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REPRESENTATIVES OF THE SUPERFAMILIES VESPOIDEA, APOIDEA (SPHECIFORMES) AND CHRYSIDOIDEA IN THE COLLECTION OF THE ZOOLOGICAL MUSEUM OF IVAN FRANKO NATIONAL UNIVERSITY OF LVIV

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Background. This paper presents analysis of a collection of wasps (Vespoidea, Apoidea (Spheciformes) and Chrysidoidea) housed in the Zoological Museum of Ivan Franko National University of Lviv. The collection includes 779 specimens of wasps which belong to 70 species and 32 genera. The collection is represented by specimens collected from 1966 and 1972 to the present. Most of the specimens were collected in Ukraine, eight specimens were collected in the United States of America (2012), Germany (2005), Latvia (2005), Lithuania (2005), Italy (2012) and Egypt (2005).

The aim of the study is to analyze the biodiversity and distribution of wasp species on the territory of Western Ukraine and some other regions of Ukraine and to prepare the preliminary list of the wasp species of this region, based on entomological collections.

Material and Methods. The object of our research was the collection of wasps (Vespoidea, Apoidea (Spheciformes) and Chrysidoidea). Wasps were collected by the museum and zoology department staff, students, amateur naturalists and mostly by the first author of this study. Insects were identified using binocular stereoscopic microscope Bresser Advance ICD 10x-160x and specialized keys.

Results. We analyzed 779 specimens of wasps which belong to 70 species, seven families (Vespidae, Pompilidae, Scoliidae, Tiphidae, Sphecidae, Crabronidae and Chrysididae) and 32 genera (*Ammophila*, *Ancistrocerus*, *Anoplius*, *Arachnospila*, *Bembecinus*, *Bembix*, *Cerceris*, *Chrysis*, *Chrysura*, *Dolichovespula*, *Ectemnius*, *Eumenes*, *Gorytes*, *Holopyga*, *Lestica*, *Lindenius*, *Mellinus*, *Nysson*, *Oxybelus*, *Palarus*, *Parnopes*, *Pemphredon*, *Philanthus*, *Priocnemis*, *Polistes*, *Psenulus*, *Trypoxylon*, *Sceliphron*, *Scolia*, *Tiphia*, *Vespa* and *Vespula*). The publication provides a list of species stored in the Zoological Museum and their analysis by region and years of collection.

Conclusions. The collection of the Zoological Museum of Ivan Franko National University of Lviv presents specimens of wasp species from 15 regions of Ukraine and six other countries. The largest number of specimens (716) was collected on the territory of Western Ukraine. Among all analyzed specimens, one species is invasive for the territory of Europe – *Sceliphron curvatum*. Such studies allow us to compile a preliminary list of wasp species on the territory of Western Ukraine for the first time.

Keywords: Hymenoptera, wasps, distribution, chorology, fauna diversity

INTRODUCTION

The Zoological Museum's (ZMD) Entomological Collections have a great scientific value, in addition to their aesthetic and educational value. Among them are Konstantin Stanislav Petrussky's, Adam Sulima Ulyanovsky's, Ernst-Friedrich Germar's (Shydlovskyy & Holovachov, 2005) and Otto Staudinger's collections. All entomological collections are the source and confirmation of information on the world's faunal diversity, the spread of common and rare animal species and the state of their conservation. Since the analysis of invertebrate collections in the ZMD is currently in its infancy, there is little knowledge about them. There is a large number of invertebrates in the museum, so their identification and inventory will facilitate further research on collected materials (Tymkiv *et al*., 2018).

Representatives of the superfamilies Vespoidea, Apoidea (Spheciformes) and Chrysidoidea are among the most important ecological groups of insects. They are an integral part of almost all ecosystems and food chains.

Wasps are an important functional link in the development of biocenosis and have great practical importance, especially as useful entomophagous and potential pollinators of many angiosperms. Given the important role of wasps in terrestrial ecosystems, they are an interesting group for research. However, on the territory of Western Ukraine wasps are poorly studied, so the analysis of the ZMD entomological collection and authors' private collections is very important for understanding the fauna of wasps. It can become the basis for further research and for the museum catalog.

Studies of wasps on the territory of Ukraine were conducted by O. Kumpanenko, H. Honchar, V. Gorobchyshyn (2021), Yu. Protsenko, V. Gorobchyshyn (2015), O. Kumpanenko (2018) and K. Martynova (2017).

The aim of this study is to analyze the biodiversity and distribution of wasp species on the territory of Western Ukraine and some other regions of Ukraine and to prepare the preliminary list of the wasp species of this region, based on entomological collections.

MATERIALS AND METHODS

The object of our study is a collection of wasps from the superfamilies of Vespoidea, Apoidea (Spheciformes) and Chrysidoidea housed in the ZMD. Wasps were collected by the museum and zoology department staff, students, amateur naturalists and mostly by the first author of this study. Insects were collected during the warm period of 2017–2021, using entomological nets and the Moericke (yellow) pan traps. The collected imagoes were pinned on the entomological pins and studied with binocular stereoscopic microscope Bresser Advance ICD 10x-160x (Bresser, Germany).

The nomenclature and systematics follow the revision of Catalog of Sphecidae (Pulawskyi, 2020). Identification of representatives of the superfamily Apoidea (Spheciformes) was generally based on the keys and descriptions in Medvedev (1978) and Schmid-Egger (2011), Vespoidea in Dvorak & Roberts (2006) and Schmid-Egger, Achterberg, Neumeyer, Morinière & Schmidt (2017) and superfamily Chrysidoidea on the keys Paukkunen, Berg, Soon, Ødegaard & Rosa (2015).

RESULTS AND DISCUSSION

The museum collection of wasps includes 779 specimens of 70 species which belong to 7 families (Vespidae, Pompilidae, Scoliidae, Tiphidae, Sphecidae, Crabronidae and Chrysididae) and 32 genera (*Ammophila* Kirby, 1798, *Ancistrocerus* Wesmael, 1836, *Anoplius* Dufour, 1834, *Arachnospila* Kincaid, 1900, *Bembecinus* Costa, 1859, *Bembix* Fabricius, 1775, *Cerceris* Latreille, 1802, *Chrysis* Linnaeus, 1761, *Chrysura* Dahlbom, 1845, *Dolichovespula* Rohwer, 1916, *Ectemnius* Dahlbom, 1845, *Eumenes* Latreille, 1802, *Gorytes* Latreille, 1805, *Holopyga* Dahlbom, 1854, *Lestica* Billberg, 1820, *Lindenius* Lepeletier and Brullé, 1835, *Mellinus* Fabricius, 1790, *Nysson* Latreille, 1802, *Oxybelus* Latreille, 1796, *Palarus* Latreille, 1802, *Parnopes* Latreille, 1796, *Pemphredon* Latreille, 1796, *Philanthus* Fabricius, 1790, *Priocnemis* Schiødte, 1837, *Polistes* Latreille, 1802, *Psenulus* Kohl, 1897, *Trypoxylon* Latreille 1796, *Sceliphron* Klug, 1801, *Scolia* Fabricius, 1775, *Tiphia* Fabricius, 1775, *Vespa* Linnaeus, 1758 and *Vespula* Thomson, 1869) (**Table 1**).

Table 1. **Species diversity of wasps in the collection of Zoological Museum of the Ivan Franko National University of Lviv**

Superfamily	Family	Genus	Species	Number of specimens
Vespoidea	Vespidae	*Ancistrocerus*	*Ancistrocerus parietinus* Linnaeus, 1761	1
			Ancistrocerus trifasciatus (Müller, 1776)	1
		Dolichovespula	*Dolichovespula adulterina* (Buysson, 1905)	1
			Dolichovespula media (Retzius, 1783)	2
			Dolichovespula norwegica (Fabricius, 1781)	4
			Dolichovespula saxonica (Fabricius, 1793)	24
			Dolichovespula sylvestris (Scopoli, 1763)	9
		Polistes	*Polistes dominula* (Christ, 1791)	182
			Polistes gallicus (Linnaeus, 1767)	13
			Polistes nimpha (Christ, 1791)	77
		Vespula	*Vespula germanica* (Fabricius, 1793)	124
			Vespula maculifrons (Buysson, 1905)	2
			Vespula rufa (Linnaeus, 1758)	7
			Vespula vulgaris (Linnaeus, 1758)	45
		Vespa	*Vespa crabro* Linnaeus, 1758	108
		Eumenes	*Eumenes coarctatus* (Linnaeus, 1758)	4
			Eumenes coronatus (Panzer, 1799)	2
			Eumenes pedunculatus (Panzer, 1799)	1
	Scoliidae	*Scolia*	*Scolia hirta* (Schrank, 1781)	5
			Scolia quadripunctata Fabricius, 1775	8
	Tiphiidae	*Tiphia*	*Tiphia ruficornis* Klug, 1810	1
			Tiphia femorata Fabricius,1775	3
	Pompilidae	*Anoplius*	*Anoplius nigerrimus* (Scopoli, 1763)	1
			Anoplius infuscatus (Vander Linden, 1827)	1
			Anoplius viaticus (Linnaeus,1758)	2
		Arachnospila	*Arachnospila minutula* (Dahlbom, 1842)	1
		Priocnemis	*Priocnemis parvula* Dahlbom, 1845	1
			Priocnemis fennica Haupt, 1927	1
			Priocnemis hyalinata Fabricius, 1793	1

Superfamily	Family	Genus	Species	Number of specimens
Apoidea	Sphecidae	*Sceliphron*	*Sceliphron curvatum* (Smith, 1870)	20
			Sceliphron destillatorium (Illiger, 1807)	29
			Sceliphron spirifex (Linnaeus, 1758)	1
		Ammophila	*Ammophila sabulosa* (Linnaeus, 1758)	1
	Crabronidae	*Bembecinus*	*Bembecinus tridens* (Fabricius, 1781)	4
		Bembix	*Bembix rostrata* (Linnaeus, 1758)	2
		Cerceris	*Cerceris arenaria* (Linnaeus,1758)	6
			Cerceris dorsalis Eversmann, 1849	1
			Cerceris quadrifasciata (Panzer, 1799)	1
			Cerceris quinquefasciata (Rossi,1792)	3
			Cerceris hortivaga Kohl, 1880	6
			Cerceris ruficornis (Fabricius, 1793)	1
			Cerceris rybyensis (Linnaeus, 1771)	1
		Ectemnius	*Ectemnius cavifrons* (Thomson,1870)	1
			Ectemnius cephalotes (Olivier,1792)	1
			Ectemnius continuus (Fabricius, 1804)	2
			Ectemnius fossorius (Linnaeus, 1758)	7
			Ectemnius lituratus (Panzer, 1804)	5
			Ectemnius lapidarius (Panzer, 1803)	6
			Ectemnius rubicola (Dufour & Perris, 1840)	1
			Ectemnius rugifer (Dahlbom, 1845)	1
		Lestica	*Lestica alata* (Panzer, 1797)	2
			Lestica clypeata (Schreber, 1759)	4
		Lindenius	*Lindenius albilabris* (Fabricius, 1793)	1
		Mellinus	*Mellinus arvensis* (Linnaeus,1758)	1
		Nysson	*Nysson maculosus* (Gmelin, 1790)	2
			Nysson spinosus (J.Forster, 1771)	5
		Pemphredon	*Pemphredon inornata* Say, 1824	1
		Philanthus	*Philanthus triangulum* (Fabricius, 1775)	13
		Psenulus	*Psenulus fuscipennis* (Dahlbom, 1843)	1
		Palarus	*Palarus variegatus* (Fabricius, 1781)	1
		Trypoxylon	*Trypoxylon fronticorne* Gussakovskij, 1936	1
		Oxybelus	*Oxybelus maculipes* Smith, 1856	1
			Oxybelus mucronatus (Fabricius, 1793)	1
		Gorytes	*Gorytes laticinctus* (Lepeletier, 1832)	3
			Gorytes quinquefasciatus (Panzer, 1798)	1
Chrysidoidea	Chrysididae	*Chrysis*	*Chrysis terminata* Dahlbohm, 1854	3
			Chrysis fulgida Linnaeus, 1761	3
		Chrysura	*Chrysura trimaculata* (Förster, 1853)	1
		Holopyga	*Holopyga fastuosa* (Lucas, 1849)	1
		Parnopes	*Parnopes grandior* (Pallas, 1771)	1

The family Crabronidae is represented in the collection by the largest number of species (32) belonging to 15 genera. The second largest family is the Vespidae (18 species). The poorest families in the number of species are the Scoliidae and the Tiphiidae represented by only two species each.

Most of the specimens collected mainly on the territory of Ukraine (in particular Cherkasy, Crimea, Vinnytsia, Volyn, Zakarpattia, Zaporizhia, Ivano-Frankivsk, Lviv,

Odesa, Poltava, Rivne (Rivne Nature Reserve), Kharkiv, Khmelnytsky and Kherson regions), three specimens were collected in the United States of America (2012), and one each in Germany (2005), Latvia (2005), Lithuania (2005), Italy (2012) and Egypt (2005) (**Table 2**). Unfortunately, specimens that were collected in Italy and Germany are stored without the collector's name on the label.

Table 2. **The origin of the specimens in the ZMD collection of wasps**

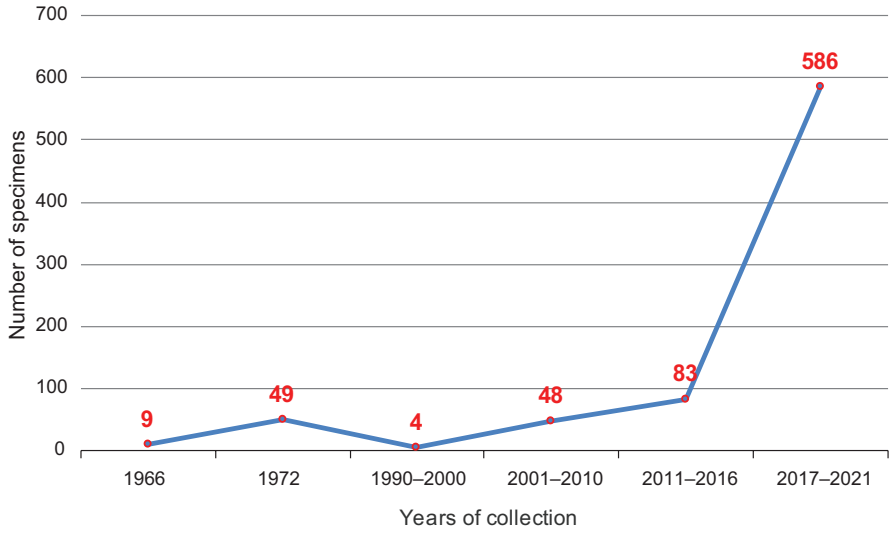
Country	Regions	Number of specimens
Ukraine	Lviv	483
	Rivne	118
	Volyn	71
	Zakarpattia	25
	Kharkiv	20
	Ivano-Frankivsk	20
	Cherkasy	13
	Ternopil	10
	Khmelnytsky	3
	Kherson	2
	Odessa	1
	Crimea	1
	Poltava	1
	Vinnytsia	1
	Zaporizhzhia	1
	Western Ukraine (without exact locality of collection)	1
USA		3
Latvia		1
Italia		1
Lithuania		1
Germany		1
Egypt		1

The greater part of the specimens in the collection were caught from western regions: Lviv, Volyn and Rivne. Specimens collected by the museum staff from the United States of America belong to two species: *Polistes dominula* and *Vespula maculifrons*. One specimen from Latvia belongs to *Vespula vulgaris* species, one specimen from Lithuania – *Mellinus arvensis*, one from Egypt – *Vespa crabro*. Specimens from Italy (*Sceliphron spirifex*) and Germany (*Vespa crabro*) are stored with unknown collectors on their labels.

Two specimens of *Vespula maculifrons* were collected in the United States of America. This species is the most common in the eastern part of North America, whereas *Polistes dominula* is an invasive species in the United States.

The majority of the collected species are common and widespread in Ukraine, except *Sceliphron curvatum* which is an invasive species in Europe (Tymkiv, Nazaruk, Shydlovskyy & Tsaryk, 2015).

The oldest collected specimens date from 1966 and 1972 (collector – associate professor of zoology Ivan Bublyk). The following 25 years (1991–2000, 2001–2010, 2011–2016) are represented by 4, 48 and 83 specimens respectively. Specimens were collected by faculty and museum staff, students (during educational practice and expeditions), and a few specimens – by amateur naturalists. The rest of the specimens were collected during the last few years 2017–2021 by the authors of the article (see **Figure**).



Analysis of specimens by year of their collection

All studied insects after their identification were inventoried and entered into the database.

CONCLUSIONS

The collection of the Zoological Museum of Ivan Franko National University of Lviv presents specimens of wasp species from 15 regions of Ukraine and six other countries. The largest number of specimens (716) was collected from the territory of Western Ukraine. Among all analyzed specimens, one species is invasive for the territory of Europe – *Sceliphron curvatum*. Such studies allow us to compile a preliminary list of wasp species on the territory of Western Ukraine for the first time.

Identification and inventory of the museum collection of wasps will facilitate further research on the collected materials and form the basis for the catalog.

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 international, national and institutional guidelines for the care and use of laboratory animals were followed.

AUTHOR CONTRIBUTIONS

Conceptualization, [S.P-H.]; methodology, [S.P-H.]; validation, [-]; formal analysis, [-]; investigation, [S. P-H; I.S.]; resources, [S. P-H; I.S.; I.Sh.]; data curation, [-]; writing – original draft preparation, [S. P-H.]; writing – review and editing, [I. S.; Y. Ts.; I. Kh.]; visualization, [S.P-H.]; supervision, [S.P-H., I. S.]; project administration, [S.P-H.]; funding acquisition, [-]. All authors have read and agreed to the published version of the manuscript.

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ПРЕДСТАВНИКИ НАДРОДИН VESPOIDEA, APOIDEA (SPHECIFORMES) ТА CHRYSIDOIDEA У КОЛЕКЦІЇ ЗООЛОГІЧНОГО МУЗЕЮ ЛЬВІВСЬКОГО НАЦІОНАЛЬНОГО УНІВЕРСИТЕТУ ІМЕНІ ІВАНА ФРАНКА

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Вступ. У статті представлено аналіз колекції ос (Vespoidea, Apoidea (Spheciformes) та Chrysidoidea), яка зберігається у Зоологічному музеї Львівського національного університету імені Івана Франка. Колекція налічує 779 екземплярів ос, які належать до 70 видів із 32 родів. У колекції представлені екземпляри, зібрані з 1966 року по теперішній час. Більшість зразків зібрано здебільшого на території України, вісім – у Сполучених Штатах Америки (2012), Німеччині (2005), Латвії (2005), Литві (2005), Італії (2012) та Єгипті (2005). Метою дослідження є вивчення поширення видів ос надродин Vespoidea, Apoidea (Spheciformes) і Chrysidoidea на території заходу та деяких інших регіонів України на основі музейної колекції, а також формування попереднього списку цих видів.

Матеріал і методи. Об'єктом дослідження була колекція ос (Vespoidea, Apoidea (Spheciformes) та Chrysidoidea). Зразки були зібрані працівниками музею, кафедри, студентами, натуралістами-аматорами та, здебільшого, першим автором цієї статті. Комах ідентифікували за допомогою бінокулярного стереоскопічного мікроскопа Bresser Advance ICD 10x-160x і спеціалізованих визначників.

Результати. Ми проаналізували 779 екземплярів ос, які належать до 70 видів, семи родин (Vespidae, Pompilidae, Scoliidae, Tiphidae, Sphecidae, Crabronidae та Chrysididae) і 32 родів (*Ammophila*, *Ancistrocerus*, *Anoplius*, *Arachnospila*, *Bembecinus*, *Bembix*, *Cerceris*, *Chrysis*, *Chrysura*, *Dolichovespula*, *Ectemnius*, *Eumenes*, *Gorytes*, *Holopyga*, *Lestica*, *Lindenius*, *Mellinus*, *Nysson*, *Oxybelus*, *Palarus*, *Parnopes*, *Pemphredon*, *Philanthus*, *Priocnemis*, *Polistes*, *Psenulus*, *Trypoxylon*, *Sceliphron*, *Scolia*, *Tiphia*, *Vespa* і *Vespula*). У статті представлено перелік видів, що зберігаються в Зоологічному музеї, та їхній аналіз за регіонами і роками збору.

Висновки. У колекції Зоологічного музею Львівського національного університету імені Івана Франка представлені зразки видів ос із 15 областей України та шести інших країн. Найбільша кількість зразків (716) зібрана на території західної України. Серед усіх досліджуваних екземплярів один вид є інвазивним для території Європи – *Sceliphron curvatum*. Такі дослідження дають змогу нам уперше сформувати попередній список видів ос для території західної України.

Ключові слова: Hymenoptera, оси, поширення, хорологія, фауністичне різноманіття

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