | Primitively eusocial. Flight from April to September. Polylectic. Nesting unknown | NT |
| 15 | L. sabulosum (Warncke, 1886) | Primitively eusocial. Flight from April to October. Polylectic. Nesting unknown | LC |
| 16 | L. sexnotatum (Kirby, 1802) | Solitary. Univoltine (April–October). Polylectic. Nesting unknown | NT |
| 17 | L. villosulum (Kirby, 1802) | Solitary. Bivoltine (April–October). Polylectic, with preference to Asteraceae. Nest in soil | LC |
| 18 | L. xanthopus (Kirby,1802) | Solitary. Univoltine (May–August). Polylectic. Nest in soil | NT |
| 19 | L. zonulum (Smith, F.,1848) | Solitary. Univoltine (May–October). Polylectic. Nest in soil | LC |
| 20 | Rophites quinquespinosus Spinola 1808 | Solitary. Univoltine (May–October). Oligolectic on Lamiaeaceae. Nest in soil | NT |
| 21 | Sphecodes gibbus (Linnaeus,1758) | Kleptoparasite. Flight from April to September. It does not collect pollen. Parasite in nests of Halictus spp. and Lasioglossum spp. | LC |
| 22 | Systropha curvicornis (Scopoli, 1770) | Solitary. Univoltine (June–August). Oligolectic on Convolvulus L. (Convolvulaceae). Nest in soil | NT |

Comments: Species conservation (IUCN Red List Categories): LC – Least concern, NT – Near Threatened

Примітки: Охорона видів (категорії Червоного списку МСОП): LC – "Найменший ризик", NT – "Близький до загрозливого стану"
All collected Halictidae species are native for the territory of Europe. These species are listed in two categories of the IUCN Red List: “Least concern” (15 species) and “Near Threatened” (7 species).

Among the collected Halictidae, 11 species are solitary, 10 are primitively eusocial and 1 species is a kleptoparasite. 17 species nest in soil, and for 4 species, the mode of nesting is unknown. Polylectic species predominate in our collection of Halictidae (18 species or ≈ 82 % of all collected Halictidae), the number of oligolectic species is significantly lower (3 species or ≈ 14 %) and one species (≈ 4 %) does not need to collect pollen, because of its kleptoparasitism.

In our collection, the Megachilidae family is presented by 11 species from 4 genera – *Anthidium* Fabricius, 1805, *Chelostoma* Latreille, 1809, *Megachile* Latreille, 1802, *Osmia* Panzer, 1806 (Table 3).

**Table 3. Bees of the Megachilidae family occurring on the territory of the city of Lviv**

| No | Species | Species biology | Conservation |
|----|---------|-----------------|--------------|
| 1. | *Anthidium manicatum* (Linnaeus, 1758) | Solitary. Univoltine (May–August). Polylectic. Nest in cavities in different substrates | LC |
| 2. | *A. oblongatum* (Illiger, 1806) | Solitary. Univoltine (May–August). Polylectic. Nest in cavities in different substrates | LC |
| 3. | *Chelostoma campanularum* (Kirby, 1802) | Solitary. Univoltine (June–August). Oligolectic on *Campanula* L. (Campanulaceae). Nest in cavities in the wood | LC |
| 4. | *C. florisomne* (Linnaeus, 1758) | Solitary. Univoltine (May–July). Oligolectic on Ranunculaceae. Nest in cavities in the wood | LC |
| 5. | *Megachile centuncularis* (Linnaeus, 1758) | Solitary. Univoltine (June–August). Polylectic. Nest in cavities in different substrates | LC |
| 6. | *M. circumcincta* (Kirby, 1802) | Solitary. Univoltine (May–August). Polylectic. Nest in cavities in different substrates | LC |
| 7. | *M. ericetorum* Lepeletier, 1841 | Solitary. Univoltine (June–August). Oligolectic on Fabaceae. Nest in cavities in the wood | LC |
| 8. | *M. willughbiella* (Kirby, 1802) | Solitary. Univoltine (June–August). Polylectic. Nest in cavities in the wood or soil | LC |
| 9. | *Osmia bicornis* (Linnaeus, 1758) | Solitary. Univoltine (April–June). Polylectic. Nest in cavities in different substrates | LC |
| 10. | *O. cornuta* Latreille, 1805 | Solitary. Univoltine (March–June). Polylectic. Nest in cavities in different substrates | LC |
| 11. | *O. leaiana* (Kirby, 1802) | Solitary. Univoltine (May–August). Oligolectic on Asteraceae. Nest in cavities in different substrates | LC |

**Comments:** Species conservation (IUCN Red List Categories): LC – Least concern

**Примітки:** Охорона видів (категорії Червоного списку МСОП): LC – “Найменший ризик”
All collected Megachilidae species are native for the territory of Europe, solitary cavity-nesters and listed in the category “Least concern” of the IUCN Red List. Seven species (≈ 64 % of all collected Megachilidae) are polylectic and four species (≈ 36 %) are oligolectic.

In our collection, the Melittidae family is presented by 5 species from 3 genera – *Dasypoda* Latreille, 1802, *Macropis* Panzer, 1809, *Melitta* Kirby, 1802 (*Table 4*).

*Table 4. Bees of the Melittidae family occurring on the territory of the city of Lviv*

| No | Species                  | Species biology                        | Conservation |
|----|--------------------------|----------------------------------------|--------------|
| 1  | *Dasypoda hirtipes*      | Solitary. Univoltine (June–August). Oligolectic on Asteraceae. Nest in soil | LC           |
| 2  | *Macropis europaea*      | Solitary. Univoltine (July–September). Oligolectic on *Lysimachia* L. (Primulaceae). Nest in soil | LC           |
| 3  | *M. fulvipes*            | Solitary. Univoltine (July–September). Oligolectic on *Lysimachia* L. (Primulaceae). Nest in soil | LC           |
| 4  | *Melitta leporina*       | Solitary. Univoltine (June–August). Oligolectic on Fabaceae. Nest in soil | LC           |
| 5  | *M. tricincta*           | Solitary. Univoltine (July–September). Monolectic on *Odontites vernus* Dumort., 1827 (Orobanchaceae). Nest in soil | NT           |

**Comments:** Species conservation (IUCN Red List Categories): LC – “Least concern”, NT – “Near Threatened”

All collected Melittidae species are native for the territory of Europe, solitary and nesting in soil. Four of them are listed in the category “Least Concern” and one – in the category “Near Threatened” of the IUCN Red List. Melittidae species are pollen specialists and forage on the plants from one family, genus or even species.

The summarized data for all six families of bees show a predominance of polylectic species (≈ 61 %), while the number of oligolectic species (≈ 23 %), or species that do not need to collect pollen (≈ 16 %) is much smaller. The Shannon’s diversity index is ≈ 3.718 and the Shannon evenness measure is ≈ 0.799 (the honeybee *Apis mellifera* was excluded in both calculations).

**CONCLUSIONS**

The current composition of the bees’ fauna within the city of Lviv includes 106 species, which belong to 25 genera and 6 families (Apidae, Andrenidae, Colletidae, Halictidae, Megachilidae and Melittidae).

The family Apidae is presented by 33 species and is the richest by the number of species among all the six families. The family Andrenidae is presented by 32 species, Halictidae – 22 species, Megachilidae – 11 species and Melittidae – 5 species. The family Colletidae is presented by 3 species only and is the poorest family in the number of species in our collection.

All species discussed above are native for the territory of Europe. The majority of them are polylectic (≈ 61 %), while the number of oligolectic species (≈ 23 %), or species that do not need to collect pollen (≈ 16 %) is much smaller.
The Shannon’s diversity index is \( \approx 3.718 \) and the Shannon evenness measure is \( \approx 0.799 \) (the honeybee Apis mellifera was excluded in both calculations). This index indicates a high species diversity that can be associated with the variety of habitats and food sources.

Analysis of the impact of urbanization and various environmental factors on the species diversity of bees requires further detailed studies. This research can lay the basement for further studies in this field.

**ACKNOWLEDGMENTS**

We express the deepest thanks to Mykola Skyrpan, Kateryna Nazaruk and Oleksiy Malovanyi for the help with the sampling of the materials.

**COMPLIANCE WITH ETHICAL STANDARDS**

**Conflict of Interest**: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

**Human Rights**: This article does not contain any studies with human subjects performed by any of the authors.

**Animal studies**: All institutional, national and institutional guidelines for the care and use of laboratory animals were followed.

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СПИСОК ВІДІВ БДЖОЛИНИХ (HYMENOPTERA, APOIDEA) НА ТЕРИТОРІЇ ЛЬВОВА (УКРАЇНА). ЧАСТИНА ІІ: РОДИНИ COLLETFIDAE LEPELETIER, 1841; HALICTIDAE THOMSON, 1869; MEGACHILIDAE LATREILLE, 1802 ТА MELITTIDAE MICHENER, 2000

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Вступ. У статті представлено результати досліджень бджолиних (Hymenoptera, Apoidea), які трапляються на території м. Львова. Бджолині є одними з найважливіших запилювачів багатьох покритонасінних рослин. Дослідження видового різноманіття бджолиних дуже важливи не тільки на природних територіях, але і на урбанізованих. Міста мають значний вплив на видове різноманіття бджолиних, їхню біологію та збереження. Дослідження сукупності всіх бджолиних на території м. Львова проводяться вперше за більш ніж 80 років, і ми сподіваємося, що ці матеріали стануть основою для подальших детальніших досліджень у цьому напрямі.

Матеріали та методи. Львів є найбільшим містом у західній Україні й розташований на краю горбистого пасма Розточчя. Матеріал збирали упродовж теплого періоду 2017–2019 років. Для лову комах ми використовували ентомологічні сачки та пастки Меріке. Також збирали комах, збитих транспортом на дорозі. Крім цього, аналізували ентомологічні колекції Зоологічного музею Львівського національного університету імені Івана Франка. Для визначення комах використовували стереомікроскоп і спеціальні визначники. Для оцінювання видового різноманіття використали індекс Шеннона. Також для полегшення інтерпретації результату обчислили вирівняність індексу Шеннона.

Результати. Упродовж досліджень ми проаналізували 960 екземплярів бджолиних (Hymenoptera, Apoidea), які трапляються на території м. Львова. Бджолині є одними з найважливіших запилювачів багатьох покритонасінних рослин. Дослідження видового різноманіття бджолиних дуже важливи не тільки на природних територіях, але і на урбанізованих. Міста мають значний вплив на видове різноманіття бджолиних, їхню біологію та збереження. Дослідження сукупності всіх бджолиних на території м. Львова проводяться вперше за більш ніж 80 років, і ми сподіваємося, що ці матеріали стануть основою для подальших детальніших досліджень у цьому напрямі.

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Результати. Упродовж досліджень ми проаналізували 960 екземплярів бджолиних, котрі належать до 106 видів, 25 родів і 6 родин. У цій статті представлено аналіз таксономічного різноманіття бджолиних родини Colletidae (3 види), Halictidae (22 види), Megachilidae (11 видів) і Melittidae (5 видів). Різноманіття бджолиних із родин Andrenidae і Apidae було представлене у першій частині цього циклу публікації [27].
Висновки. Усі види бджолиних із шести родин є аборигенними для території Європи. Більшість із них є полілектами (≈ 61 %), а кількість оліголектичних видів (≈ 23 %) і видів, котрі не збирають пилок (≈ 16 %), є значно меншою. Індекс видового різноманіття Шеннона становить ≈ 3,718, а індекс вирівняності Шеннона – ≈ 0,799 (в обох розрахунках медоносна бджола *Apis mellifera* не була взята до уваги). Аналіз впливу урбанізації та різних чинників середовища на видове різноманіття бджолиних потребує подальших детальних досліджень.

**Ключові слова:** бджолині, видове різноманіття, Львів, Україна