

New records of the genus *Temnostoma* Le Peletier & Serville, 1828 (Diptera: Syrphidae) in the NW Balkans

Novi nalazi roda *Temnostoma* Le Peletier & Serville, 1828 (Diptera: Syrphidae) na području sjeverozapadnog Balkana

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Abstract

The genus *Temnostoma* comprises saproxylic hoverflies whose larvae develop by boring into wet, decaying wood, where they feed on microorganisms. Records of these species in the northwestern Balkans are sparse in the literature and nearly absent from open-access databases. To enhance knowledge of their distribution in the region, we present new records of four *Temnostoma* species from Croatia, Bosnia and Herzegovina, and Serbia. Three species were recorded in all three countries, while *T. apiforme* was found exclusively in Croatia. This discovery marks not only the first record of this species in the country but also the first for the entire Balkan Peninsula. Furthermore, *Temnostoma meridionale* was documented in Bosnia and Herzegovina for the first time. Given that these hoverflies are large and visually striking, we hope this study will inspire interest among citizen scientists and encourage future contributions to the documentation of this genus in the region.

Keywords: Bosnia and Herzegovina, Croatia, diversity, hoverflies, Serbia, *Temnostoma apiforme*

Sažetak

Rod *Temnostoma* obuhvaća saproksilne cvjetne muhe čije se ličinke razvijaju bušeći mokro, truleće drvo, gdje se hrane mikroorganizmima. Podaci o ovim vrstama na sjeverozapadnom Balkanu rijetki su u literaturi i gotovo nepostojeći u dostupnim otvorenim bazama podataka. Kako bismo unaprijedili znanje o njihovoj rasprostranjenosti u regiji, predstavljamo nove nalaze četiriju vrsta roda *Temnostoma* iz Hrvatske, Bosne i Hercegovine te Srbije. Tri vrste zabilježene su u svim trima zemljama, dok je *T. apiforme* pronađena isključivo u Hrvatskoj. Ovo otkriće ne predstavlja samo prvi nalaz ove vrste u zemlji, već i prvi za cijeli Balkanski poluotok. Nadalje, *Temnostoma meridionale* prvi je put zabilježena u Bosni i Hercegovini. Budući da su ove cvjetne muhe krupne i vizualno upadljive, nadamo se da će ovo istraživanje potaknuti interes među građanskim znanstvenicima te pridonijeti povećanju broja zapisa o ovom rodu u regiji.

Ključne riječi: Bosna i Hercegovina, cvjetne muhe, Hrvatska, raznolikost, Srbija, *Temnostoma apiforme*

Introduction - Uvod

Among hoverflies, many species exhibit aposematic coloration, mimicking various Hymenoptera, primarily bumblebees, bees, and wasps (Van Veen 2010). Among the wasp mimics, the genus *Temnostoma* Le Peletier & Serville, 1828 stands out as one of the most convincing, with species resembling wasps not only in size and coloration but also in behaviour. The genus *Temnostoma* comprises of relatively large hoverflies (body length exceeding 10 mm) that closely mimic social wasps from the genera *Vespula* Thomson, 1869, and *Dolichovespula* Rohwer, 1916 (Żóralski and Mielczarek 2018). During flight they exhibit a striking behavior, raising their black front tarsi above their head, creating the illusion of long, wasp-like antennae (Lutovinovas and Kinduris 2015).

They inhabit moist deciduous forests, where they are often seen basking on leaves or twigs and visiting the flowers of understory plants. They exhibit territorial behaviour, chasing away larger insects from their vicinity. Highly skittish and fast, they react even to the slightest movement, quickly taking flight.

These are saproxylic species that develop inside dead and wet wood, either lying on the forest floor or partially submerged in flowing or standing water. Their larvae have a characteristic feature, the presence of two large, strongly sclerotized projections in the head region, which serve to abrade wet wood (Rotheray 1993, Krivosheina 2003).

So far, seven species of this genus have been recorded in Europe (Speight 2020). Their distribution in some parts of Europe is still far from sufficient and new country-distribution records continue to be published (Lutovinovas and Kinduris 2015, Żóralski and Mielczarek 2018). This is particularly true for Eastern Europe, where records of these species are still relatively scarce. For Bosnia and Herzegovina, no literature on these species has been published in the last 100 years (Strobl 1898, 1900). In Croatia, a single species, *Temnostoma bombylans* was recently recorded in Kopački Rit Nature Park (Jeličić et al. 2010). In Serbia these species are known to occur, *Temnostoma bombylans*, *T. meridionale* and *T. vespiforme*, but their records mostly date back to the 1990s (Radenković et al. 2013). For instance, in the largest citizen science database, iNaturalist, there are only two records from the area (iNaturalist 2024).

The aim of this study is to present new records of this genus in the three mentioned countries and to contribute to updating their current distribution in the region, as well as in Europe.

Materials and Methods - *Materijali i metode*

Specimens of the genus *Temnostoma* were collected in Croatia, Bosnia and Herzegovina, and Serbia between 2018 and 2024. In general, they were captured using an entomological net, then sacrificed and preserved. The specimens are housed in the entomology collection of the National Museum of Bosnia and Herzegovina (coll. NMBiH) or the private collections of the authors (Koren, Zagreb; Vujić, Belgrade). The collected material was identified using available identification keys (Bot and Van de Meutter 2023; Van Veen 2010).

The most of historical records of Syrphidae for Bosnia and Herzegovina, including published data (Glumac 1955; Strobl 1900, 1902) are based on the specimens stored in the entomological collections of the National Museum of Bosnia and Herzegovina (NMBiH). As these records were mainly collected at the end of the 19th and the beginning of the 20th century, dates are often missing on the labels, and they are not fully accurate about the location, so the approximate position is shown on the map. Or they were not included if the location of the finding site was not possible to determine with certainty (i.e. in cases when toponyms written on the labels are common throughout the country).

A literature review for the three countries was conducted by examining available publications, but for *T. meridionale* Krivosheina and Mamayev (1962) and *T. vespiforme* (Linnaeus 1758) only records from 1962 onwards were included in the distribution maps. This cutoff was chosen because the species *Temnostoma meridionale* were described by Krivosheina & Mamayev in 1962. Before that, all records of that species were grouped under *Temnostoma vespiforme*.

Regarding the presence of individual species in the country, we used the latest checklist of European bees and hoverflies, which includes a supplementary list of species by country (Reverté et al. 2023). Although this checklist is far from ideal and, in many cases, does not fully reflect the currently known fauna of a given country, it can serve as a useful reference for the general distribution and presence of species in a particular region.

For each species, the locality name, coordinates, dates, number of examined specimens, and the collector are documented (table 1). Known literature records are also cited, for the completeness of this overview. Additionally, notes on the significance of each record are provided.

Results and Discussion - Rezultati i rasprava

The literature records of the genus *Temnostoma* (Figure 1) in the three countries dealt with in this work are rather limited. For Croatia, only historical observations exist (Langhoffer 1919, Strobl 1902) except for one recent observation from Kopački Rit Nature Park (Jeličić et al. 2010). For Bosnia and Herzegovina only a handful, mostly century-old observations are available (Glumac 1955; Strobl 1900). For Serbia, the number of records is also limited but aside from historical records contain the records of this genus from the last few decades (Miličić et al. 2019; Radenković et al. 2013; Vujić et al. 1998; Živojinović 1950). If we consider all previous records of this genus in the three mentioned countries, there are fewer than 30 in total. Here, we present 54 new observations of this genus, which is significantly more than all previously recorded observations combined.

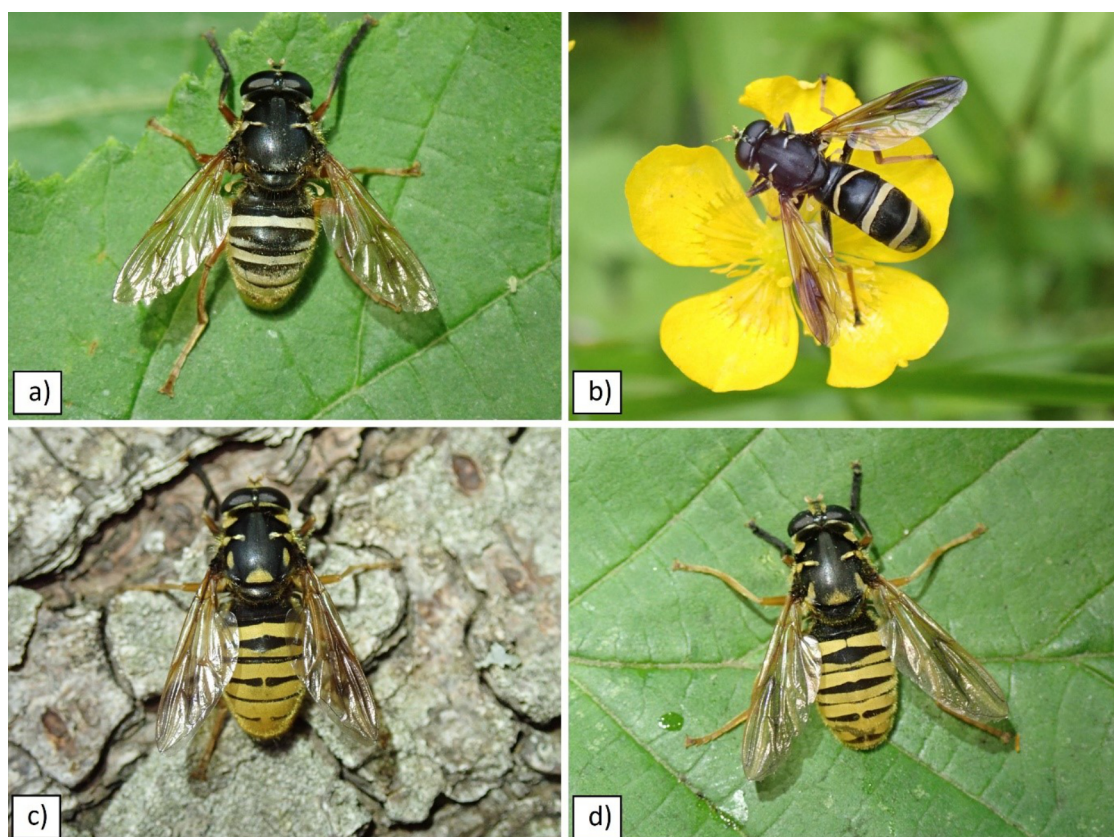


Figure 1 Species of the genus *Temnostoma* were recorded during this research. a) *Temnostoma apiforme* (Fabricius 1794), male, b) *Temnostoma bombylans* (Fabricius 1805), male c) *Temnostoma meridionale* Krivosheina i Mamayev, 1962, male, d) *Temnostoma vespiforme* (Linnaeus 1758), female, (Foto: T. Koren).

Slika 1. Vrste roda *Temnostoma* zabilježene ovim istraživanjem. a) *Temnostoma apiforme* (Fabricius 1794), mužjak, b) *Temnostoma bombylans* (Fabricius 1805), mužjak, c) *Temnostoma meridionale* Krivosheina and Mamayev 1962, mužjak, d) *Temnostoma vespiforme* (Linnaeus 1758), ženka, (Foto: T. Koren).

Table 1 Records of the genus *Temnostoma* in Croatia, Bosnia and Herzegovina, and Serbia.**Tablica 1.** Nalazi roda *Temnostoma* u Hrvatskoj, Bosni i Hercegovini te Srbiji.

Locality and habitat	Date	WGS N	WGS E	Collector
<i>Temnostoma apiforme</i> (Fabricius, 1794)				
Croatia, Jastrebarsko, forest west of Crna Mlaka, edge of deciduous forest	29.5.2020	45,61942	15,7008	Toni Koren
<i>Temnostoma bombylans</i> (Fabricius, 1805)				
Bosnia & Herzegovina, Kozara Mt., Tisovača stream, small stream valley in mixed deciduous forest	19.6.2023	45,02746	17,00756	Dejan Kulijer
Bosnia & Herzegovina, Vranica Mt., Travnička vrata, small meadow with a pond in mixed conifer and beech forest	20.6.2023	43,96239	17,7363	Dejan Kulijer
Bosnia & Herzegovina, Prenj Mt., Konjička Bijela, Rakov laz, deciduous woodland	15.6.2021	43,57874	17,93325	Dejan Kulijer
Bosnia & Herzegovina, Prenj Mt., Konjička Bijela, Bijela, deciduous woodland	15.6.2021	43,60538	17,95081	Dejan Kulijer
Serbia, Avala Mt., Čarapićev Brest, small stream valley in the ancient secondary forest of <i>Fagus x taurica</i> (<i>F. moesiaca</i>)	12.5.2018	44,69522	20,52167	Mihailo Vujić
Serbia, Vlasina, Čemernik Mt., Vlasina Rid, mesophilic meadow-shrub bordering with secondary <i>Fagus x taurica</i> forest	25.5.2018	42,72438	22,32473	Mihailo Vujić
Serbia, Vlasina, Čemernik Mt., Vlasina Rid, secondary mixed deciduous forest <i>Acer pseudoplatanus</i> / <i>Fagus x taurica</i>	26.5.2018	42,72547	22,32639	Mihailo Vujić
Serbia, Kopaonik Mt., Struga, no data	4.5.2019	43,29441	20,85769	Matija Zloporubović
Serbia, Avala Mt., Čarapićev Brest, small stream valley in the ancient secondary forest of <i>Fagus x taurica</i> (<i>F. moesiaca</i>)	28.4.2020	44,69522	20,52167	Mihailo Vujić
Serbia, Belgrade, Miljakovac, no data	3.5.2020	44,74846	20,46732	Milan Đurić
Serbia, Vardenik Mt., Masurica, Masurica river valley in ancient <i>Fagus x taurica</i> forest	3.6.2022	42,65703	22,17276	Ivan Tot
Serbia, Vlasina, Vlasina River, <i>Betula pendula</i> deciduous forest	30.7.2022	42,75149	22,32679	Mihailo Vujić
Serbia, Čemernik Mt., Cvetkova reka, mixed deciduous forest <i>Fagus x taurica</i> / <i>Acer pseudoplatanus</i> / <i>Betula pendula</i>	27.6.2024	42,74512	22,31277	Mihailo Vujić
Serbia, Avala Mt., Čarapićev Brest, small stream valley in the ancient secondary forest of <i>Fagus x taurica</i> (<i>F. moesiaca</i>)	19.5.2024	44,69522	20,52167	Mihailo Vujić
Croatia, Jastrebarsko, forest west of Crna Mlaka, edge of deciduous forest	29.5.2020	45,61942	15,7008	Toni Koren
Croatia, Zagreb, Savica, remains of willow forest around lakes	29.4.2020	45,7643	16,1809	Toni Koren
Croatia, NP Risnjak, Gerovski Kraj, Lazac meadows, a small meadow with a pond in mixed conifer and beech forest	18.6.2020	45,45145	14,60152	Toni Koren
Serbia, Crna Trava, habitat unknown	20.6.2021	42,86896	22,40405	/
Croatia, Mt. Papuk, Voćin, habitat unknown	2.5.2020	45,55401	17,60899	Marko Doboš

Table 1 Records of the genus *Temnostoma* in Croatia, Bosnia and Herzegovina, and Serbia.**Tablica 1.** Nalazi roda *Temnostoma* u Hrvatskoj, Bosni i Hercegovini te Srbiji.

Locality and habitat	Date	WGS N	WGS E	Collector
<i>Temnostoma bombylans</i> (Fabricius, 1805)				
Croatia, Gerovski Kraj, SW of the settlement, road edge, edge of <i>Fagus sylvatica</i> forest with rich vegetation	11.6.2020	45,48977	14,6279	Toni Koren
Croatia, Malogorski - Gorjani Sutinski, edge of <i>Quercus</i> forest, road edge	2.6.2020	46,18033	15,95838	Toni Koren
Croatia, Kupari, Kupa river valley, edge of <i>Quercus</i> and <i>Fagus sylvatica</i> forest, near a stream	21.5.2020	45,49485	14,69453	Toni Koren
Collection				
Bosnia & Herzegovina, Jablanica	1902	/	/	Apfelbeck, coll. NMBiH
Bosnia & Herzegovina, Ivan	1911	/	/	Winneguth, coll. NMBiH
Bosnia & Herzegovina, Ivan	1911	/	/	Winneguth, coll. NMBiH
Bosnia & Herzegovina, Lubin Th. bei Sarajevo	/	/	/	Apfelbeck, coll. NMBiH
Bosnia & Herzegovina, Hrid	/	/	/	coll. NMBiH
Serbia, Morović	13.V.1982	/	/	Ante Vujić, coll. FSUNS
Serbia, Dubašnica: Demizlok	12.VI.1994	/	/	S. Radnović, coll. FSUNS
Serbia, Dubašnica: Demizlok	4.VI.1995	/	/	Ante Vujić, coll. FSUNS
Serbia, Malinik	3.VI.1995	/	/	Ante Vujić, coll. FSUNS
Serbia, Mikuljska reka	4.VI.1993	/	/	S. Radnović, Ante Vujić, coll. FSUNS
Serbia, Fruška Gora, Petrovaradinski rit, Tekije	5.V.1985	/	/	P. Radišić, coll. FSUNS
Serbia, Kopaonik: Samokovska reka	22.VI.1991	/	/	S. Radenković, coll. FSUNS
Serbia, Kopaonik, Samokovska reka	19.VI.1996	/	/	V. Milankov, Ante Vujić, coll. FSUNS
Serbia, Suva planina, Čukljenik-Donja Studena	28.V.1985	/	/	P. Radišić, coll. FSUNS
Serbia, Vršacke planine, Ka Guduričkom vrhu	4.V.1986	/	/	Mesí c-Fiseš, coll. FSUNS
Serbia, Vršacke planine, Ka Guduričkom vrhu	8.VI.1994	/	/	Ante Vujić, coll. FSUNS
<i>Temnostoma meridionale</i> Krivosheina & Mamayev, 1962				
Bosnia & Herzegovina, Prenj Mt., Mostarska Bijela, on a dirt road in a deep karstic canyon with mixed broadleaved vegetation on the slopes	19.6.2021	43,49408	17,80494	Dejan Kulijer
Bosnia & Herzegovina, Tajan Mt., Duboka Tajašnica, deep narrow stream valley in dense mixed conifer and deciduous forest	5.6.2021	44,30498	18,22367	Dejan Kulijer

Table 1 Records of the genus *Temnostoma* in Croatia, Bosnia and Herzegovina, and Serbia.**Tablica 1.** Nalazi roda *Temnostoma* u Hrvatskoj, Bosni i Hercegovini te Srbiji.

Locality and habitat	Date	WGS N	WGS E	Collector
<i>Temnostoma meridionale</i> Krivosheina & Mamayev, 1962				
Bosnia & Herzegovina, Tajan Mt., Tisovački stream, deep narrow stream valley in dense mixed conifer and deciduous forest	5.6.2021	44,30391	18,22432	Dejan Kulijer
Serbia, Belgrade, Grocka Municipality, Vrčin, secondary mixed deciduous forest	2.5.2018	44,67215	20,62124	Mihailo Vujić
Serbia, Avala Mt., Čarapićev Brest, small stream valley in the ancient secondary forest of <i>Fagus x taurica</i> (<i>F. moesiaca</i>)	12.5.2018	44,69522	20,52167	Mihailo Vujić
Serbia, Avala Mt., Čarapićev Brest, small stream valley in the ancient secondary forest of <i>Fagus x taurica</i> (<i>F. moesiaca</i>)	26.4.2019	44,69522	20,52167	Mihailo Vujić
Serbia, Avala Mt., Čarapićev Brest, small stream valley in the ancient secondary forest of <i>Fagus x taurica</i> (<i>F. moesiaca</i>)	18.5.2019	44,69522	20,52167	Mihailo Vujić
Serbia, Belgrade, Grocka Municipality, Vrčin, secondary mixed deciduous forest	18.5.2019	44,67215	20,62124	Mihailo Vujić
Serbia, Belgrade, Grocka Municipality, Vrčin, secondary mixed deciduous forest	4.5.2020	44,67215	20,62124	Mihailo Vujić
Serbia, Belgrade, Grocka Municipality, Vrčin, secondary mixed deciduous forest	7.5.2020	44,67215	20,62124	Mihailo Vujić
Serbia, Avala Mt., Čarapićev Brest, small stream valley in the ancient secondary forest of <i>Fagus x taurica</i> (<i>F. moesiaca</i>)	8.5.2020	44,69522	20,52167	Mihailo Vujić
Serbia, Vardenik Mt., Masurica, Masurica river valley in ancient <i>Fagus x taurica</i> forest	11.5.2020	42,64716	22,18082	Mihailo Vujić
Serbia, Avala Mt., Čarapićev Brest, small stream valley in the ancient secondary forest of <i>Fagus x taurica</i> (<i>F. moesiaca</i>)	17.5.2020	44,69522	20,52167	Mihailo Vujić
Serbia, Vardenik Mt., Masurica, Masurica river valley in ancient <i>Fagus x taurica</i> forest	1.6.2022	42,65664	22,17307	Mihailo Vujić
Serbia, Vardenik Mt., Veliki Strešer, ancient <i>Fagus x taurica</i> forest	4.6.2022	42,63756	22,28385	Mihailo Vujić
Serbia, Vardenik Mt., Masurica, Masurica river valley in ancient <i>Fagus x taurica</i> forest	31.7.2022	42,64142	22,18483	Mihailo Vujić
Croatia, NP Risnjak, Crni Lug, Leska, edge of <i>Fagus sylvatica</i> forest with rich vegetation	19.6.2020	45,41944	14,67575	Toni Koren
Croatia, NP Risnjak, Kupa river valley, meadows near the stream, forest edge	21.5.2020	45,49591	14,69797	Toni Koren
Croatia, NP Risnjak, Kupa river valley, near Kupari village, forest edge	21.5.2020	45,49815	14,70076	Toni Koren
Collection				
Bosnia & Herzegovina, Stambulčić	1912	/	/	Apfelbeck, coll. NMBiH
Serbia, Kpaonik Samokovska reka	27.V.1994	/	/	Ante Vujić, coll. ESUNS

Table 1 Records of the genus *Temnostoma* in Croatia, Bosnia and Herzegovina, and Serbia.**Tablica 1.** Nalazi roda *Temnostoma* u Hrvatskoj, Bosni i Hercegovini te Srbiji.

Locality and habitat	Date	WGS N	WGS E	Collector
<i>Temnostoma vespiforme</i> (Linnaeus, 1758)				
Bosnia & Herzegovina, Ozren Mt., Milinkovac stream, small stream valley in mixed conifer and deciduous forest	27.5.2024	44,61209	18,24721	Dejan Kulijer
Bosnia & Herzegovina, Visočica Mt., Jelenjača, on <i>Sambucus ebulus</i> inflorescence by the road in beech forest	17.7.2022	43,60099	18,2644	Dejan Kulijer
Bosnia & Herzegovina, Ravan Mt., Pepelari, on a tree leaf along the dirt road in mixed conifer and deciduous forest	1.7.2020	44,30232	18,05302	Dejan Kulijer
Serbia, Avala Mt., Čarapićev Brest, small stream valley in the ancient secondary forest of <i>Fagus x taurica</i> (<i>F. moesiaca</i>)	12.5.2018	44,69522	20,52167	Mihailo Vujić
Serbia, Giljeva Mt., Trijebine, ancient <i>Pinus nigra</i> forest on serpentinite	9.7.2020	43,1911	19,89741	Mihailo Vujić
Serbia, Giljeva Mt., Trijebine, ancient <i>Pinus nigra</i> forest on serpentinite	9.7.2020	43,19046	19,89542	Milan Đurić
Serbia, Kostreševci, riparian linear forest <i>Alnus glutinosa</i> / <i>Salix alba</i> / <i>S. x fragilis</i> along Kostreševska river	9.6.2024	42,75384	22,44992	Mihailo Vujić
Croatia, Jastrebarsko, forests W of Crna Mlaka, edge of <i>Fraxinus</i> and <i>Quercus</i> forest with rich vegetation	29.5.2020	45,61942	15,7008	Toni Koren
Croatia, Gerovo, road edge toward M. Lug, edge of <i>Fagus sylvatica</i> forest with rich vegetation	9.7.2020	45,5205	14,64984	Toni Koren
Croatia, Gerovski Kraj, SE of the settlement, road edge, edge of <i>Fagus sylvatica</i> forest with rich vegetation	9.7.2020	45,49577	14,65555	Toni Koren
Croatia, Hum na Sutli, N of M. Tabor, edge of <i>Quercus</i> forest	2.6.2020	46,21987	15,67203	Toni Koren
Croatia, Malogorski - Gorjani Sutinski, edge of <i>Quercus</i> and <i>Fagus sylvatica</i> forest, near a stream	2.6.2020	46,17957	15,96019	Toni Koren
Collection				
Bosnia & Herzegovina, Stambulčić	/	/	/	Vl. Zoufal, coll. NMBiH
Bosnia & Herzegovina, Igman	/	/	/	Winneguth, coll. NMBiH
Bosnia & Herzegovina, Stambulčić	1928	/	/	Winneguth, coll. NMBiH
Bosnia & Herzegovina, Igman	1928	/	/	Winneguth, coll. NMBiH
Serbia, Fruška Gora, Vrdnik	23.V.1996	/	/	M. Horvatović, coll. FSUNS
Serbia, Kopaonik, Samokovska reka	19.VI.1996	/	/	Ante Vujić, coll. FSUNS

Temnostoma apiforme (Fabricius, 1794) (tab. 1, fig. 1a)**Published records:** none

This species is very similar to *T. vespiforme*, but not to the extent that it cannot be easily distinguished by several key characteristics. In the field, it can be recognized by its narrower and usually more white-yellow abdominal bands (Bot & Van de Meutter 2023). The most reliable distinguishing feature is the absence of wedge-shaped spots on the posterior corners of the scutum (Speight & Sarthou 2017).

Although this species has a wide geographic range, it has a relictual distribution pattern over much of its European range (Speight 2020). Its current distribution includes Northern Europe, as well as the northern and mountainous regions of Central Europe, extending into Asia as far as Japan (Speight 2020). Given this, the record from Croatia was quite unexpected. The only specimen was collected alongside several individuals of *T. vespiforme* on the same habitat edge of a deciduous forest (fig. 2). On that day, *Temnostoma* spp. were notably abundant along the forest edge, where they were observed both at rest and engaging in mating behavior.

The habitat in Croatia matches the typical conditions reported for this species in other parts of Europe: wet broad-leaved forests and forest edges, usually near a brook or stream (Bot & Van de Meutter 2023). This is the first record of *T. apiforme* in the Balkan peninsula.

Temnostoma bombylans (Fabricius, 1805) (tab. 1, fig. 1b)

Published records: Croatia (Langhoffer 1919; Strobl 1902 - without locality), Bosnia & Herzegovina (Strobl 1900), Serbia (Miličić et al. 2019; Radenković et al. 2013).

Morphologically, this species stands out significantly within the genus *Temnostoma*, as its overall appearance is more reminiscent of the genera *Ceriana* Rafinesque, 1815 or *Sphiximorpha* Rondani, 1850 (Speight 2020). However, unlike those genera, it possesses much shorter antennae. Although it is considered probably the most frequently encountered *Temnostoma* species in Europe, it is still classified as a very local species (Speight 2020). Through this study, we collected a substantial number of records, including three from Croatia, four from Bosnia and Herzegovina, and ten from Serbia. The new records fill gaps in the distribution between historical and literature-based records, indicating a connection between known populations and a broader distribution than previously recognized (Fig. 2).

The habitat of this species generally aligns with that of other species in the same genus - *Fagus* forests with over-mature trees, up to their upper altitudinal limits, as well as *Quercus*/*Carpinus*/*Ulmus* forests and old alluvial hardwood forests (Speight 2020; Van Veen 2010).

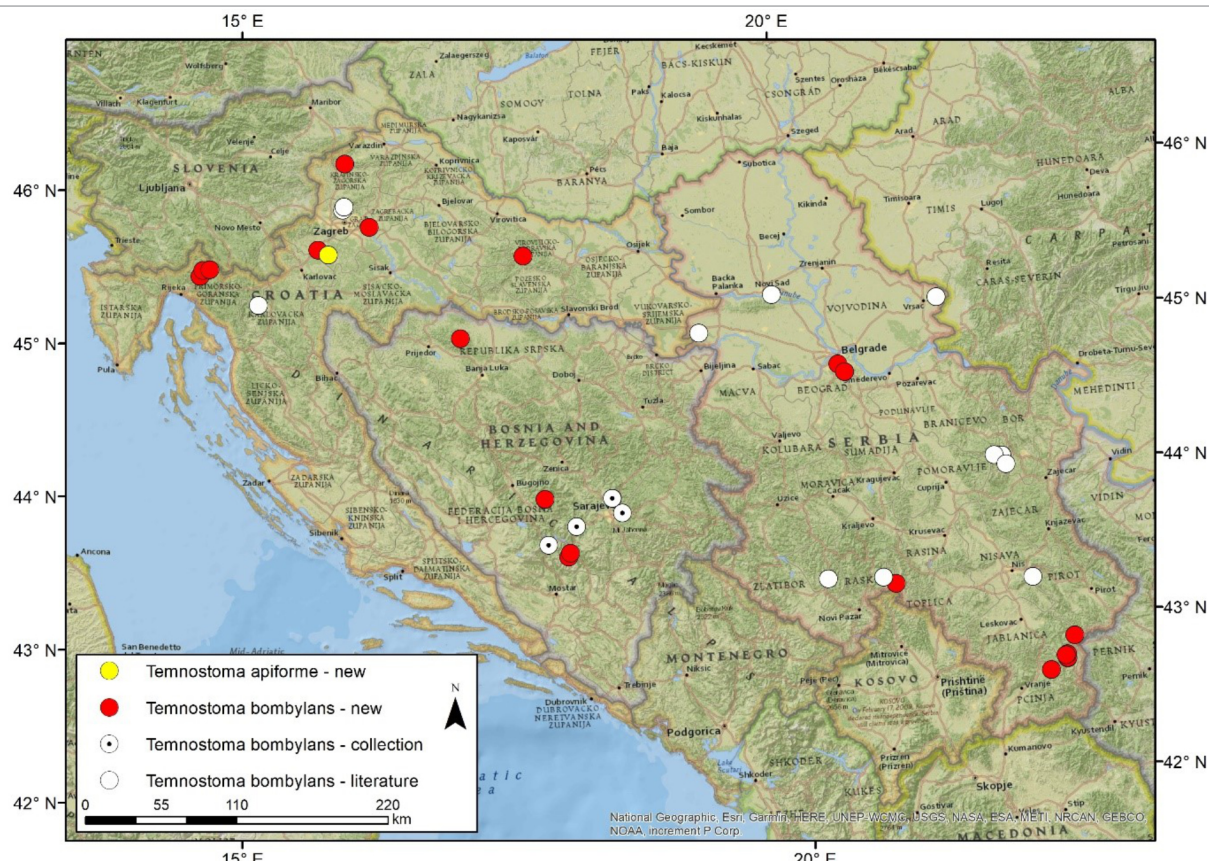


Figure 2 Distribution of *Temnostoma apiforme* and *Temnostoma bombylans* in Croatia, Bosnia and Herzegovina, and Serbia based on new, literature and collection records.

Slika 2. Rasprostranjenost vrsta *Temnostoma apiforme* i *Temnostoma bombylans* u Hrvatskoj, Bosni i Hercegovini i Srbiji temeljena na novim, literaturnim i opažanjima iz zbirke.

Temnostoma meridionale Krivosheina and Mamayev, 1962 (Table 1, Figure 1c)

Published records: Croatia (Reverté et al. 2023), Serbia (Radenković et al. 2013; Vujić et al. 1998).

This species can be easily distinguished from *T. vespiforme* by its distinct yellow markings. In this species, the yellow marks are located immediately anterior to the postalar calli but do not extend onto them, whereas in *T. vespiforme* the yellow markings are continuous from immediately anterior to the postalar calli onto the calli themselves (Speight and Sarthou 2017).

Temnostoma meridionale is widely distributed across Europe, including Sweden, Finland, Estonia, Latvia, Denmark, Poland, Germany, Luxembourg, central and southwest France (including the Pyrenees), the Czech Republic, Slovenia, the Balkan Peninsula, as well as European parts of Russia and the Caucasus (Speight 2020).

During this survey, we recorded it at two localities in Croatia, three in Bosnia and Herzegovina, and five in Serbia. This represents a significant expansion of its known range within these three countries, as the only recent records were previously limited to two localities in Serbia. The findings from Bosnia and Herzegovina further extend its known distribution to this country. In the material stored in the collection of the National Museum of Bosnia and Herzegovina, one specimen of *T. meridionale* from Stambulčić (Apfelbeck, coll.) reidentified from several stored *T. vespiforme* specimens additionally complementing the species distribution in the region (Figure 3).

Given that this species prefers beech and thermophilous oak forests with an abundance of overmature and fallen trees (Speight and Sarthou 2017) —habitats that are for example particularly common in central and northern Croatia—we expect that the number of future records will continue to increase.

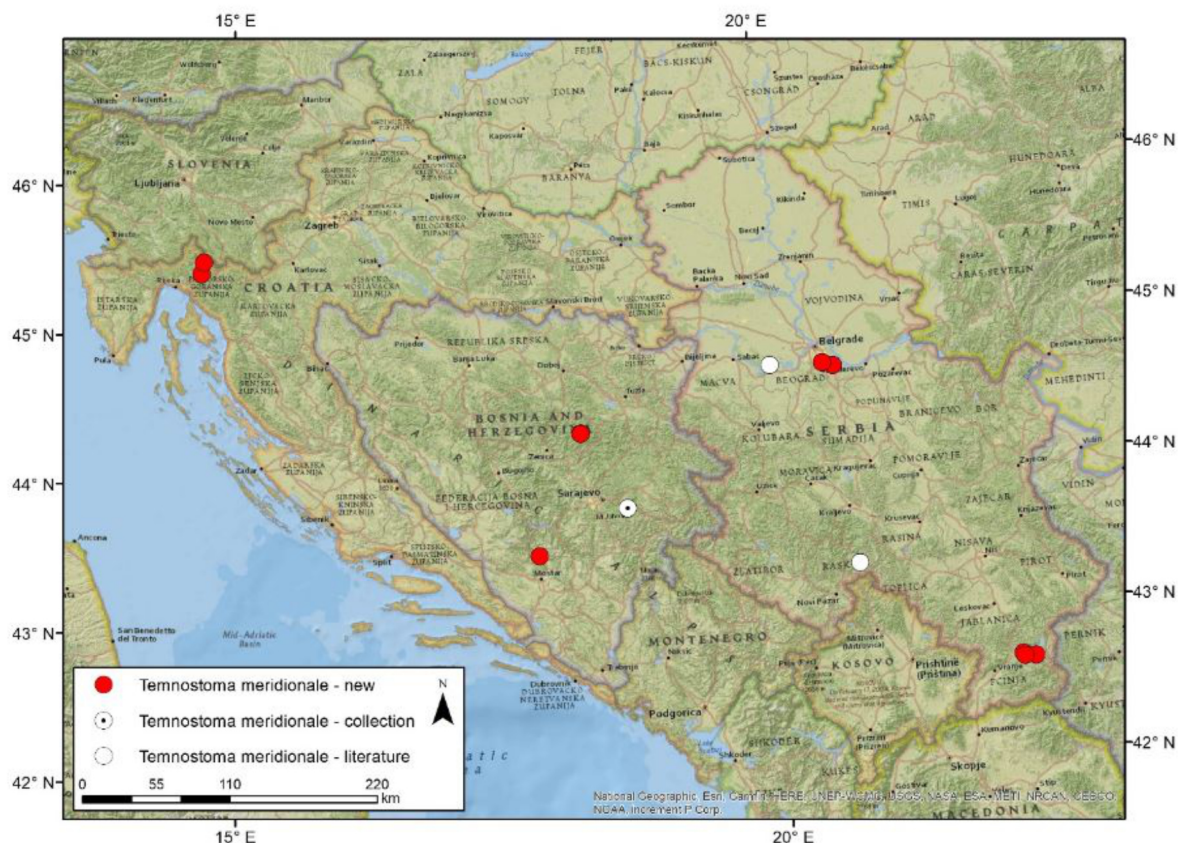


Figure 3 Distribution of *Temnostoma meridionale* in Croatia, Bosnia and Herzegovina, and Serbia based on new, literature and collection records.

Slika 3. Rasprostranjenost vrste *Temnostoma meridionale* u Hrvatskoj, Bosni i Hercegovini i Srbiji temeljena na novim, literaturnim i opažanjima iz zbirke.

Temnostoma vespiforme (Linnaeus, 1758) (tab. 1, fig. 1d)

Published records: Croatia (Jeličić et al. 2010), Bosnia & Herzegovina (Glumac 1955; Strobl 1900, 1902) – may include *T. meridionale*, Serbia (Miličić et al. 2019, Radenković et al. 2013).

Due to ongoing confusion with *T. meridionale* and *T. sericomyiaeforme* (Portschinsky, 1886) in northern Europe, the distribution of this species in Europe requires reassessment (Speight 2020). The currently assumed range extends from Sweden southward to northern Spain, from northern France eastward across most of Europe, and further through the Asian regions of Russia to the Pacific coast and Japan. Additionally, it is recorded in the Caucasus and in the Nearctic, where its range spans from Alaska south to New Mexico and east to Quebec (Speight 2020).

The range of this species in the study area has been expanded with new records and additional verification of literature data (Figure 4). In general, the species inhabits the same habitats as *T. meridionale* at many localities, suggesting that it is likely to be recorded in additional well-preserved forest habitats across the region in the future.

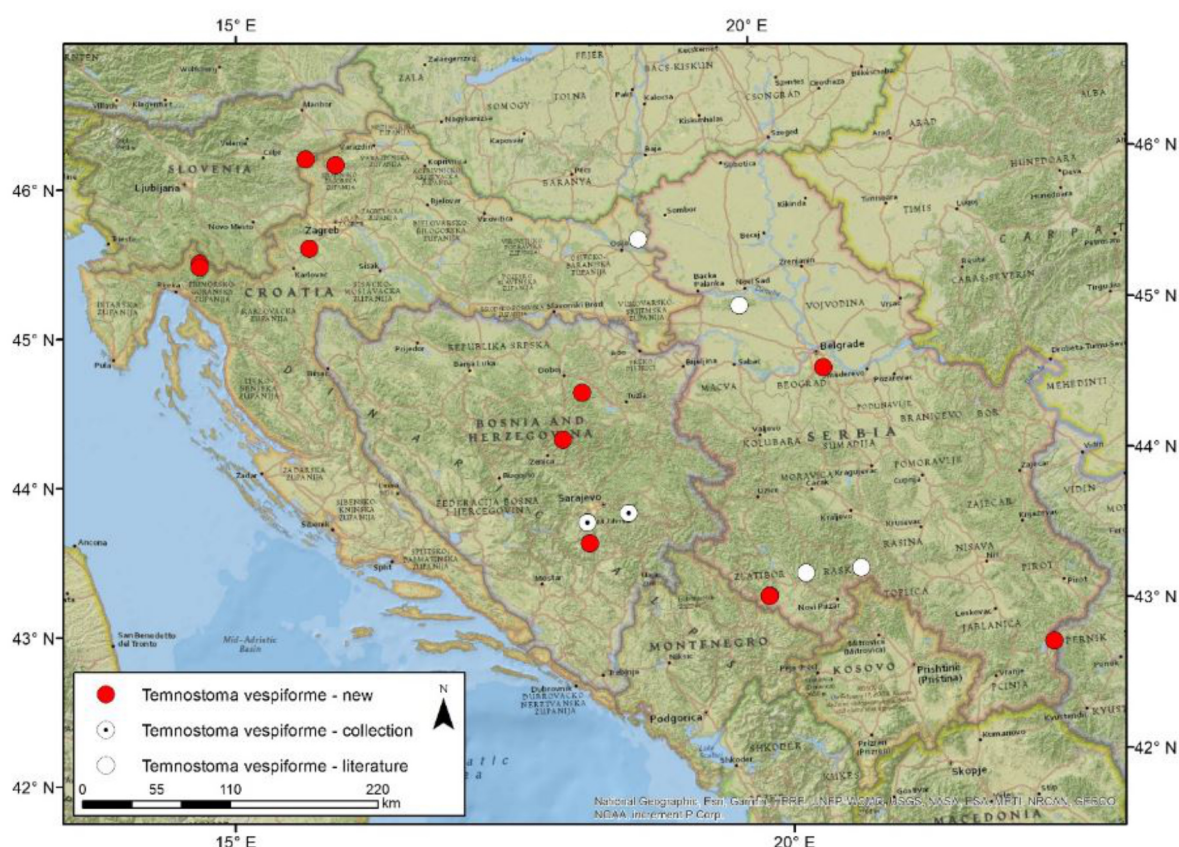


Figure 4 Distribution of *Temnostoma vespiforme* in Croatia, Bosnia and Herzegovina, and Serbia based on new, literature and collection records.

Slika 4. Rasprostranjenost vrste *Temnostoma vespiforme* u Hrvatskoj, Bosni i Hercegovini i Srbiji temeljena na novim, literaturnim i opažanjima iz zbirke.

Conclusions - Zaključci

Four species of the genus *Temnostoma* are present in the northwestern Balkans. Three species are recorded in Croatia, Bosnia and Herzegovina, and Serbia, while the fourth species, *T. apiforme*, has so far been documented only in Croatia. Distribution maps have been created for all four species, significantly expanding the known range of this genus in the region. Two of the four species, *T. apiforme* and *T. meridionale*, are classified as Near Threatened in Europe according to the recent European Red List of hoverflies (Vujić et al. 2022). However, it is essential to assess their conservation status at the national level in the future, as this region likely represents the edge of their distribution range, where threats to their populations may be more pronounced than in the core of their range. As saproxylic species, their long-term survival depends on proper forest management, particularly the retention of tree stumps with cavities that provide suitable habitats for larval development.

Acknowledgments - Zahvale

The authors wish to express their gratitude to colleagues whose observations have significantly contributed to the quality of this study, especially Matija Zloporubović, Ivan Tot, Milan Đurić, and Marko Doboš.

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