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RESEARCH ARTICLE

Preliminary investigations of the species composition of the aculeate hymenopteran community in Chornobyl Radiation and Ecological Biosphere Reserve (Hymenoptera, Aculeata)

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Abstract

The Chornobyl Radiation and Ecological Biosphere Reserve is a unique location, which is an area of posttechnogenic habitat restoration, including the Chornobyl Exclusion Zone, where comprehensive surveys of insect diversity have not yet been conducted. The communities of bees, sand wasps, and crabronids represent different functional groups in ecosystems (pollinators, predators, and kleptoparasites), so their taxonomic diversity provides a more complete conception of biodiversity in general.

Our research was carried out in May and August 2020– 2021. We identified 159 species from 12 families. For each insect species, information is provided on the diet, nesting, lifestyle, and conservation status of bees according to the European Red List of Bees and the Ukrainian Red Book. Most of the bee species on the European Red List of Bees belong to the category 'Least Concern', but also registered rare species from the category 'Data Deficient' - 8 species, 'Near Threatened' - 5 species, 'Endangered' - 4 species (*Colletes nasutus, Melitta melanura*, *Dasypoda braccata*, *Trachusa interrupta*), 'Vulnerable' - 2 species (*Colletes fodiens*, *Halictus leucaheneus*). There have also been some interesting finds among the wasps,

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e.g. *Arachnospila alvarabnormis*, this species of spider wasps (Pompilidae) registered for the first time in the fauna of Ukraine.
Data on the taxonomic diversity of bees and wasps are given for the Reserve for the first time, and although they are preliminary, we demonstrate considerable scientific potential for studying multicomponent communities in areas recovering from man-made disasters.

Keywords
Chornobyl exclusion zone, digger wasp, spider wasps, taxonomic diversity, wild bees.

Introduction

In the Anthropocene, biodiversity loss due to increased habitat transformation remains an increasingly obvious challenge for the scientific community. Reserves, in turn, are designed to protect diversity; they have unique conditions that allow the conservation of native species and their habitats. The Chornobyl Radiation and Ecological Biosphere Reserve (ChREBR) is a unique place that represents the gradual restoration of ecosystems after a technogenic disaster and the cessation of human activity. The reserve was established on 26 April 2016 with the purpose of preserving the typical natural complexes of Polissya, supporting and increasing the barrier function of the Chornobyl Exclusion Zone and the unconditional (mandatory) resettlement zone, rehabilitation of areas contaminated with radionuclides, assistance in organising and conducting international scientific research (Decree, No. 174/2016). It is necessary to recall that the Chornobyl accident in 1986 resulted in the release of large amounts of radioactive materials and the significant contamination of approximately 200000 square kilometres of land (Yablokov et al. 2010).

Investigating communities of different species, and in particular the assessment of taxonomic diversity, helps to understand ecosystem restoration processes. The selected insects represent different functional groups and occupy different ecological niches. Bees, as pollinators of flowering plants, depend on their diversity and also on the availability of nesting sites. Therefore, bee diversity is an indirect indicator of flowering plant diversity. The current state of bee populations is a matter of concern, as their diversity is now declining worldwide. Therefore, according to Nieto et al. (2014) and Rasmont et al. (2017), 77 species of wild bees in Europe are at high risk of extinction, while there are insufficient data to estimate the populations of another 1101 species (56.7 % of species in Europe). Wasps are both predators and situational pollinators. For instance, Pompilidae wasps are known for their dietary preferences - certain groups of spiders, so in the context of habitat - Pompilidae are indicators of the diversity of their prey - spiders. Crabronid wasps are also predators, which also sheds light on the wider diversity of prey species associated with crabronids.

Many insects studies have been carried out on the territory of the Chornobyl Exclusion Zone; the beginning of these studies dates back to the year of the accident – 1986 (Stovbchatyy and Rodionova 2011). Some studies on insects have recently been carried out: Møller & Mousseau (2006, 2009), Møller et al. (2012), Mousseau and Møller (2012), Bezrukov et al. (2015), Drozda (2017), Raines et al. (2020) and others. To a greater extent, these works are devoted to studying the effects of radiation at different times of exposure at the genetic and physiological levels. Fewer studies have been devoted to the assessment of insect diversity. These include the notable work of Møller et al. (2013), who concluded that the diversity of insects in the Chornobyl Exclusion Zone depends on the level of radiation, and in this and other work, Raines et al. (2020), the authors report finding 13 species of bumblebees. However, at present, there are no papers showing the current state of taxonomic diversity of Hymenoptera in the Chornobyl exclusion zone. There are not many studies showing ecosystem recovery after man-made disasters, but there are studies in Fukushima (Yoshioka et al. 2015). The authors showed that in the evacuation zone, the number of the largest bees *Xylocopa appendiculata* Smith, 1852 decreased, while the number of small bees decreased slightly. It is likely that the difference in number and diversity of insects may depend on the time since the accident and, of course, after human activity has ceased.

The aim of our study is to describe the taxonomic diversity of the ChREBR hymenopterans, as there is no comprehensive information on the species composition and distribution of these insects in the reserve. In this paper, we do not relate insect diversity to the level of radiation contamination.

Note that our research does not cover the entire period of flight activity of the insects studied, and was stopped due to military events in 2022, so we give a preliminary taxonomic diversity, which will be updated when it becomes possible to resume research in the area.

Materials and Methods

The Chornobyl Radiation and Ecological Biosphere Reserve (ChREBR) is located in the north of Kyiv region and covers an area of 226.964,7ha. It is formed on land within the Chornobyl Exclusion Zone and the Zone of Unconditional (Compulsory) Resettlement (Fig. 1). The reserve borders with the Belarusian exclusion zone and the Polessye State Radioecological Reserve (PSRER). Together, these areas form a complex transboundary nature reserve.

Prior to the Chornobyl nuclear power plant accident (1986), the area had been significantly altered by human activities: draining of swamps, reclamation canals, and intensive agriculture with pastures (Hostert et al. 2011).

Information on soil and vegetation is given according to the Chronicle of the Nature of the ChREBR (Litopys 2021). The soil cover of the reserve is characterised by the predominance of soddy-podzolic, sandy, silty-sandy, sandy loamy and, less frequently, nongleyed soils and varying degrees of gleyed soils, which are typical of subhorizontal dissected hilly-morainic and morainic-water-glacial plains and subhorizontal hilly-depression landscapes. A significant percentage of the territory of the reserve is occupied by peaty gley, peaty gley, and peaty bog soils, which were formed on predominantly low-lying peat of various glacio-depressional plains in depressions of the valley relief, as well as for suprafloodplains. These soils form the background to the soil cover of the study area.

The vegetation of the Reserve has a boreal character, and plant species of bog, meadow-bog, and meadow-steppe complexes play a significant role in its formation. This type of vegetation is typical for Polissya: wide-ranging species, endemics, and vicariants are almost absent; there is also an adventive element (compare Pashkevich N. in Lytopis 2021 and Petrov 2016).

Insects were caught with a sweeping net and by pan traps (diameter 75 mm, height 35 mm, white, yellow, or blue coloured), placed in a line. We visited the reserve on 14–17.07.2020; 01–03.09.2020; 17–21.05.2021, 12–14.07.2021, 13–17.09.2021. At each site, insects were sampled with a net for about 45 minutes and then 15 pan traps were set for at least 6 hours per day/per site. All sampling sites are shown on the map at Fig. 1.

The data on the ecological characteristics of wasps and bees are given after the following sources: Day (1988), Gros (1994), Oehlke and Wolf (1987), Bitsch (2017), Fateryga and Shorenko (2012), Gorobchishin (2005, 2006), Nemkov, (1990), Kazenas (2001), Kumpanenko et al. (2021), Kurzewski (1987), Lomholdt (1975), Voblenko et al. (1996), Pesenko et. al (2000), Osytshnjuk (1977), Osytshnjuk et. al. (2005), (2008); Michez and Eardley (2007), Bogusch and Jakub (2012), Loken (1973, 1984), Scheuchl (1995; 1996), Banaszak et al., (1998), Loktionov and Leley (2014).

Coordinates and abundance data are provided for species with conservation categories (Akimov et al. 2009, Decree 2021, according The Red Data Book of Ukraine), or those with a population status other than «Least Concern» on the European Red List of Bees, Nieto et al. (2014).

The species classification follows Wahis (2006), Ascher and Pickering (2022), and Pulawski (2021).

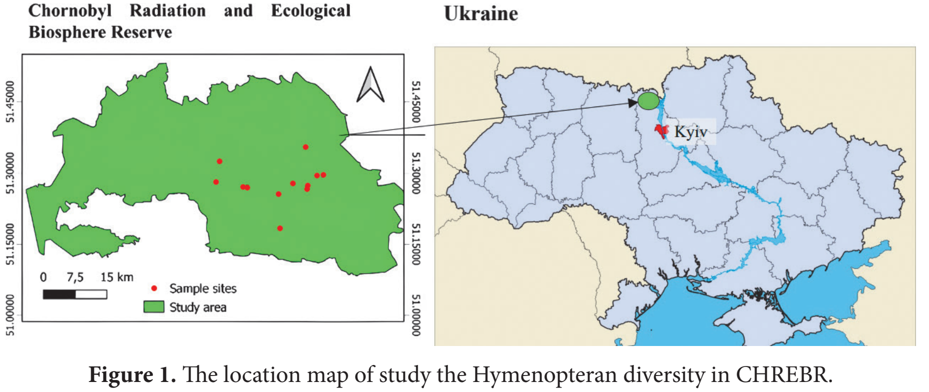

Figure 1. The location map of study the Hymenopteran diversity in CHREBR.

Results and Discussion

A total of 931 specimens of different Aculeata were collected in May–August 2020–21.

As a result of our research, 159 species were identified. This species list is given for the territory of the reserve for the first time, as well as a study carried out for the first time for the Chornobyl Exclusion Zone. The table shows their biological characteristics and conservation categories according to the European Red List of Bees and Red Data Book of Ukraine. For other hymenopterans, risk assessments for population status across Europe have not been carried out, so we provide information for bees only.

For the reasons described above, the completeness of our information on the species composition of Hymenoptera communities is not conclusive. However, by comparing the taxonomic diversity of the insect groups studied with previously studied nature reserves or national parks in Ukraine, we were able to establish some new findings of wasps and bees, complementing the information on the occurrence of rare species with different conservation categories. For example, in the Kanevsky Nature Reserve, we listed 38 species of Pompilidae wasps (Kumpanenko 2018), in our study 21 species, as well as one new to the fauna of Ukraine, *Arachnospila alvarabnormis* (Wolf, 1965). For the Chornomorskiy Biosphere Reserve, one of the largest biosphere reserves, we listed 49 species of digger wasps (Sphecidae + Crabronidae) (Gorobchyshyn and Protsenko 2004) and in this study – 47, which indicates the considerable potential of the area in question.

In fact, our data for wild bees are less comprehensive even in comparison with other territories and historical information, as, for example, for the whole Ukraine about 700 species are known (Osychnyuk 1977). Nevertheless, there is no detailed historical information on the occurrence of the insects studied on the territory of ChREBR. The northern part of Ukraine, which includes the reserve, is rarely mentioned in the literature as a place for studying any bee species, there are only rare records of bee occurrence in Chornobyl before the catastrophe (Osychnyuk 1970, 1977). The information on the species composition of bees in the southern part of the Kyiv region was gived by Lebedev (1933) and Osychnyuk (1977), which indicates about 400 species. It refers mainly to the city of Kyiv, the south of the region and areas adjacent to the Kyiv region (Poltava, Cherkasy), which is also richer in terms of habitat diversity compared to the northern part of Ukraine.Information on the species composition of bees in the southern part of the Kyiv region, which indicates about 400 species, refers mainly to the city of Kyiv, the south of the region, and areas adjacent to the Kyiv region (Poltava, Cherkasy), which is also richer in terms of habitat diversity compared to the northern part of Ukraine (Lebedev 1933, Osychnyuk 1970, 1977). There is also information on the species composition of most families of aculeate wasps from the Polesie State Radioecological Reserve (Belarus), located in the Belarusian Chornobyl Exclusion Zone (Shlyakhtenok 2006, 2007, 2010; Shlyakhtenok and Agunovich 2008).

There is reason to suppose that the composition of the fauna of the Chornobyl reserve will be similar to that of the Belarusian part. For example, the protected species *Megascolia maculata* is also registered in the Belarusian Nature Reserve. A special feature of this species is its close association with the beetle *Oryctes nasicornis*, whose larvae *M. maculata* use to rear its offspring. This close association between the wasp, the beetle, and the habitat (dead wood for the beetle larvae and thus for the brood of *M. maculata*) is an interesting but fragile system of relationships, although the status of *M. maculata* in Europe is not entirely clear at the moment, as the species is known to spread in Germany (Tischendorf and Dieterich 2020). The same applies to *Sphex funerarius*, which has a protected status in Ukraine, but

Our study did not cover the spring period, when bee diversity is also considered to be high, and some species, e.g. Andrenidae bees, are most active in the spring-summer period. However, the study of the summer bee community allowed us to show some peculiarities of the distribution of rare species and the consortia they form with forage plants, as well as to indicate the species that are also unknown in the Belarusian part (Apoidea of Belarus). For example, our research has shown that *Dasypoda braccata*, an oligolect of Dipsacaceae (not specified for Belarus), which was mentioned for Kyiv in 1933, is now found only in the reserve that is located in the north of the region. At present, we have not investigated the exact reason for the decline and local extinction of the species in its historical range, but an obvious reason is the destruction of its habitat and the apparent decrease of its forage plants due to increasing land transformation, as, for example, *D. braccata* is known to be extinct in Austria (Kratschmer et al. 2021). On the territory of the reserve, which was essentially agricultural 35 years ago, there was probably a local population of *D. braccata*, and with the cessation of all human activities that deliberately lead to the destruction of habitats and forage plants (ploughing, agriculture, construction), the population of *Dasypoda braccata* has started to increase. This assumption is partly supported by land cover studies, which have shown that agricultural land undergoes the greatest change after the cessation of any activity (Tishchenko and Landin 2020). A similar situation in terms of habitat conservation/restoration could probably apply to *Trachusa interrupta*, although no records of this species were reported for northern Ukraine, and the northernmost habitats were known from the Kharkiv oblast and not reported for Belarus. These two species have been recorded feeding on the flowers of *Scabiosa ochroleuca* L., an endangered species in Europe. Bee communities associated with Dipsacaceae plants, in particular *Scabiosa* spp, are of particular interest in the Action Plans for the Conservation of Threatened Pollinator Species in the EU (Hochkirch et al. 2021), and it is possible that the habitats of these species found in the Chornobyl Nature Reserve may serve as refugia for these highly specialised bee species in Europe, as well as for *Melitta melanura*, an oligolect of *Campanula* flowers, which is also listed in the Action Plans. *Colletes nasutus*, which we found in the ChREBR, is also known for its preference for nesting in sandy soils and its close trophic relationship with plants of *Anchusa officinalis.* Another species, *Colletes succinctus*, an oligolect of *Calunna vulgaris*, is relatively common in heathland

Table 1. The list of Aculeata species from the Chornobyl radiation and ecological biosphere reserve

Species name	Species life history traits
Family Scoliidae Latreille 1802 Subfamily Scoliinae Latreille 1802	
Megascolia (Regiscolia) maculata (Drury, 1773)	Scarabeidae. Western Palearctic to Central Asia 1 ♀, 1 ♂, Ukraine, ChREBR, -51.273676; -30.217267, 14.VII. 2020 (leg. Kumpanenko) Red Data Book of Ukraine
Scolia (Discolia) hirta (Schrank, 1781)	Scarabeidae. Western Palearctic to Central Asia
Scolia (Scolia) sexmaculata (Müller, 1766)	Scarabeidae. Western Palearctic to Central Asia
Family Sapygidae Latreille, 1810 Subfamily Sapyginae Latreille, 1810	
Sapygina decemguttata (Jurine, 1807)	Cleptoparasite of *Heriades truncorum, H. crenulatus*, *Osmia nigriventris, Chelostoma florisomne* (Megachilidae) Europe, Near East
Family Pompilidae Latreille, 1805 Subfamily Pepsinae Lepeletier, 1845	
Auplopus carbonarius (Scopoli, 1763)	Prey: Agelenidae, Anyphaenidae, Araneidae, Clubionidae, Dysderidae, Gnaphosidae, Lycosidae, Oxyopidae, Philodromidae, Pisauridae, Salticidae, Segestriidae, Sparassidae, Tetragnathidae, Thomisidae, Zoridae, and others. Palearctic.
Cryptocheilus (Adonta) notatus (Rossius, 1729)	Prey: Agelenidae, Amaurobiidae, Cheiracanthiidae, Gnaphosidae, and Lycosidae. Europe to Central Asia, northern Africa.
Dipogon (Deuteragenia) subintermedius (Magretti 1886)	Prey: Araneidae, Clubionidae, Salticidae, Segestriidae. Central Europe to Central Asia
Priocnemis (Priocnemis) cordivalvata Haupt, 1926	Prey: Clubionidae, Miturgidae. Central, Northern and Eastern Europe, Siberia.
Priocnemis (Priocnemis) fennica Haupt, 1927	Prey: Agelenidae, Clubionidae, Liocranidae, and Lycosidae. Central, Northern and Eastern Europe.
Priocnemis (Priocnemis) hyalinata (Fabricius, 1793)	Prey: Clubionidae, Lycosidae, Salticidae. From northern and central Europe to Uzbekistan.
Priocnemis (Priocnemis) melanosoma Kohl, 1880	Prey: Lycosidae. Central Europe.
Subfamily Pompilinae Latreille, 1805	
Agenioideus (Agenioideus) cinctellus (Spinola, 1808)	Prey: Salticidae, Thomisidae. Palearctic.
Agenioideus (Agenioideus) sericeus (Vander Linden, 1827)	Prey: Araneidae, Linyphiidae, Philodromidae, Pisauridae, Salticidae, Thomisidae. Palearctic.
Anoplius (Anoplius) concinnus (Dahlbom, 1843)	Prey: Gnaphosidae, Lycosidae, Pisauridae, Salticidae. Palearctic.
Anoplius (Arachnophroctonus) viaticus (Linnaeus, 1758)	Prey: Agelenidae, Gnaphosidae, Liocranidae, Lycosidae, Philodromidae, Pisauridae, Salticidae, Thomisidae. Palearctic.
Aporinellus (Aporinellus) sexmaculatus (Spinola, 1805)	Prey: Cheiracanthiidae, Clubionidae, Philodromidae, Salticidae, Thomisidae. Western Palearctic to Central Asia.
Arachnospila (Ammosphex) alvarabnormis (Wolf, 1965)	Prey: Spiders. Central and Eastern Europe. 1♀, Ukraine, ChREBR, -51.184118; -30.123261, 02.IX.2020 (leg. Honchar), New for Ukraine
Arachnospila (Ammosphex) anceps (Wesmael, 1851)	Prey: Agelenidae, Clubionidae, Gnaphosidae, Lycosidae, Pisauridae, Salticidae, and Thomisidae. Palearctic.
Arachnospila (Anoplochares) spissa (Schioedte, 1837)	Prey: Lycosidae, Salticidae. Palearctic.

Table 1. (continued)

Species name	Species life history traits
Episyron albonotatum (Vander Linden, 1827)	Prey: Araneidae. Palearctic.
Episyron arrogans (Smith, 1873)	Prey: Araneidae. Palearctic.
Episyron rufipes (Linnaeus, 1758)	Prey: Araneidae. Palearctic.
Evagetes (Evagetes) crassicornis (Shuckard, 1837)	Cleptoparasite of *Arachnospila anceps, A. consobrina, A. minutula* and *A. trivialis, Anoplius nigerrimus* (Pompilidae). Holarctic.
Parabatozonus lacerticida (Pallas, 1771)	Prey: Araneidae. Palearctic.
Pompilus cinereus (Fabricius, 1775)	Prey: Araneidae, Cheiracanthiidae, Gnaphosidae, Lycosidae, Philodromidae, Pisauridae, Salticidae, Thomisidae, Zoridae, Zoropsidae and others. Palearctic, Ethiopian, and Indo-Malayan regions.
Family Vespidae Latreille, 1802 Subfamily Polistinae Bequert, 1918	
Polistes (Polistes) nimpha (Christ, 1791)	Eusocial, insects. Palearctic.
Family Sphecidae Latreille, 1802 Subfamily Ammophilinae André, 1886	
Ammophila campestris Latreille, 1809	Prey: Caterpillars of Noctuidae, Pieridae, Geometridae, and pseudocaterpillars of Tenthredinidae. Palearctic.
Ammophila sabulosa (Linnaeus, 1758)	Prey: Caterpillars of Noctuidae, Pieridae, Geometridae, Erebidae, Drepanidae, Notodontidae. Palearctic.
Ammophila terminata F. Smith, 1856	Prey: Caterpillars of Geometridae. Southern Europe, north Africa to Kazakhstan.
Podalonia affinis (W. Kirby, 1798)	Prey: Caterpillars of Noctuidae. Palearctic.
Podalonia luffii (Saunders, 1903)	Prey: Caterpillars of Noctuidae. Central and Eastern Europe to Kazakhstan.
Subfamily Sphecinae Latreille, 1802	
Prionyx nudatus (Kohl,1885)	Prey: Acrididae. Southern Europe, Northern Africa, Southwest and Central Asia, Kazakhstan.
Sphex funerarius Gussakovskij, 1934	Prey: Tettigoniidae. Palearctic. 1 ♀, Ukraine, ChREBR, -51.2556164; -30.119145, 14.VII. 2020 (lLeg. Gorobchyshyn). 3 ♀, Ukraine, ChREBR, -51.28641; -29.80935, 14.VII. 2020 (Legleg. Gorobchyshyn). Red Data Book of Ukraine
Family Crabronidae Latreille, 1802 Subfamily Astatinae Lepeletier, 1845	
Astata boops (Schrank, 1781)	Prey: Pentatomidae, Cydnidae. Palearctic, Oriental.
Dryudella tricolor (Vander Linden, 1829)	Prey: Pentatomidae, Scutelleridae, Lygaeidae, Reduviidae, Cydnidae, Alydidae, and Rhopalidae. Palearctic.
Subfamily Bembicinae Latreille, 1802	
Bembecinus hungaricus Frivaldszky, 1876	Prey: Cicadellidae, Psyllidae, Fulgoridae. Southern Europe, Minor Asia.
Bembecinus tridens (Fabricius, 1781)	Prey: Fulgoridae, Cercopidae, Psyllidae. Palearctic.
Bembix rostrata (Linnaeus, 1758)	Prey: Calliphoridae, Muscidae, Syrphidae, and Tabanidae. Palearctic.
Gorytes quinquefasciatus (Pazer, 1798)	Prey: Auchenorrhyncha. Palearctic.

Table 1. (continued)

Species name	Species life history traits
Harpactus elegans (Lepeletier, 1832)	Prey: Aphrodes, Deltocephalus, Cicadellidae, Issidae. Central and Southern Europe, Minor Asia, Kazakhstan, West Siberia.
Harpactus morawitzi Radoszkowski, 1884	Prey: Cicadellidae. Southwestern Europe, Central Asia.
Subfamily Crabroninae Latreille, 1802	
Crabro (Crabro) peltarius (Schreber, 1784)	Prey: Brachycera. Palearctic.
Crossocerus (Crossocerus) exiguus (Vander Linden, 1829)	Prey: Aphidoidea. Palearctic.
Ectemnius (Clytochrysus) cavifrons (Thomson, 1870)	Prey: Anthomyidae, Chrysididae Ichneumonidae, Pteromalidae. Palearctic.
Ectemnius (Ectemnius) dives (Lepeletier et Brulle, 1834)	Prey: Syrphidae, Tachinidae. Holarctic.
Lestica (Ceratoculus) alata (Panzer, 1797)	Prey: Crambidae, Geometridae, Noctuidae, Pyralidae, Tortricidae. Palearctic.
Lestica (Clypeocrabro) clypeata (Schreber, 1759)	Prey: Crambidae, Noctuidae, Sesiidae, Geometridae, Empididae, Muscidae, Syrphidae. Palearctic.
Lindenius albilabris (Fabricius, 1793)	Prey: Miridae, Chloropidae, Dolichopodidae, Muscidae. Palearctic.
Lindenius mesopleuralis (F. Morawitz, 1890)	Prey: Insects Europe, Kazakhstan.
Liris niger (Fabricius, 1775)	Prey: Gryllidae. Palearctic, Oriental.
Oxybelus argentatus Curtis, 1833	Prey: Therevidae. Europe.
Oxybelus bipunctatus Olivier, 1811	Prey: Muscoidea, Empidoidea, Tephritoidea, Carnoidea, Oestroidea, Asiloidea. Holarctic.
Oxybelus quatuordecimnotatus Jurine, 1807	Prey: Agromyzidae, Lauxaniidae, Drosophilidae. Palearctic.
Oxybelus subspinosus Klug, 1835	Prey: Brachycera. Southern Europe, Northern Africa, Minor Asia.
Oxybelus trispinosus (Fabricius, 1787)	Prey: Brachycera. Europe, Minor and Central Asia.
Palarus variegatus (Fabricius, 1781)	Prey: Aculeata. Europe, Northern Africa to Central Asia.
Tachysphex nitidus (Spinola, 1805)	Prey: Tettigoniidae. Palearctic.
Tachysphex pompiliformis (Panzer, 1805)	Prey: Tettigoniidae. Palearctic.
Tachysphex psammobius (Kohl, 1880)	Prey: Acrididae. Holarctic.
Trypoxylon (Trypoxylon) attenuatum F. Smith, 1851	Prey: Theridiidae, Argiopidae, Thomisidae, Salticidae, Linyphiidae, and Araneidae. Western Palearctic.
Trypoxylon (Trypoxylon) figulus (Linnaeus, 1758)	Prey: Argiopidae, Salticidae, Epeiridae, Tomisidae. Holarctic.
Subfamily Mellininae Latreille, 1802	
Mellinus arvensis Linnaeus, 1758	Prey: Anthomyiidae, Calliphoridae, Muscidae, Sarcophagidae, Tachinidae, Syrphidae, Tabanidae. Palearctic.
Subfamily Pemphredoninae Dahlbom, 1835	
Diodontus minutus (Fabricius, 1793)	Prey: Aphididae. Palearctic.

Table 1. (continued)

Species name	Species life history traits	
Passaloecus singularis Dahlbom, 1894	Prey: Aphididae. Palearctic.	
Pemphredon (Cemonus) lethifer (Schuckard, 1837)	Prey: Aphididae. Holarctic.	
Subfamily Philanthinae Latreille, 1802		
Cerceris arenaria (Linnaeus, 1758)	Prey: Curculionidae. Palearctic.	
Cerceris quadricincta (Panzer, 1799)	Prey: Curculionidae. Central and southern Europe, northern Africa, and central Asia.	
Cerceris quinquefasciata (Rossi, 1792)	Prey: Curculionidae, Chrysomelidae. Palearctic.	
Cerceris ruficornis (Fabricius, 1793)	Prey: Curculionidae. Palearctic.	
Cerceris rybyensis (Linnaeus, 1771)	Prey: Halictidae, Andrenidae, Colletidae, and Apidae. Palearctic.	
Cerceris sabulosa (Panzer, 1799)	Prey: Halictidae, Andrenidae, Colletidae, and Apidae. Palearctic.	
Philanthus coronatus (Thunberg, 1784)	Prey: Halictidae. Palearctic.	
Philanthus triangulum (Fabricius, 1775)	Prey: *Apis mellifera* L., Halictidae, Andrenidae. Western Palearctic, Africa.	
Family Colletidae Lepeletier, 1841 Subfamily Colletinae Lepeletier, 1841		
Colletes (Colletes) succinctus (Linnaeus,1758)	Solitary, strong oligolectic (*Calluna vulgaris* (L.) Hull.), ground-nesting. Western Palearctic. 2 ♀, Ukraine, ChREBR, -51.184185; -30.123973, 01.IX.2020 (leg. Honchar, Kovalenko).	NT
Colletes (Rhinocolletes) nasutus Smith, 1853	Solitary, strong oligolectic (*Anchusa officinalis* L.), ground-nesting. Western Palearctic. 1 ♀, Ukraine, ChREBR, -51.324301; -29.920694, 16.VI.2021 (leg. Honchar).	EN
Colletes (Pachycolletes) cunicularius (Linnaeus,1761)	Solitary, polylectic, ground-nesting Palearctic.	LC
Colletes (Simcolletes) similis Schenck,1853	Solitary, oligolectic (Asteraceae), ground-nesting. Palearctic.	LC
Colletes (Simcolletes) fodiens (Geoffroy,1785)	Solitary, oligolectic (Asteraceae), ground-nesting. Palearctic. 2 ♀, Ukraine, ChREBR, -51.294617; -30.248431, 14.VII.2020 (leg. Honchar)	VU
Colletes (Simcolletes) daviesanus Smith, 1846	Solitary, oligolectic (Asteraceae), ground-nesting. Palearctic.	LC
Subfamily Hylaeinae Viereck, 1916		
Hylaeus (Hylaeus) communis Nylander,1852	Solitary, polylectic, cavity nesting. Palearctic.	LC
Hylaeus (Hylaeus) leptocephalus (Morawitz, 1870)	Solitary, polylectic, cavity nesting. Palearctic.	LC
Hylaeus (Patagiata) difformis (Eversmann, 1852)	Solitary, polylectic, cavity nesting. Palearctic.	LC
Hylaeus (Prosopis) confusus Nylander, 1852	Solitary, polylectic, cavity nesting. Palearctic.	LC
Hylaeus(Abrupta) cornutus (Curtis, 1831)	Solitary, polylectic, cavity nesting. Western Palearctic.	LC
Family Andrenidae Latreille, 1802 Subfamily Andreninae Latreille, 1802		
Andrena (Andrena) varians (Kirby, 1802)	Solitary, polylectic, ground nesting. Western Palearctic.	LC

Table 1. (continued)

Species name	Species life history traits	
Andrena (Melandrena) vaga Panzer, 1799	Solitary, polylectic (prefers *Salix* L.spp), ground nesting. Western Palearctic.	LC
Andrena (Cnemidandrena) fuscipes (Kirby, 1802)	Solitary, strong oligolectic (*Calluna vulgaris* (L.) Hull), ground-nesting. Western Palearctic. 3 ♀, Ukraine, ChREBR, -51.184185; -;30.123973, 01.IX.2020 (leg. Honchar, Kovalenko).	DD
Andrena (Euandrena) chrysopus Perez, 1903	Solitary, strong oligolectic (*Asparagus officinalis* L.), ground nesting. Western Palearctic. 3 ♀, Ukraine, ChREBR, -51.354167; -30.210556, 14.VI. 2021 (leg. Honchar). The Red Data Book of Ukraine.	DD
Andrena (Melandrena) albopunctata (Rossi, 1792)	Solitary, polylectic, ground nesting. Western Palearctic.	LC
Andrena (Melandrena) cineraria (Linnaeus, 1758)	Solitary, polylectic, ground nesting. Palearctic.	LC
Andrena (Melandrena) limata Smith, 1853	Solitary, polylectic, ground nesting. Palearctic. 1 ♀, Ukraine, ChREBR, -51.273268; -30.216779, 17.V.2021 (leg. Honchar).	DD
Andrena (Melandrena) morio Brulle, 1832	Solitary, polylectic, ground nesting. Western Palearctic.	LC
Andrena (Micrandrena) minutuloides Perkins, 1914	Solitary, polylectic, ground nesting. Western Palearctic. 1 ♀, Ukraine, ChREBR, -51.273268; -30.216779, 17.V.2021 (leg. Honchar).	DD
Andrena ovatula s.l.(Kirby, 1802)	Solitary, oligolectic (Fabaceae), ground nesting. Western Palearctic. 2 ♂, Ukraine, ChREBR, -51.294617; -30.248431, 17.V.2021 (leg. Honchar).	NT
Subfamily Panurginae Leach, 1815		
Panurgus (Panurgus) calcaratus Scopoli, 1763	Solitary, oligolectic (Asteraceae), ground-nesting. Palearctic	LC
Family Halictidae Thomson, 1869 Subfamily Halictinae Thomson, 1869.		
Halictus (Hexataenites) sexcinctus (Fabricius, 1775)	Solitary, polylectic, ground nesting. Western Palearctic.	LC
Halictus (Protohalictus) rubicundus (Christ, 1791)	Primitively eusocial, polylectic, ground-nesting. Palearctic, Nearctic.	LC
Halictus (Seladonia) subauratus (Rossi, 1792)	Primitively eusocial, polylectic, ground-nesting. Palearctic.	LC
Halictus (Seladonia) tumulorum (Linnaeus, 1758)	Primitively eusocial, polylectic, ground-nesting. Palearctic.	LC
Halictus (Seladonia) leucaheneus Ebmer, 1972	Primitively eusocial, polylectic, ground-nesting. Palearctic. 1 ♀ Ukraine, ChREBR, -51.281066; -29.908970; -, 16.VI.2021 (leg.Honchar)	VU
Lasioglossum (Dialictus) morio (Fabricius, 1793)	Primitively eusocial, polylectic, ground-nesting. Palearctic.	LC
Lasioglossum (Evylaeus) politum (Schenck, 1853)	Primitively eusocial, polylectic, ground-nesting. Palearctic.	LC
Lasioglossum (Hemihalictus) lucidulum (Schenck, 1861)	Solitary, polylecti.c, ground-nesting. Palearctic	LC
Lasioglossum (Lasioglossum) costulatum (Kriechbaumer, 1873)	Solitary, oligolectic (Campanulaceae), ground nesting. Palearctic. 1 ♀, Ukraine, ChREBR, -51.324301; -29.920694, 16.VI.2021 (leg. Honchar)	NT

Table 1. (continued)

Species name	Species life history traits	
Lasioglossum (*Lasioglossum*) *sexnotatum* (Kirby, 1802)	Solitary, polylectic, ground nesting. Western Palearctic. 1 ♀, Ukraine, ChREBR, -51.255616; -30.119145, 16.VI. 2021 (leg. Honchar). 1 ♀, Ukraine, ChREBR, -51.354167; -30.210556, 16.VI.2021 (leg. Honchar)	NT
Lasioglossum (Sphecodogastra) interruptum (Panzer, 1798)	Primitively eusocial, polylectic, ground-nesting. Western Palearctic.	LC
Lasioglossum (Sphecodogastra) calceatum (Scopoli, 1763)	Primitively eusocial, polylectic, ground-nesting. Palearctic.	LC
Lasioglossum (Hemihalictus) minutissimum (Kirby, 1802)	Solitary, polylectic, ground nesting. Western Palearctic.	LC
Sphecodes albilabris (Fabricius, 1793)	Cleptoparasite (*Colletes cunicularius*, *Halictus quadricinctus*, *Melitturga clavicornis*, *Dasypoda hirtipes*). Palearctic.	LC
Sphecodes crassus Thomson, 1870	Cleptoparasite (*Lasioglossum pauxillum*, *Lasioglossum punctatissimum*, *Lasioglossum quadrinotatulum*, *Lasioglossum nitidiusculum*, *Lasioglossum prasinum*). Palearctic.	LC
Sphecodes monilicornis (Kirby, 1802)	Cleptoparasite (*Halictus rubicundus*, *Lasioglossum albipes*, *L. calceatum*, *L. leucozonium, L. malachurum*, *L. quadrinotatulum*, *L. zonulum*, *Andrena flavipes*, *Halictus maculatus*, *H. tumulorum*, *L. laticeps*, *L. pauxillum*, *L. villosulum*). Palearctic.	LC
Subfamily Nomiinae Robertson, 1904		
Nomiapis (Nomiapis) diversipes (Latreille, 1806)	Solitary, oligolectic (Fabaceae), ground nesting. Palearctic.	LC
Subfamily Nomioidinae Börner 1919		
Nomioides (Nomioides) minutissimus (Rossi, 1790)	Solitary, polylectic, ground nesting. Palearctic.	LC
Subfamily Rophitinae (Schenck 1866)		
Systropha (Systropha) curvicornis (Scopoli, 1770)	Solitary, strong oligolectic (*Convolvulus arvensis* L.), ground-nesting. Western Palearctic. 4♀, 1♂, Ukraine, ChREBR, -51.273270; -30.216782, 12.VII.2021 (Legleg. Honchar). 6♀, 7♂, Ukraine, ChREBR, -51.277776; -30.168893, 13.VII.2021 (Legleg. Honchar)	LC
Family Melittidae Schenk 1860 *Subfamily Dasypodainae Börner*, 1919		
Dasypoda (*Dasypoda*) *hirtipes* (Fabricius, 1793)	Solitary, oligolectic (Asteraceae), ground-nesting. Palearctic.	LC
Dasypoda (*Dasypoda*) *morawitzi* Radchenko, 2016	Solitary, oligolectic (Asteraceae), ground-nesting. Western Palearctic.	LC
Dasypoda (Megadasypoda) braccata Eversmann, 1852	Solitary, strong oligolectic (Dipsacaceae), ground nesting. Western Palearctic. 5♀, 2♂, Ukraine, ChREBR, -51.273676; -30.217267., 14.VII.2020 (Legleg. Kumpanenko, Honchar, Gorobchyshyn). 3♀, 1♂, Ukraine, ChREBR, -51.295782; -30.269059, 14.VII.2020 (Legleg. Kumpanenko, Honchar, Gorobchyshyn). 4♀, 3♂, Ukraine, ChREBR, -51.2710156; -30.0135112;, 15.VII.2020 (Legleg. Kumpanenko, Honchar, Gorobchyshyn). 5♀, 2♂, Ukraine, ChREBR, -51.2556164; -30.1191453, 15.VII.2020 (Legleg. Kumpanenko, Honchar, Gorobchyshyn);. Red Data Book of Ukraine.	EN
Subfamily Macropidinae Robertson, 1904		
Macropis (Macropis) europaea Warncke, 1973	Solitary, strong oligolectic (*Lysimachia vulgaris*, *L. punctata*), ground nesting. Palearctic.	LC

Table 1. (continued)

Species name	Species life history traits	
Subfamily Melittinae Schenk 1860		
Melitta (Cilissa) haemorrhoidalis (Fabricius, 1775)	Solitary, strong oligolectic (*Campanula* L.), ground nesting. Western Palearctic.	LC
Melitta (Cilissa) melanura (Nylander, 1852)	Solitary, strong oligolectic (*Campanula* L. Campanulaceae), ground-nesting. Palearctic. 1 ♀, Ukraine, ChREBR, -51.256228; -30.118824, 14.VII.2020 (Legleg. Honchar). Red Data Book of Ukraine.	EN
Melitta (Melitta) leporina (Panzer, 1799)	Solitary, strong oligolectic (Fabaceae), ground-nesting. Palearctic.	LC
Melitta (Melitta) nigricans Alfken, 1905	Solitary, strong oligolectic (Lythraceae: *Lythrum* L.), ground nesting. Western Palearctic.	LC
Family Megachilidae Latreille, 1802 Subfamily Megachilinae Latreille, 1802		
Anthidiellum (Anthidiellum) strigatum (Panzer, 1805)	Solitary, oligolectic (prefers *Lotus corniculatus* L.), cavity nesting. Palearctic.	LC
Anthidium (Anthidium) manicatum (Linnaeus, 1758)	Solitary, polylectic, cavity nesting. Palearctic.	LC
Anthidium (Anthidium) septemspinosum Lepeletier, 1841	Solitary, polylectic, cavity nesting. Palearctic. 1 ♀ Ukraine, ChREBR, -51.273163; -30.216821, 1999, (leg. Tyutyunnik Y.).	DD
Coelioxys (Melissoctonia) conoideus (Illiger, 1806)	Cleptoparasite (*Megachile maritima*, *M. lagopoda*). Palearctic.	LC
Coelioxys (Paracoelioxys) elongatus Lepeletier, 1841	Cleptoparasite (*Megachile willughbiella*, *M. circumcincta*, *M. ligniseca*, *M. centuncularis, M. leachella*). Palearctic.	LC
Chelostoma (Foveosmia) distinctum (Stoeckhert, 1929)	Solitary, oligolectic (Campanulaceae: *Campanula* L.), cavity nesting. Western Palearctic.	LC
Heriades (Heriades) truncorum (Linnaeus, 1758)	Solitary, oligolectic (Asteraceae), cavity nesting. Western Palearctic.	LC
Hoplitis (Hoplitis) adunca (Panzer, 1798)	Solitary, oligolectic (Boraginaceae: *Echium* L.), cavity nesting. Western Palearctic.	LC
Lithurgus cornutus (Fabricius, 1787)	Solitary, oligolectic (Asteraceae), cavity nesting. Palearctic.	LC
Megachile (Eutricharaea) leachella Curtis, 1828	Solitary, polylectic, cavity nesting. Palearctic.	LC
Megachile (Megachile) versicolor Smith, 1844	Solitary, polylectic, cavity nesting. Palearctic. 2 ♀ Ukraine, ChREBR, -51.273676; -30.217267, 14.VII. 2020 (leg. Honchar).	DD
Megachile (Xanthosarus) circumcincta (Kirby, 1802)	Solitary, polylectic, cavity-nesting. Transpalaearctic-Eurosiberian.	LC
Megachile (Xanthosarus) lagopoda (Linnaeus, 1761)	Solitary, polylectic, cavity nesting. Palearctic.	LC
Megachile (Xanthosarus) nigriventris Schenck, 1868	Solitary, oligolectic (Fabaceae), cavity-nesting. Palearctic. 1 ♀ Ukraine, ChREBR, -51.271087; -30.000570, 15.VII. 2020 (leg. Kumanenko).	DD
Megachile (Xanthosarus) willughbiella (Kirby, 1802)	Solitary, polylectic, cavity nesting. Palearctic.	LC
Osmia (Helicosmia) caerulescens (Linnaeus, 1758)	Solitary, polylectic, cavity nesting. Palearctic.	LC
Osmia (Osmia) bicornis (Linnaeus, 1758)	Solitary, polylectic, cavity nesting. Palearctic.	LC

Table 1. (continued)

Species name	Species life history traits	
Stelis (Stelis) breviuscula (Nylander, 1848)	Cleptoparasite (*Osmia spinulosa).* Palearctic.	LC
Trachusa (Paraanthidium) interrupta (Fabricius, 1781)	Solitary, oligolectic (Dipsacaceae), cavity nesting. West Palaearctic, Afrotropical, Indomalayan. 2♀, 2♂, Ukraine, ChREBR, -51.271087; -30.000570;, 14.VII. 2020 (Legleg. Kumpanenko, Honchar, Gorobchyshyn); 1♀, 2♂ Ukraine, ChREBR, -51.295782; -30.269059;, 14.VII. 2020 (Legleg. Kumpanenko, Honchar, Gorobchyshyn); 2♀, 1♂; Ukraine, ChREBR, -51.2710156,; -30.0135112, 15.VII. 2020 (Legleg. Kumpanenko); 3♀, 2♂ Ukraine, ChREBR, -51.2556164; -30.1191453, 15.VII. 2021 (Legleg. Kovalenko, Honchar, Gorobchyshyn). Red Data Book of Ukraine.	EN
Family Apidae Latreille, 1802 Subfamily Apinae Latreille, 1802		
Apis mellifera Linnaeus, 1758	Eusocial and polylectic.	DD
Amegilla (Amegilla) quadrifasciata (de Villers, 1789)	Solitary, polylectic, ground nesting. West Palaearctic, Afrotropical.	LC
Anthophora (Anthophora) plumipes (Pallas, 1772)	Solitary, polylectic, ground nesting. Palearctic.	LC
Anthophora (Clisodon) furcata (Panzer, 1798)	Solitary, oligolectic, cavity-nesting. Palearctic.	LC
Bombus (Bombus) terrestris (Linnaeus, 1758)	Eusocial, polylectic, ground-nesting. Palearctic.	LC
Bombus (Bombus) lucorum (Linnaeus, 1761)	Eusocial, polylectic, ground-nesting. Palearctic.	LC
Bombus (Melanobombus) lapidarius (Linnaeus, 1758)	Eusocial, polylectic, ground-nesting. Palearctic.	LC
Bombus (Thoracobombus) pascuorum (Scopoli, 1763)	Eusocial, polylectic, ground-nesting. Palearctic.	LC
Bombus (Thoracobombus) ruderarius (Müller, 1776)	Eusocial, polylectic, ground-nesting. Palearctic.	LC
Eucera (Eucera) interrupta Baer, 1850	Solitary, oligolectic (Fabaceae), ground nesting. Palearctic.	LC
Eucera (Eucera) longicornis (Linnaeus, 1758)	Solitary, oligolectic (Fabaceae), ground nesting. Palearctic.	LC
Tetralonia (Tetralonia) malvae (Rossi, 1790)	Solitary, oligolectic (Malvaceae), ground nesting. Western Palearctic.	LC
Tetraloniella (Tetraloniella) dentata (Germar, 1839)	Solitary, oligolectic (Acteraceae), ground nesting. Palearctic.	LC
Melecta (Melecta) albifrons (Forster, 1771)	Cleptoparasite (*Anthophora acervorum*). Western Palearctic.	LC
Thyreus histrionicus (Illiger, 1806)	Cleptoparasite (*Amegilla quadrifasciata*). Palearctic.	LC
Subfamily Xylocopinae Latreille, 1802		
Ceratina (Euceratina) cyanea (Kirby 1802)	Subsocial, polylectic, cavity nesting. Western Palearctic.	LC
Epeolus variegatus (Linnaeus,1758)	Cleptoparasite (*Colletes daviesanus,* *C. fodiens, and C. similis*).	LC
Xylocopa (Xylocopa) valga Gerstaecker, 1872	Subsocial, polylectic, cavity nesting Palearctic. 1 ♀, Ukraine, ChREBR, -51.273676,; -30.217267, 02.IX. 2020 (Legleg. Honchar); 1 ♀, Ukraine, ChREBR, -51.295782; -30.269059, 15.VII. 2021 (Legleg. Kumpanenko, Honchar, Gorobchyshyn). The Red Data Book of Ukraine. Palearctic.	LC

(which has formed on cuttings under power lines) and is found here together with *Andrena fuscipes*, also a narrow oligolect on heather. Similar habitats for these two species have previously been identified in Shatsk National Nature Park in the Volyn region, but represent natural complexes of the Polissya forest (Kumpanenko et al. 2021). *Andrena chrysopus* - oligolectic on asparagus - has already been mentioned for Kyiv (Honchar 2017), its location in Chornobyl, in a river valley with abundant *Asparagus* communities - is the northernmost location of distribution in Ukraine, although the species is also mentioned for the Minsk highlands (Apoidea of Belarus). It is particularly noteworthy that these species are 'data deficient' according to the European Red List of Bees and therefore require careful study of their population status, as there is insufficient information on their abundance across Europe. The location of the site and the availability of suitable habitat for its population only emphasise the crucial conservation value of the reserve. Our results will serve to build a more comprehensive picture of the distribution and abundance of species with insufficient data in Europe and the potential of the ChREBR to study ecosystem recovery characteristics through indicator species.

Conclusions

For the first time, 159 species of hymenopteran insects were recorded for the territory of ChREBR, including 79 species of bees (Colletidae - 11, Andrenidae - 10, Halictidae - 19, Mellitidae - 8, Megachilidae - 19 and Apidae - 18) and 74 species of wasps (Scoliidae - 3, Sapygidae - 1, Pompilidae - 21, Vespidae - 1, Sphecidae - 7, Crabronidae - 40). According to the European Red List, most of the bee species are in the «Least Concern» category, but there are also species listed as «Data Deficient» - 7 species, «Near Threatened» - 4 species, «Endangered» - 4 species, and «Vulnerable» - 1 species, which shows the high conservation value of the reserve. New finds of rare and protected species from the Red Data Book of Ukraine were registered: *Megascolia maculata*, *Sphex funerarius*, *Andrena chrysopus* («DD»), *Colletes nasutus* («EN»), *Dasypoda braccata* («EN»), *Melitta melanura* («EN»), *Trachusa interrupta* («EN»), *Xylocopa valga* («LC»).

The discovery of rare bee species associated with a narrow range of host plants also shows that the reserve has considerable potential to restore bee populations and habitats.

The data underpinning the analysis reported in this paper are deposited at GBIF, the Global Biodiversity Information Facility, and are available at (in the process of registration)

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References

Akimov IA (Ed.) (2009) Red Data Book of Ukraine. Animals. Hlobalkonsaltynh, Kyiv, 1–624 pp. ISBN: 9789669705907 [Chervona knyha Ukrayiny. Tvarynnyy svit] [in Ukrainian]

Ascher JS, Pickering J (2022) Discover Life bee species guide and world checklist (Hymenoptera: Apoidea: Anthophila).URL: https://www.discoverlife.org/mp/20q?guide=Apoidea_species

Banaszak J, Romasenko L (1998) Megachilid bees of Europe (Hymenoptera, Apoidea, Megachilidae). Bydgoszcz: Bydgoszcz University of Kazimiez Wielki, Bydgoszcz, 239 pp.

Bezrukov V, Møller AP, Milinevsky G, Rushkovsky S, Sobol M, Mousseau TA (2015) Heterogeneous relationships between abundance of soil surface invertebrates and radiation from Chernobyl. Ecological Indicators 52: 128–133. https://doi.org/10.1016/j.ecolind.2014.11.014

Bitsch Bitsch J (2017) Les Sapygidae d'Europe (Hymenoptera, Aculeata). Bulletin de la Société entomologique de France 122 (1): 7–34. [in French]

Bodingbauer S, Hörren T, Jacobs HJ, Kornmilch JC, Niehoff B, Schweitzer L, Voigt N, Heyde J, Witt R, Wübbenhorst J (2020) Expansion von *Sphex funerarius* Gussakovskij 1934 nach Norden (Hymenoptera, Sphecidae). Ampulex 11: 58–65. URL: [in German]http://www.ampulex.de/ampu11.pdf#page=58

Bogusch P, and Straka J (2012). Review and identification of the cuckoo bees of central Europe (Hymenoptera: Halictidae: Sphecodes). Zootaxa 3311(1): 1–41. https://doi.org/10.11646/ZOOTAXA.3311.1.1 URL: http://www.mapress.com/zootaxa/2012/f…

Day MC (1988) Spider wasps Hymenoptera: Pompilidae. Dorchester: Royal Entomological Society of London, Dorchester, 60 pp. URL https://www.royensoc.co.uk/wp-content/uploads/2021/12/Vol06_Part04.pdf

Drozda V (2017) The Life life Strategies strategies and Structure structure of Populations populations of *Tortrix tortrix* moths (Lepidoptera, Tortricidae) in Ecosystems ecosystems of the Exclusion exclusion Zone zone of the Chernobyl Nuclear nuclear Power power Plantplant. Agrobiodiversity for Improving Nutrition, Health and Life Quality, 1,: 108–113. http://sandbox.agrobiodiversity.uniag.sk/scientificpapers/article/view/38

Fateryga AV, Shorenko KI (2012) Scoliid wasps (Hymenoptera: Scoliidae) in the fauna of the Crimea. Ukrainska Entomofaunistyka 3(2): 11–20. [in Russian]

Gorobchishin V (2005) Digger wasps (Hymenoptera: Sphecidae: Sphecinae, Astatinae, Pemphredoninae) of Forestforest-steppes of Ukraine (fauna and ecology information). Proceedings of Zoological Muséum of Kyiv Taras Shevchenko National UniversityProceedings of Zoological museum of Kiev Taras Shevchenko National university Kyiv: «Kyiv university», Vol. 3: 46–63. [in Ukrainian]

Gorobchishin V (2006) Digger wasps (Hymenoptera: Sphecidae: Larinae, Amphilantinae, Crabroninae, Melininae) of forest-steppes of Ukraine (fauna and ecology information). Proceedings of Zoological museum of Kiev Taras Shevchenko National University. Kyiv, Vol. 4: 105–154. [in Ukrainian]

Gorobchyshyn VA, and Protsenko YV (2004) Digger wasps (Hymenoptera, Sphecidae) of the Ivano-Rybalchan district of the Black Sea Reserve and some of their ecological features. Bulletin of Kyiv University. Problems of regulation of physiological functions. Issue, 9:, 39–40. [in Ukrainian]

Gros E (1994) Notes sur la biologie de quelques *Priocnemis* Schioedte (Hymenoptera, Pompilidae). Bulletin de la Société entomologique de France 99(4): 357–364. [in French] https://www.persee.fr/doc/bsef_0037-928x_1994_num_99_4_17075

Hochkirch A, Vujić A, Flinn G (2021) Species Action Plans for EU Pollinators – Shortlist of 15 Species Action Plans. Action Plans for conservation of threatened pollinator species in the EU Contract 07.0202/2020/839411/SER/ENV.0.2

Hostert P, Kuemmerle T, Prishchepov A, Sieber A, Lambin EF, Radeloff VC (2011) Rapid land use change after socio-economic disturbances: the collapse of the Soviet Union versus Chernobyl. Environmental Research Letters 6(4): 045201. http://dx.doi.org/10.1088/1748-9326/6/4/045201

Kazenas VL (2001) Fauna and biology of digger wasps (Hymenoptera, Sphecidae) of Kazakhstan and Central Asia. Almaty: Nauka, Almaty, 320 pp. [in Russian]

Kratschmer S, Zettel H, Ockermüller E, Zimmermann D, Schoder S, Neumayer J, Gusenleitner F, Zenz K, Mazzucco K, Ebmer AW, Kuhlmann M (2021) Threat ahead? An experts' opinion on the need for red lists of bees to mitigate accelerating extinction risks – the case of Austria. Bee World. 2021 Jul 27, 98(3): 74–77. https://doi.org/10.1080/0005772X.2021.1940734

Kumpanenko AS (2018) Fauna of the spider wasps (Hymenoptera: Pompilidae) of the Kaniv Nature Reserve and the park 'Theophania'. The Kharkov Entomological Society Gazette The Kharkov Entomol. Soc. Gaz. Vol. XXVI26 (1): 50–54. [in Russian]

Kumpanenko OS, Honchar HY, Gorobchyshyn VA, Protsenko YV (2021) Preliminary list of some Aculeata (Hymenoptera: Chrysidoidea, Pompiloidea, Vespoidea, Apoidea) of the Shatsk National Natural Park (Volyn Region, Ukraine). The Kharkov Entomological Society Gazette 29(1): pp. 8–19. http://dx.doi.org/10.36016/KhESG-2021-29-1-2

Kurzewski FF (1987) A review of nesting behavior in the *Tachysphex pompiliformis* group, with observations on five species (Hymenoptera: Sphecidae). Journal of the Kansas Entomological Society 60(1): 118–126.

Lebedev AG (1933) To the knowledge of the fauna and ecology of pollinating insects of flowering plants. I. Bees of Kyiv region. Collection of Works of the Sector of Ecology of the Terrestrial Animals, 1: 13–50. [in Ukrainian]

Litopys pryrody, Chornobyl′s′kyy radiatsiyno ekolohichnyy biosfernyy zapovidnyk (2022), tom 5: 269 s [Annals of nature, Chernobyl radiation ecological biosphere reserve, volume 5: 269 p.] [in Ukrainian] URL: https://zapovidnyk.org.ua/files-pdf/litopys_2021_tom_5.pdf

Løoken A (1973) Studies on Scandinavian Bumble bumble Bees bees (Hymenoptera, Apidae). Norwegian Journal of Entomology 20(1): 1–218.

Løoken A (1984) Scandinavian species of the genus *Psithyrus*, Lepeletier (Hymenoptera: Apidae). Entomologica Scandinavica 23: 1–45.

Loktionov VM, Leley AS (2014) Spider wasps (Hymenoptera: Pompilidae) of the Russian Far East. Vladivostok: Dalnauka, Vladivostok, 472 pp. [Loktionov VM, Leley AS (2014) Dorozhnyye osy (Hymenoptera: Pompilidae) Dal'nego Vostoka Rossii. Vladivostok: Dal'nauka] [in Russian]

Lomholdt O (1975) The Sphecidae (Hymenoptera) of Fennoscandia and Denmark. // Fauna Entomologica Scandinavica. Vol. 4: 1–450.

Michez D, and Eardley C (2007) Monographic revision of the bee genus *Melitta* Kirby 1802 (Hymenoptera: Apoidea: Melittidae). Annales de la Société entomologique de France, 43(4): 379–440. https://doi.org/10.1080/00379271.2007.10697535

Møller AP, Barnier F, Mousseau TA (2012) Ecosystems effects 25 years after Chernobyl: pollinators, fruit set and recruitment. Oecologia 170(4): 1155–1165. https://doi.org/10.1007/s00442-012-2374-0

Møller AP, Mousseau TA (2006) Biological consequences of Chernobyl: 20 years on. Trends in ecology & evolution 21(4): 200–207. https://doi.org/10.1016/j.tree.2006.01.008

Møller AP, Mousseau TA (2009) Reduced abundance of insects and spiders linked to radiation at Chernobyl 20 years after the accident. Biology Letters 5(3): 356–359. https://doi.org/10.1098/rsbl.2008.0778

Møller AP, Nishiumi I, Suzuki H, Ueda K, Mousseau TA (2013) Differences in effects of radiation on abundance of animals in Fukushima and Chernobyl. Ecological Indicators 24: 75–81. http://dx.doi.org/10.1016/j.ecolind.2012.06.001

Mousseau TA, Møller AP (2012) Entomological studies in Chernobyl and Fukushima. American Entomologist 58(3): 148–150.

Nemkov PG (1990) Digger wasps of the Gorytini tribe of the fauna of the USSR (Hymenoptera, Sphecidae). Genera *Gorytes*, *Pseudoplisus*, *Kohlia*. Entomological review T. LXIX69(3): 675–680. [in Russian]

Nieto A, Roberts SPM, Kemp J, Rasmont P, Kuhlmann M, García Criado M, Biesmeijer JC, Bogusch P, Dathe HH, Dela Rúa P, De Meulemeester T, Dehon M, Dewulf A, Ortiz-Sánchez FJ, Lhomme P, Pauly A, Potts SG, Praz C, Quaranta M, Radchenko VG, Scheuchl E, Smit J, Straka J, Terzo M, Tomozii B, Window J, Michez D (2014) European Red List of Bees. Publication Office of the European Union, Luxembourg, 86. https://doi.org/10.2779/77003

Oehlke J, Wolf H (1987) Beiträge zur Insekten-Fauna der DDR: Hymenoptera – Pompilidae. Beiträge zur Entomologie 37(2): 279–390. [in German] https://doi.org/10.21248/contrib.entomol.37.2.279-390

Osytshnjuk AZ, Romasenko L, Banaszak J, Cierzniak T (2005) Andreninae of the Central and Eastern Palaearctic, Part 1. Polish Entomological Society, Poznań, Bydgoszcz, 426 pp.

Osytshnjuk AZ, Romasenko L, Banaszak J, Motyka E (2008) Andreninae of the Central and Eastern Palaearctic, Part 2. Polish Entomological Society, Poznań, Bydgoszcz, Andreninae of the Central and Eastern Palaearctic, 240 p

Osytshnjuk, GZ (1977). Fauna of Ukraine. Volume 12. Bees. Issue 5. Andrenid bees. Kyiv (Naukova Dumka, Kyiv), 328 pp. [in Ukrainian]

Osytshnjuk, GZ (1977). Fauna of Ukraine. Volume 12. Bees. Issue 5. Andrenid bees. Kyiv (Naukova Dumka), 328 p

Pesenko YA, Banaszak J, Radchenko VG (2000) Bees of the family Halictidae (excluding *Sphecodes*) of Poland: taxonomy, ecology, bionomics. Wydawnictwo Uczelniane Wyższej Szkoły Pedagogicznej w BydgoszczyWydawnictwo Uczelniane, 348 pp.

Petrov MF (2016) Botanical and geographical research of the Chornobyl zone. Problems of the Chornobyl exclusion zone 15–16: 52–263. [in Ukrainian]

Pulawski WJ (2021) Catalog of Sphecidae sensu lato (= Apoidea excluding Apidae). URL: https://www.calacademy.org/scientists/projects/catalog-of-sphecidae

Raines KE, Whitehorn PR, Copplestone D, Tinsley MC (2020) Chernobyl-level radiation exposure damages bumblebee reproduction: a laboratory experiment. Proceedings of the Royal Society B 287(1937): 20201638. https://doi.org/10.1098/rspb.2020.1638

Rasmont P, Devalez J, Pauly A, Michez D, Radchenko VG (2017) Addition to the checklist of IUCN European wild bees (Hymenoptera: Apoidea). Annales de la Société entomologique de France (NS) 53(1): 17–32. https://doi.org/10.1080/00379271.2017.1307696

Scheuchl E (1995) Illustrierte Bestimmungstabellen der Wildbienen Deutschlands und Österreichs. Band I: Anthophoridae [Illustrated determination tables for the wild bees of Germany and Austria. Volume 1: Anthophoridae]. Apollo Books, 158 pp. [in German]

Scheuchl E (1996) Illustrierte Bestimmungstabellen der Wildbienen Deutschlands und Österreichs. Band II: Megachilidae / Melittidae [Illustrated determination tables for the wild bees of Germany and Austria. Volume 2: Megachilidae]. Apollo Books, 116p. [in German]

Shlyakhtenok AS (2006) Species composition and structure of communities family digger wasps Hymenoptera, Sphecidae in Polesye Radiological Nature Reserve. Proceedings of the National Academy of Sciences of Belarus. Biological series 3: 109–115. [In Russian].

Shlyakhtenok AS (2007) Species composition and structure family communities of spider wasps (Hymenoptera, Pompilidae) in Polesie Radiological Nature Reserve. Proceedings of the National Academy of Sciences of Belarus. Biological series 3: 91–96. [In Russian].

Shlyakhtenok AS (2010) Wasps of family Tiphiidae, Scoliidae, Sapygidae, Chrysididae, Mutillidae (Hymenoptera, Aculeata) of Polesie Radiological Nature Reserve. Proceedings of the National Academy of Sciences of Belarus. Biological series 1: 104–110. [In Russian].

Shlyakhtenok AS, Agunovich RG (2008) The analyses of species diversity of family Vespidae (Hymenoptera) Polesie Radiological Nature Reserve. Proceedings of the National Academy of Sciences of Belarus. Biological series 4: 113–119. [In Russian].

Stovbchatyy VM, Rodionova NV (2011) Zoologists in the «Red Forest». Vestnik zoologii Visnyk of Zoology 45 (2): 99–104. [in Ukrainian]

Tischendorf S, Dieterich D (2020). Nachweis der Dolchwespe *Megascolia maculata* (Drury 1773) in Hessen (Hymenoptera, Scoliidae) – Wird die größte europäische Hautflüglerart in naher Zukunft zu einem festen Bestandteil der deutschen Fauna?Nachweis der Dolchwespe Megascolia maculata (Drury 1773) in Hessen (Hymenoptera, Scoliidae). Ampulex 11: 18–21. [in German]

AMPULEX, 18.

Tishchenko OG, Landyin VP (2020) Changes in the underlying surface and vegetation in the Chornobyl Exclusion Zone during 1986–2017. Yaderna Energetika ta Dovkyillya, 4(19): 75–84. [in Ukrainian] http://dx.doi.org/10.31717/2311-8253.20.4.9

Voblenko A, Gorobchishin V, Nesterov M (1996) Digger wasps (Hymenoptera, Sphecidae) of Ukrainian Polesye. Sphecos. N30: 14–15.

Wahis R (2006) Mise à jour du Catalogue catalogue systématique des Hyménoptères hyménoptères Pompilides pompilides de la région ouesteuropéenne. Additions et Correctionscorrections [Update of the systematic catalog of pompilid hymenoptera in the Western European region. Additions and corrections]. Notes Fauniques de Gembloux 59(1): 31–36. [in French]

Yablokov AV, Nesterenko VB, Nesterenko AV, Sherman-Nevinger JD (2010) Chernobyl: Consequences consequences of the Catastrophe catastrophe for People people and the Environmentenvironment. Blackwell, Boston, 39: 327 pp. John Wiley & Sons.

Yoshioka A, Mishima Y, Fukasawa K (2015) Pollinators and other flying insects inside and outside the Fukushima evacuation zone. PLoS One 10(11): e0140957. https://doi.org/10.1371/journal.pone.0140957

*** Annals of nature, Chernobyl radiation ecological biosphere reserve, volume 5 (2022) 269 pp. [in Ukrainian] https://zapovidnyk.org.ua/files-pdf/litopys_2021_tom_5.pdf

*** Apoidea of Belarus.

*** Decree of the Ministry of Environmental Protection of Ukraine and natural resources of Ukraine № 29 List animal species listed in the Red Book of Ukraine (animal world), 19.01.2021 [in Ukrainian] https://zakon.rada.gov.ua/laws/show/z0260-21#n10

*** Decree of the President of Ukraine № 174/2016 About the creation of the Chernobyl radiation and ecological biosphere reserve, 26.04.2016 [in Ukrainian] https://zakon.rada.gov.ua/laws/show/174/2016#Text

*** Decree of the Ministry of Environmental Protection of Ukraine and natural resources of Ukraine, January 19, 2021 No. 29 List animal species listed in the Red Book of Ukraine (animal world)] [in Ukrainian] URL: https://zakon.rada.gov.ua/laws/show/z0260-21#n10

*** Ukaz Prezydenta Ukrayiny № 174/2016 Pro stvorennya Chornobyl′s′koho radiatsiyno-ekolohichnoho biosfernoho zapovidnyka [Decree of the President of Ukraine № 174/2016 About the creation of the Chernobyl radiation and ecological biosphere reserve, 26.04.2016], URL: https://zakon.rada.gov.ua/laws/show/174/2016#Text [in Ukrainian]