DIVERSITY AND DISTRIBUTION OF GENUS *Ceratina* Latreille, 1802 IN BOSNIA AND HERZEGOVINA (Hymenoptera: Apidae)

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Original scientific paper

Summary

The paper presents a check list and distribution of species belonging to the genus *Ceratina* in Bosnia and Herzegovina during the period 2018-2023. Data on the diversity and distribution of *Ceratina* species have not been previously published. In addition to the field-collected material, specimens of *Ceratina* species stored in the collection of the National Museum of Bosnia and Herzegovina were included in the species overview. A total of six species belonging to the genus *Ceratina* were recorded, representing 23% of the European fauna and 55% of the *Ceratina* species fauna in the Western Balkan Peninsula region. The distribution of species was analyzed based on their occurrence in relation to the biogeographical regions of Bosnia and Herzegovina, with most findings in the Mediterranean region, 50% of occurrences. All six identified species from Bosnia and Herzegovina are represented in the Mediterranean region.

Key words*: solitary bees, pollination, biodiversity, conservation*.

INTRODUCTION

Genus *Ceratina* stands as the exclusive genus within the Ceratinini tribe. A total of 26-27 species have been recorded in Europe (Michez *et al*., 2019; Ghisbain *et al*., 2023). The distribution of Ceratinini spans across all continents, with limited local distribution observed in a few Asian species (Terzo, 2000). For instance, the subgenus *Euceratina* exhibits endemism in the West-Palearctic and Central Asian region. Ceratinini are characterized as diminutive, long-tongued bees, exhibit three submarginal cells, with the second cell assuming an almost triangular shape. The cuticle displays vibrant metallic blue hues in numerous species, occasionally revealing golden-green tones or, less frequently, black. Male individuals feature a conspicuous yellow or ivory white spot on the clypeus, while most females possess a smaller spot centrally located. The antennae exhibit a broadening towards the tip. *Ceratina* species are solitary bees that nest in stems. They excavate burrows into the pith along an extensive length of the stem, installing cells in a linear arrangement, each separated by partitions crafted from chewed medulla. The emerging adults of the subsequent generation appear at the end of the season, overwintering as adults before departing the nest in the ensuing spring or summer. During summer, these bees emerge and often survive winter in groups within

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hollow stems. Mating occurs in spring, followed by nest construction in stems rich in pith, utilizing the remaining pith to seal the cells. Females carve nesting burrows in dead, dry, and broken wood, or herbaceous stems where the pith is exposed. Pollen is collected using the hairs on their hind legs and stored in the crop (Terzo & Rasmont, 2011). *Ceratina* species are notably thermophilic, with their activity heightened by rising daytime temperatures (Terzo *et al*., 1994; Michez *et al*., 2019). Consequently, they are primarily found in the Mediterranean biogeographical region and become active as soon as spring arrives in warmer climates. The species diversity decreases significantly with increasing distance from the Mediterranean climate, whether in altitude towards mountains or in more northern regions of Europe. Most pollinators, including wild bees, exhibit negative population trends (Potts *et al*., 2010; Goulson *et al*., 2015; Dicks *et al*., 2021; Ghisbain *et al*., 2021). The primary drivers of pollinators population decline involve habitat loss due to changes in land use and management practices (Kremen *et al*., 2002; Steffan-Dewenter and Westphal 2008; Kennedy *et al*., 2013) and climate change (González-Varo *et al*., 2013; Martinet *et al*., 2021). Regarding the status and trends of bees (*Anthophila*) in Europe, the European Red List of Bees (Nieto *et al*., 2014) reveals that 37% of bee species, excluding Data Deficient cases, are experiencing population declines. Additionally, various national Red Lists in Europe suggest that up to 40% of bee species face threats (Drossart *et al*., 2019).

Recognizing the prevailing deficiencies in information pertaining to pollinator taxonomy and distribution data, especially the limited availability of publicly accessible records detailing national occurrences, two recent studies in Europe have been undertaken to revise the inventory of European bees (Ghisbain *et al*., 2023) and the country-specific records of European bees (Reverté *et al*., 2023).

It is particularly challenging in countries without long-term research and monitoring of pollinator status to implement protective measures and mitigate negative impacts.

In Bosnia and Herzegovina, data on the geographic distribution and status of bees are scarce, and there is a need for the publication of current information on pollinators (Reverté *et al*., 2023; Leclercq *et al*., 2023; Marshall *et al*., 2024). The paper presents data on the distribution of species from the genus *Ceratina*, which, until now, have not been recorded and published for Bosnia and Herzegovina.

MATERIAL AND METHODS

Field research of bees in Bosnia and Herzegovina was conducted in the period of six years, 2018-2023. Sampling was carried out using methods of active collection with an entomological net. The sampled material is stored as dry stuffed individuals at the University of Sarajevo, Faculty of Science, in the zoological collection of the Biology Department. The study also includes specimens from Viktor Apfelbeck collection stored in the National Museum of Bosnia and Herzegovina.

The preparation and identification of the collected material was prepared at the Department of Biology in the Laboratory of Ecology and Hydrobiology of the

University of Sarajevo - Faculty of Science. Specimens stored in the Zoological Collection of the National Museum were processed in the Museum. The processing and identification of the material was carried out by Adi Vesnić using taxonomical keys (Amiet *et al*., 2007).

The geographical distribution of the species was analyzed in the QGIS program, based on the coordinates of the localities taken in the field. The elevation data were collected from the DEM raster, the biogeographic division of Bosnia and Herzegovina into biogeographical regions data has been downloaded from the EEA Datahub.

For the museum specimen, locality data were taken from specimen labels and precisely plotted on the Google Earth map, at the exact locations specified by the toponyms on the labels.

The assessment of the number of *Ceratina* species involved a review of literature faunistic data from Bosnia and Herzegovina (Apfelbeck, 1896), Croatia (Vogrin, 1918), Serbia (Mudri-Stojnić, 2021; Nieto *et al*., 2014; Kuhlmann *et al.*, 2020; Rafajlović and Seleši, 1958; Vogrin, 1955, 1918; Markov, 2017; Markov *et al*., 2016; Živojinović, 1950; Petrik, 1958; Lebedev, 1931), Slovenia (Gogala, 2023), and Montenegro (Apfelbeck, 1896).

RESULTS AND DISCUSSION

In this study we examined 31 individuals collected in the field and nine specimens deposited in the collection of the Natural History Museum in Sarajevo. Individuals initially identified as *Ceratina callosa* were subsequently reclassified and treated as *Ceratina chalybea*. A total of six species were identified: *Ceratina (Ceratina) cucurbitina* (Rossi, 1792), *Ceratina (Euceratina) chalcites* Germar, 1839, *Ceratina (Euceratina) chalybea* Chevrier, 1872, *Ceratina (Euceratina) cyanea* (Kirby, 1802), *Ceratina (Euceratina) dentiventris* Gerstaecker, 1869, and *Ceratina (Euceratina) gravidula* Gerstaecker, 1869.

In the Western Balkan Peninsula, the genus *Ceratina* is represented by a total of 11 species. It is important to reassess the national faunistic lists of *Ceratina* species, especially considering that the current faunistic lists includes species whose distribution is not within the Balkan Peninsula, such as *Ceratina (Euceratina) loewi* and *Ceratina (Euceratina) nigroaenea* (Apfelbeck, 1896; Vogrin, 1918; Mudri-Stojnić, 2021). Additionally, species such as *Ceratina (Dalyatina) parvula*, *Ceratina (Euceratina) nigrolabiata*, and *Ceratina (Neoceratina) bispinosa* are absent from the national checklists for Western Balkan countries, despite their expected distribution according to the European distribution map (Terzo & Rasmont, 2011). Therefore, there is a need for research, evaluation and revision of the species distribution within the genus *Ceratina* in the Western Balkan region. In this study the species *Ceratina callosa* is treated as *Ceratina chalybea*, all the specimens of *C. callosa* from the National Museum of Bosnia and Herzegovina were redetermined as *Ceratina chalybea* Chevrier, 1872. The species *Ceratina callosa* is quoted in the national checklist for the Western Balkan Peninsula countries, and earlier authors used the name *Ceratina callosa* partly also for

the species *Ceratina chalybea* Chevrier, 1872. Considering the data from the Atlas Hymenoptera (*Ceratina callosa* is distributed in the western and central Mediterranean (Terzo & Rasmond, 2011) and not present in the Balkan region.

The most abundant species in our study is *Ceratina cyanea* (Figure 1-2.) with 19 occurrences (47.5%), followed by *Ceratina cucurbitina* with 11 occurrences (27.5%), *Ceratina chalybea* with 4 occurrences (10.0%), *Ceratina chalcites* with 3 occurrences (7.5%), *Ceratina gravidula* with 2 occurrences (5.0%), and *Ceratina dentiventris* with 1 occurrence (2.5%) (Table 1; Figure 3-8.).

Figure 1. *Ceratina gravidula*, male general habitus in lateral view
Figure 1. Mužjak vrste Ceratina gravidula, lateralno

Figure 2. *Ceratina cyanea*, female general habitus in lateral view
Figure 2. Ženka vrste Ceratina cyanea, lateralno

Table 1. Review of findings with faunistic data and coordinates, ZMBiH - samples from the Collection of the National Museum of Bosnia and Herzegovina; samples from the National Museum of Bosnia and Herzegovina collection in Bosnia and Herzegovina lacked sampling dates; ZOBY_AV – zoological collection of Adi Vesnić at Biology Department Sarajevo.
Tabela 1. Pregled nalaza sa faunističkim podacima i koordinatama, ZMBiH - uzorci iz zbirke Zemaljskog muzeja Bosne i Hercegovine, uzorci iz zbirke Zemaljskog muzeja Bosne i Hercegovine nemaju zabilježene datume uzorkovanja; ZOBY_AV – zoološka kolekcija Adija Vesnića na Odsjeku za biologiju Sarajevo.

Species	Date MM/DD/YYYY	Collection/ Leg	Latitude	Longitude	Locality
1. *Ceratina chalybea*	No records	ZMBiH/ Apfelbeck	43.827778	18.305967	Ilidža
2. *Ceratina chalybea*	No records	ZMBiH/ Vineguth	43.870595	18.385618	Hum- Sarajevo
3. *Ceratina chalybea*	No records	ZMBiH/ Vineguth	43.827380	18.373240	Lukavica
4. *Ceratina chalybea*	6/22/2019	ZOBY_AV	43.528988	18.087750	Kasici, Rakitnica
1. *Ceratina chalcites*	5/2/2018	ZOBY_AV	42.808392	17.998697	Kijev Do, Crkva
2. *Ceratina chalcites*	8/21/2020	ZOBY_AV	43.364050	17.850414	Suhi Do, Vrapcic
3. *Ceratina chalcites*	6/8/2021	ZOBY_AV/ Kulijer, D.	43.560176	18.246124	Krca
1. *Ceratina cucurbitina*	6/13/2019	ZOBY_AV	43.601443	17.705457	Diva Grabovca
2. *Ceratina cucurbitina*	5/2/2018	ZOBY_AV	42.808392	17.998697	Kijev Do, Crkva
3. *Ceratina cucurbitina*	6/17/2018	ZOBY_AV	42.918086	17.594843	Klek, Sedlo
4. *Ceratina cucurbitina*	4/29/2018	ZOBY_AV	42.926992	17.572038	Klek, Krmeci
5. *Ceratina cucurbitina*	4/29/2018	ZOBY_AV	42.926992	17.572038	Klek, Krmeci

6. *Ceratina cucurbitina*	8/17/2019	ZOBY_AV	43.991285	18.290234	Zupca, Breza
7. *Ceratina cucurbitina*	7/28/2019	ZOBY_AV/ Smailagic, L.	44.780612	19.314196	Bijeljina Ekocentar jezero
8. *Ceratina cucurbitina*	6/13/2019	ZOBY_AV	43.601443	17.705457	Diva Grabovica
9. *Ceratina cucurbitina*	No records	ZMBiH/ Vineguth	43.081426	17.953042	Stolac
10. *Ceratina cucurbitina*	No records	ZMBiH/ Apfelbeck	43.849159	18.355462	Alipašin most
11. *Ceratina cucurbitina*	No records	ZMBiH/ Vineguth	43.044073	17.784914	Dol.- blato, Hutovo blato
1. *Ceratina cyanea*	4/26/2021	ZOBY_AV/ Kulijer, D.	42.912684	17.609950	Gornji Klek, Neum
2. *Ceratina cyanea*	7/14/2018	ZOBY_AV	43.633847	17.042561	Livanjsko Polje, Plaza Busko
3. *Ceratina cyanea*	7/30/2019	ZOBY_AV/ Smailagic, L.	44.780612	19.314196	Bijeljina Ekocentar jezero
4. *Ceratina cyanea*	7/30/2019	ZOBY_AV/ Smailagic, L.	44.782388	19.319921	Bijeljina Ekocentar jezero
5. *Ceratina cyanea*	7/30/2019	ZOBY_AV/ Smailagic, L.	44.777050	19.326614	Bijeljina Ekocentar jezero
6. *Ceratina cyanea*	6/13/2019	ZOBY_AV	43.601443	17.705457	Diva Grabovica
7. *Ceratina cyanea*	6/22/2019	ZOBY_AV	43.528988	18.087750	Kasici, Rakitnica
8. *Ceratina cyanea*	6/26/2021	ZOBY_AV	42.847159	17.979742	Zavala
9. *Ceratina cyanea*	4/30/2018	ZOBY_AV	42.925049	17.583042	Klek
10. *Ceratina cyanea*	7/28/2019	ZOBY_AV/ Smailagic, L.	44.780965	19.325209	Bijeljina Ekocentar jezero
11. *Ceratina cyanea*	7/30/2019	ZOBY_AV/ Smailagic, L.	44.779454	19.318461	Bijeljina Ekocentar jezero
12. *Ceratina cyanea*	7/31/2019	ZOBY_AV/ Smailagic, L.	44.776277	19.329005	Bijeljina Ekocentar jezero
13. *Ceratina cyanea*	6/22/2019	ZOBY_AV	43.554628	18.074685	Rakitnica, usce
14. *Ceratina cyanea*	6/21/2019	ZOBY_AV	43.608013	18.259930	Visocica, Jelenjak
15. *Ceratina cyanea*	9/3/2021	ZOBY_AV	43.991084	18.290370	Zupca
16. *Ceratina cyanea*	9/10/2023	ZOBY_AV	43.991084	18.290370	Zupca
17. *Ceratina cyanea*	No records	ZMBiH/ Hilf	44.980612	17.901019	Dervent
18. *Ceratina cyanea*	No records	ZMBiH/ Vineguth	43.845614	18.394233	Vraca
19. *Ceratina cyanea*	No records	ZMBiH/ Vineguth	43.786769	19.010990	Banja stijena
1. *Ceratina dentiventris*	5/16/2020	ZOBY_AV	43.154621	17.771627	Pocitelj, Bivolje brdo
1. *Ceratina gravidula*	6/28/2021	ZOBY_AV	42.847159	17.979742	Zavala
2. *Ceratina gravidula*	6/22/2019	ZOBY_AV	43.554628	18.074685	Rakitnica, usce

Figure 3. Findings of *Ceratina (Ceratina) cucurbitina* (Rossi, 1792) in Bosnia and Herzegovina
Figure 3. Nalazi vrste Ceratina (Ceratina) cucurbitina (Rossi, 1792) u Bosni i Hercegovini

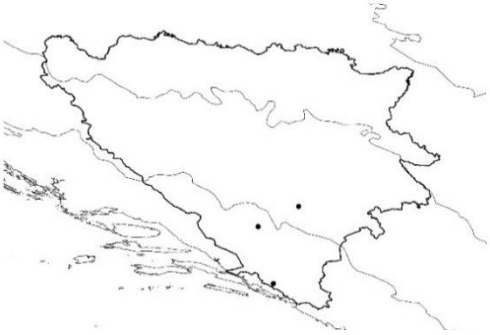

Figure 4. Findings of *Ceratina (Euceratina) chalcites* Germar, 1839 in Bosnia and Herzegovina
Figure 4. Nalazi vrste Ceratina (Euceratina) chalcites Germar, 1839 u Bosni i Hercegovini

Figure 5. Findings of *Ceratina* (*Euceratina) chalybea* Chevrier, 1872 in Bosnia and Herzegovina
Figure 5. Nalazi vrste Ceratina (Euceratina) chalybea Chevrier, 1872 u Bosni i Hercegovini

Figure 6. Findings of *Ceratina (Euceratina) cyanea* (Kirby, 1802) in Bosnia and Herzegovina
Figure 6. Nalazi vrste Ceratina (Euceratina) cyanea (Kirby, 1802) u Bosni i Hercegovini

Figure 7. Findings of *Ceratina (Euceratina) dentiventris* Gerstaecker, 1869 in Bosnia and Herzegovina
Figure 7. Nalazi vrste Ceratina (Euceratina) dentiventris Gerstaecker, 1869 u Bosni i Hercegovini

Figure 8. Findings of *Ceratina* (*Euceratina) gravidula* Gerstaecker, 1869 in Bosnia and Herzegovina
Figure 8. Nalazi vrste Ceratina (Euceratina) gravidula Gerstaecker, 1869 u Bosni i Hercegovini

Among the total number of samples, the distribution in the biogeographical regions of Bosnia and Herzegovina was: Mediterranean region 50% of the specimens, Dinaric region 30% and in Continental region 20% of the specimens. All species were present in the Mediterranean region, four in Dinaric and two species were registered in the Continental region (Figure 1-6; Table 2).

Table 2. Overview of species from the genus *Ceratina* by biogeographic regions of Bosnia and Herzegovina with the species altitude range.
Tabela 2. Pregled vrsta iz roda Ceratina po biogeografskim regijama Bosne i Hercegovine i vertikalnoj distribuciji.

Species	**Mediterranean**	**Dinaric**	**Continental**	**Altitude m**
1. Ceratina chalybea	1	3		563±150 (438-780)
2. Ceratina chalcites	2	1		785±760 (138-1623)
3. Ceratina cucurbitina	8	2	1	226±231 (35-599)
4. Ceratina cyanea	6	6	7	340±325 (39-1315)
5. Ceratina dentiventris	1			173
6. Ceratina gravidula	2			(276-342)
Total number of findings	**20**	**12**	**8**	359±344 (35-1623)

Elevated diurnal temperatures induce increased activity in *Ceratina* species (Terzo *et al*., 1994). The thermophilic character of species from the genus *Ceratina* is also reflected in the distribution of finds and species on the vertical distribution. The average altitude of the collected samples is 359±344 (35-1623), which also indicates the thermophilic character of species from the genus *Ceratina* in Bosnia and Herzegovina.

CONSLUSIONS

The current level of knowledge regarding species from the genus *Ceratina* in Bosnia and Herzegovina has not been thoroughly studied, and data on species diversity and distribution indicate a high degree of diversity and a need for future field research.
Current data on the distribution and diversity of species from the genus *Ceratina* show that the genus is represented by six species. It represents 55% of the species of the genus *Ceratina* in the Western Balkan Peninsula.
All species from the genus *Ceratina* in Bosnia and Herzegovina were recorded in the Mediterranean region, four species were recorded in the Dinaric and two species in the Continental region.
The limited number of findings and the low level of research, it is still not possible to estimate important bee areas, although the most likely centers of bee diversity in Bosnia and Herzegovina are the Mediterranean and sub-Mediterranean region.

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RAZNOLIKOST I RASPROSTRANJENOST RODA *Ceratina* Latreille, 1802 U BOSNI I HERCEGOVINI (Hymenoptera: Apidae)

Sažetak

U radu je prezentiran faunistički popis i rasprostranjenost vrsta iz roda *Ceratina* u Bosni i Hercegovini, na osnovu uzoraka prikupljenih u periodu 2018-2023. Uz terenski prikupljeni materijal, u faunistički i geografski pregled vrsta uključeni su i primjerci vrsta roda *Ceratina* pohranjeni u zbirci Zemaljskog muzeja Bosne i Hercegovine.
Zabilježeno je ukupno šest vrsta koje pripadaju rodu *Ceratina*, što predstavlja 23% evropske faune i 55% faune vrsta *Ceratina* u regionu Zapadnog Balkanskog poluostrva. Rasprostranjenost vrsta analizirana je na osnovu njihove zastupljenosti u odnosu na biogeografske regije Bosne i Hercegovine, pri čemu je najviše nalaza u mediteranskoj regiji, 50% nalaza. Svih šest identificiranih vrsta iz Bosne i Hercegovine zastupljeno je na području mediteranske regije, četiri vrste su zabilježene u dinarskoj i dvije vrste u kontinentalnoj regiji. Zbog ograničenog broja nalaza i niskog nivoa istraženosti, još uvijek nije moguće procijeniti značajna područja za pčele, iako su najvjerovatniji centri diverziteta pčela u Bosni i Hercegovini mediteranska i submediteranska regija.

Ključne riječi: *pčele samice, oprašivanje, biodiverzitet, zaštita.*