Background. The article presents the results of the research on bees (Hymenoptera, Apoidea) that occur in the city of Lviv. Bees are effective and important pollinators of many wild and agricultural angiosperm plants. However, bees are very sensitive to the environmental changes, especially to changes caused by humans. Urbanization often degrades nesting habitats for bees, decreases the abundance of oligolectic species, etc. Many different factors may have various effects on different species of bees. Thus, such investigations are very important and topical. A comprehensive study of all Apoidea the 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 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 warm period of 2017–2019. The Moericke (yellow) pan traps and the entomological nets were used. Also we collected dead bees (killed by traffic) along the roads. Besides, we analyzed the entomological collection of the Zoological Museum of the Ivan Franko National University [ZMD] (Lviv). The stereoscopic microscope and different specialized keys for bee species identification were used.

Results. We analyzed 960 specimens of bees which belong to 106 species, 25 genera and 6 families (Apidae, Andrenidae, Colletidae, Halictidae, Megachilidae and Melittidae). In the first part of present study, we review two families: Andrenidae and Apidae. In our collection, the family Andrenidae is presented by 32 species and family Apidae by 33 species.

Conclusions. All of these species are native for the territory of Europe. The majority of them are polylectic (80 % of all collected Apidae and Andrenidae excluding kleptopara-
sistic species; 60 % in total) and nest in soil (96 % and 72 % respectively). Most part of analyzed species is listed within two categories of the IUCN Red List: “Least Concern” – 43 species (66 % of all collected Apidae and Andrenidae); “Data Deficient” – 20 species (31 % respective). Only two species (3 %) are listed as “Near Threatened” (Andrena hattorfiana (Fabricius, 1781) and A. ovatula (Kirby, 1802)). Xylocopa valga Gerstäcker, 1872 has a conservation status of “Rare” in the Red Data Book of Ukraine.

Keywords: bees, species diversity, Andrenidae, Apidae, Lviv, Ukraine

INTRODUCTION

Bees are one of the most important pollinators of many species of wild angiosperm plants. 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 in the cities.

Research of wild bees in urban context started relatively recently [1]. Over the past two decades, numerous contributions on the implications of urbanization for biodiversity conservation have been published [10]. Most of the investigations show negative impacts of urbanization on wild bees. For example, the effects of pesticides, emerging pathogens from managed bees, climate change and land-use change are negatively correlated with bee species richness [2, 3, 6, 7, 9]. 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 [2]. Each of these factors may have different effects on different species of bees [3]. Despite a large number of investigations, many urbanization factors that influence biodiversity and pollination remain unstudied [14]. So, such research is very important and topical today.

History of Apoidea research on the territory of Lviv Region. Detailed entomological studies of the superfamily Apoidea on the territory of modern Western Ukraine began approximately 150 years ago for the first time. Maximilian Nowicki [23] and Antoni Wierzejski [24, 25] laid the foundation for these studies. Their work was continued by Jan Śnieżek who worked on bumblebees and bees generally [26]. But the most fundamental contribution to the development of apiology in the Eastern Poland and Galicia was made by Jan Noskiewicz at the beginning of 20th century. In his papers, the detailed faunistic composition of bees on the territory of Galicia, especially in Ukrainian Roztochia and Lviv with its outskirts (Ivano-Frankove, Yavoriv, Vynnyky, etc.) and the description of the insects’s morphology and physiology were given [18 – 22]. Significant research on the territory of Western Ukraine was also conducted by Hanna Osychnyuk [27–29]. However, she relied on Noskiewicz’s data regarding the bees of the city of Lviv and its outskirts.

Among the recent investigations of Apoidea (genus Bombus Latreille, 1802) on the territory of Lviv (and Western Ukraine in general), contributions published by Iryna Konovalova should be noted [8, 11].

The current research of all Apoidea on the territory of Lviv is conducted for the first time.
MATERIALS AND METHODS

Lviv is the largest city in Western Ukraine and the seventh-largest city in the country overall with total area of 182.01 km$^2$. It is located on the edge of the Roztochia Upland. Lviv urban landscape is complemented and enriched with numerous parks and public gardens. There are over twenty parks and three botanical gardens.

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 the attraction traps (insects are attracted by colour) [16]. We used pans of 18 cm in diameter and 7 cm in depth. 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.

We used stereoscopic microscope MBS-2 and different specialized keys for bee species identification [4, 5, 12, 13, 30, 31, 33]. The higher level classification of bees follows Ch. D. Michener [15]. Information about IUCN Red List Categories was obtained from the “European Red List of bees” [17]. Information about species biology was taken from the relevant literature [4, 5, 12, 13, 30, 33].

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. In this first part of our study, we review two families: Andrenidae (348 examined specimens) and Apidae (411 examined specimens).

The family Andrenidae in our collection is presented by 32 species from two genera – *Andrena* Fabricius, 1775 and *Panurgus* Panzer 1806 (Table 1).

| No | Species | Species biology | Conservation |
|----|---------|-----------------|-------------|
| 1. | Andrena bicolor Fabricius, 1775 | Solitary. Bivoltine (March–June; June–August). Polylectic. Nest in soil | LC |
| 2. | A. bimaculata (Kirby, 1802) | Solitary. Bivoltine (March–May; July–August). Polylectic. Nest in soil | DD |
| 3. | A. chrysosceles (Kirby, 1802) | Solitary. Univoltine (April–June). Polylectic. Nest in soil | DD |
| 4. | A. cineraria (Linnaeus, 1758) | Solitary. Univoltine (April–July). Polylectic. Nest in soil | LC |
| 5. | A. denticulata (Kirby, 1802) | Solitary. Univoltine (July–September). Polylectic, with preference to Asteraceae. Nest in soil | DD |
| 6. | A. dorsata (Kirby, 1802) | Solitary. Bivoltine (March–May; July–August). Polylecic. Nest in soil | DD |
| 7. | A. flavipes Panzer, 1799 | Solitary. Bivoltine (March–June; July–September). Polylectic. Nest in soil | LC |
| No | Species | Species biology | Conservation |
|----|---------|-----------------|-------------|
| 8. | *A. florea* (Fabricius, 1793) | Solitary. Univoltine (May–July). Oligoelectic on *Bryonia* L. (Cucurbitaceae). Nest in soil | DD |
| 9. | *A. floricola* (Fabricius, 1781) | Solitary. Bivoltine (April–May; July–August). Polylectic, with preference to Brassicaceae and Apiaceae. Nest in soil | DD |
| 10. | *A. fucata* (Smith, 1847) | Solitary. Univoltine (May–July). Polylectic. Nest in soil | DD |
| 11. | *A. gravida* (Imhoff, 1832) | Solitary. Univoltine (April–May). Polylectic. Nest in soil | DD |
| 12. | *A. haemorrhhoa* (Fabricius, 1775) | Solitary. Univoltine (March–June). Polylectic. Nest in soil | LC |
| 13. | *A. hattorfiana* (Fabricius, 1852) | Solitary. Univoltine (June–August). Oligoelectic on *Knautia* L. (Caprifoliaceae). Nest in soil | NT |
| 14. | *A. humilis* (Imhoff, 1832) | Solitary. Univoltine (May–July). Oligoelectic on Asteraceae. Nest in soil | DD |
| 15. | *A. labialis* (Kirby, 1802) | Solitary. Univoltine (May–July). Polylectic, with preference to Fabaceae. Nest in soil | DD |
| 16. | *A. lapponica* (Zetterstedt, 1838) | Solitary. Univoltine (April–June). Polylectic. Nest in soil | LC |
| 17. | *A. lauteryi* (Alfken, 1899) | Solitary. Univoltine (April–June). Oligoelectic on Fabaceae (mainly *Lathyrus* L.). Nest in soil | DD |
| 18. | *A. lepida* (Schenck, 1861) | Solitary. Univoltine (March–May; July–August). Polylectic. Nest in soil | DD |
| 19. | *A. limata* (Smith, 1853) | Solitary. Univoltine (April–September). Polylectic. Nest in soil | DD |
| 20. | *A. minutula* (Kirby, 1802) | Solitary. Univoltine (May–June; June–September). Polylectic. Nest in soil | DD |
| 21. | *A. nitida* (Müller, 1776) | Solitary. Univoltine (April–June). Polylectic. Nest in soil | LC |
| 22. | *A. ovata* (Kirby, 1802) | Solitary. Univoltine (March–June; June–September). Polylectic, with preference to Fabaceae. Nest in soil | NT |
| 23. | *A. paucisquama* (Noskiewicz, 1924) | Solitary. Univoltine (May–June). Oligoelectic on *Campanula* L. (Campanulaceae). Nest in soil | DD |
| 24. | *A. pilipes* (Fabricius, 1781) | Solitary. Univoltine (April–May; July–August). Polylectic. Nest in soil | LC |
| 25. | *A. praecox* (Scopoli, 1763) | Solitary. Univoltine (March–May). Polylectic. Nest in soil | LC |
| 26. | *A. proxima* (Kirby, 1802) | Solitary. Univoltine (May–June). Oligoelectic on Apiaceae. Nest in soil | DD |
| 27. | *A. rosae* (Panzer, 1801) | Solitary. Univoltine (April–May; July–August). Polylectic. Nest in soil | DD |
| 28. | *A. schencki* (Morawitz, 1866) | Solitary. Univoltine (May–July). Polylectic. Nest in soil | DD |
| 29. | *A. subopaca* (Nylander, 1848) | Solitary. Univoltine (May–July). Polylectic. Nest in soil | LC |
30. *A. tibialis* (Kirby, 1802)  
Solitary. Univoltine (April–July). Polylectic. Nest in soil  
LC

31. *A. ventralis* Imhoff, 1832  
Solitary. Univoltine (March–May). Polylectic. Nest in soil  
DD

32. *Panurgus calcaratus* (Scopoli, 1763)  
Solitary. Univoltine (June–September). Oligolectic on yellow-flowered Asteraceae. Nest in soil  
LC

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

Примітки: Охорона видів (категорії Червоного списку МСОП): LC – “Найменший ризик”, DD – “Відомостей недостатньо”, NT – “Близький до загрозливого стану”

The majority of the collected Andrenidae are listed in two categories of the IUCN Red List: “Data Deficient” – 19 species and “Least Concern” – 11 species. Only two species are listed as “Near Threatened” – *Andrena hattorfiana* and *A. ovatula*. Specimens of both species were collected dead along the roads (were damaged by traffic).

All collected Andrenidae are native for the territory of Europe, solitary and nesting in soil. 25 species (78 % of all collected Andrenidae) are polylectic and 7 species (22 %) are oligolectic.

The family Apidae in our collection is presented by 33 species from 10 genera – *Anthophora* Latreille, 1803, *Apis* Linnaeus, 1758, *Bombus* Latreille, 1802, *Epeoloides* Giraud, 1863, *Epeolus* Latreille, 1802, *Eucera* Scopoli, 1770, *Melecta* Latreille, 1802, *Nomada* Scopoli, 1770, *Tetraloniella* Ashmead, 1899, *Xylocopa* Latreille, 1802 (Table 2).

### Table 2. Bees of the family Apidae occurring on the territory of Lviv City

| No | Species | Species biology | Conservation |
|----|---------|-----------------|--------------|
| 1  | *Anthophora aestivalis* (Panzer, 1801) | Solitary. Univoltine (March–August). Polylectic. Nest in soil | LC |
| 2  | *A. furcata* (Panzer, 1798) | Solitary. Univoltine (May–August). Oligolectic on Lamiaceae. Nest in soil or in rotten wood and plant stems | LC |
| 3  | *A. plumipes* (Pallas, 1772) | Solitary. Univoltine (March–May). Polylectic. Nest in soil | LC |
| 4  | *Apis mellifera* Linnaeus, 1758 | Eusocial. Have perennial colonies with flight period from March to October. Polylectic. Nest in artificial hives or in the tree cavities | DD |
| 5  | *Bombus barbutellus* (Kirby, 1802) | Kleptoparasite. Flight from April to September. It does not collect pollen. Parasite in nests of *B. hortorum* (Linnaeus, 1761) | LC |
| 6  | *B. bohemicus* (Seidl, 1837) | Kleptoparasite. Flight from April to August. It does not collect pollen. Parasite in nests of *B. lucorum* Linnaeus, 1761 | LC |
| 7  | *B. campestris* (Panzer, 1801) | Kleptoparasite. Flight from April to September. It does not collect pollen. Parasite in nests of *B. humilis* Illiger, 1806, *B. muscorum* (Linnaeus, 1758), *B. pascuorum* (Scopoli, 1763), *B. ruderarius* (Fabricius, 1793) and *B. sylvarum* (Linnaeus, 1761) | LC |
| No | Species                         | Species biology                                                                 | Conservation |
|----|---------------------------------|---------------------------------------------------------------------------------|--------------|
| 8  | *B. hortorum* (Linnaeus, 1761)  | Eusocial. Flight from March to October. Polylectic. Nest in soil cavities or on its surface | LC           |
| 9  | *B. hypnorum* (Linnaeus, 1758)  | Eusocial. Flight from March to September. Polylectic. Nest in soil cavities or on its surface | LC           |
| 10 | *B. lapidarius* (Linnaeus, 1758) | Eusocial. Flight from March to October. Polylectic. Nest in soil cavities       | LC           |
| 11 | *B. lucorum* (Linnaeus, 1761)   | Eusocial. Flight from March to September. Polylectic. Nest in soil cavities or on its surface | LC           |
| 12 | *B. pascorum* (Scopoli, 1763)   | Eusocial. Flight from March to October. Polylectic. Nest in soil cavities or on its surface | LC           |
| 13 | *B. pratorum* (Linnaeus, 1761)  | Eusocial. Flight from March to July. Polylectic. Nest in soil cavities or on its surface | LC           |
| 14 | *B. ruderarius* (Müller, 1776)  | Eusocial. Flight from April to September. Polylectic. Nest in soil cavities or on its surface | LC           |
| 15 | *B. rupestris* (Fabricius, 1793) | Kleptoparasite. Flight from May to August. It does not collect pollen. Parasite in nests of *B. lapidarius* (Linnaeus, 1758) | LC           |
| 16 | *B. sylvarum* (Linnaeus, 1761)  | Eusocial. Flight from May to September. Polylectic. Nest in soil cavities or on its surface | LC           |
| 17 | *B. sylvestris* Lepeletier, 1832 | Kleptoparasite. Flight from April to September. It does not collect pollen. Parasite in nests of *B. pratorum* (Linnaeus, 1761) | LC           |
| 18 | *B. terrestris* (Linnaeus, 1758) | Eusocial. Flight from March to October. Polylectic. Nest in soil cavities       | LC           |
| 19 | *B. vestalis* (Geoffroy, 1785)  | Kleptoparasite. Flight from April to August. It does not collect pollen. Parasite in nests of *B. terrestris* (Linnaeus, 1758) | LC           |
| 20 | *Epeoloides coecutiens* (Fabricius, 1775) | Kleptoparasite. Flight from June to August. It does not collect pollen. Parasite in nests of *Macropis europaea* Warncke, 1973, *M. fulvipes* (Fabricius 1805) | LC           |
| 21 | *Epeolus variegatus* (Linnaeus, 1758) | Kleptoparasite. Flight from June to August. It does not collect pollen. Parasite in nests of *Colletes daviesanus* Smith, 1846, *C. fodiens* (Geoffroy,1785), *C. halophilus* Verhoeff, 1943, *C. succinctus* (Linnaeus,1758) | LC           |
| 22 | *Eucera longicornis* (Linnaeus, 1758) | Solitary. Univoltine (May–July). Oligolecic on Fabaceae. Nest in soil           | LC           |
| 23 | *E. nigrescens* Pérez, 1879     | Solitary. Univoltine (June–July). Oligolecic on Fabaceae. Nest in soil         | LC           |
| 24 | *Melecta albifrons* (Forster, 1771) | Kleptoparasite. Flight from April to June. It does not collect pollen. Parasite in nests of *Anthophora plumipes* (Pallas, 1772), *A. fulvitarsis* Brullé, 1832 and *A. paretina* Fabricius 1793 | LC           |
| 25 | *Nomada alboguttata* Herrich-Schäffer, 1839 | Kleptoparasite. Bivoltine (April–June; July–September). It does not collect pollen. Parasite in nests of *Andrena barbilabris* (Kirby, 1802), *A. ventralis* Imhoff, 1832, *A. argenata* Smith, 1844 | LC           |
| 26 | *N. bifasciata* Olivier, 1811   | Kleptoparasite. Flight from March to June. It does not collect pollen. Parasite in nests of *Andrena gravida* Imhoff, 1832 | LC           |
| 27 | *N. flavoguttata* (Kirby, 1802)  | Kleptoparasite. Flight from March to September. It does not collect pollen. Parasite in nests of *Andrena* spp. | LC           |
| No | Species | Species biology | Conservation |
|----|---------|----------------|--------------|
| 28 | *N. fucata* Panzer, 1798 | Kleptoparasite. Bivoltine (April–June; July–August). It does not collect pollen. Parasite in nests of *Andrena flavipes* Panzer, 1799 | LC |
| 29 | *N. moeschleri* Alfken, 1913 | Kleptoparasite. Flight from April to June. It does not collect pollen. Parasite in nests of *Andrena haemorrhoea* (Fabricius, 1781), *A. helvola* (Linnaeus, 1758), *A. fucata* Smith, 1847 | LC |
| 30 | *N. ruficornis* (Linnaeus, 1758) | Kleptoparasite. Flight from March to July. It does not collect pollen. Parasite in nests of *Andrena haemorrhoea* (Fabricius, 1781) | LC |
| 31 | *N. sexfasciata* Panzer, 1799 | Kleptoparasite. Flight from May to July. It does not collect pollen. Parasite in nests of *Eucera* spp. | LC |
| 32 | *Tetraloniella dentata* (Germar, 1839) | Solitary. Univoltine (May–August). Polylectic. Nest in soil | LC |
| 33 | *Xylocopa valga* Gerstäcker, 1872 | Subsocial. Univoltine (April–September). Polylectic. Nest in the wood | LC Rare* |

**Comments:** Species conservation (IUCN Red List Categories): LC – Least concern, DD – Data deficient; Rare* – conservation status follows to the Red Data Book of Ukraine

Most of the Apidae are listed in the IUCN Red List in the category “Least Concern” (32 species) and only one species (*Apis mellifera*) is listed as “Data Deficient”. *Xylocopa valga* has a conservation status “Rare” in the Red Data Book of Ukraine [32].

Among the collected Apidae, five species are solitary and nesting in soil, one is solitary and nesting in soil or in rotten wood (or plant stems), one is subsocial and nesting in wood, 10 are eusocial and nesting in soil cavities or on its surface (except for *A. mellifera*, which nests in artificial hives or in tree cavities), 16 are kleptoparasitic species. Finally, 14 species (42 % of all collected Apidae) are polylectic, 3 species (9 %) are oligolectic and 16 species (49 %) do not need to collect pollen due to their kleptoparasitism.

**CONCLUSIONS**

The current composition of the bees’ fauna of Andrenidae and Apidae within the city of Lviv includes 65 species. These two families are the richest by the number of species among all the six families that occur on the territory of Lviv. The family Andrenidae is presented by 32 species from 2 genera and the family Apidae is presented by 33 species from 10 genera.

All species discussed above are native for the territory of Europe. The majority of them are polylectic (80 % of all collected Apidae and Andrenidae excluding kleptoparasitic species; 60 % in total, including kleptoparasitic species), and nesting in soil (96 % of all collected Apidae and Andrenidae excluding kleptoparasitic species; 72 % in total). The predominance of polylectic species which can forage on a variety of plant species was predictable since this group of bees is easier to adapt to the changes of environmental conditions.

The majority of the studied species are listed in two categories in the IUCN Red List: “Least Concern” – 43 species (66 % of all collected Apidae and Andrenidae in total); “Data Deficient” – 20 species (31 %). Only two species (3 %) are listed as “Near Threa-
tended” (*Andrena hattorfiana* and *A. ovatula*). In addition, one species (*Xylocopa valga*) has a conservation status “Rare” in the Red Data Book of Ukraine. This research can lay the foundation for further studies in this area.

**ACKNOWLEDGMENTS**

We express the deepest thanks to Mykola Skyrpan, Kateryna Nazaruk and Oleksiy Malovanyi for the help with the sampling of 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 the 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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Вступ. У статті представлено результати досліджень бджолиних (Hymenoptera, Apoidea), які трапляються на території м. Львова. Бджолині є ефективними та важливими запилювачами багатьох диких та сільськогосподарських покритонасінних рослин. Однак ці комахи дуже чутливі до середовища існування, особливо антропогенно зміненого. Урбанізація часто погіршує середовище для гніздування бджолиних, зменшує кількість видів-оліголектів тощо. Багато чинників можуть по-різному впливати на різні види бджолиних, тож їхнє дослідження є на сьогодні дуже актуальним. Дослідження усіх бджолиних загалом на території м. Львова проводиться вперше за більш ніж 80 років, і ми сподіваємося, що ці матеріали стануть основою для подальших більш детальних досліджень у цій сфері.

Матеріали та Методи. Львів є найбільшим містом у західній Україні й розташований на краю горбистого пасма Розточчя. Матеріал збирали впродовж 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 стереоскопічний мікроскоп і спеціальні визначники.

Результати. Протягом досліджень ми проаналізували 960 зразків бджолиних, котрі належать до 106 видів, 25 родів і 6 родин (Apidae, Andrenidae, Colletidae, Halictidae, Megachilidae та Megittidae). У цій статті представлено дві родини: Andrenidae та Apidae. Родина Andrenidae у наших зборах представлена 32 видами, а родина Apidae – 33.

Висновки. Усі досліджени види є аборигенними для території Європи. Більшість із них є полілектами (80 % від видів обох родин з виключенням клептопарацитів; 60 % від загальної кількості видів із двох родин) та гніздяться у ґрунті (96 % та 72 % відповідно). Більшість проаналізованих видів у Червоному списку МСОП фігурують у двох категоріях: "Найменший ризик" – 43 види (66 % від суми видів обох родин); "Відомостей недостатньо" – 20 видів (31 %). Тільки два види (3 %) належать до категорії "Близький до загрозливого стану" (Andrena hattorfiana та A. ovata). Також один вид (Xylocopa valga) занесений до Червоної книги України у статусі "Рідкісний".

Ключові слова: бджолині, видове різноманіття, Andrenidae, Apidae, Львів, Україна