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NEW DATA ON TACHINID FAUNA (DIPTERA: TACHINIDAE) IN SERBIA

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Abstract

This study contributes to the knowledge of the tachinid fauna of Serbia, with material primarily collected from southern regions of the country. A total of 16 tachinid species were identified, including *Carcelia dubia*, representing a new record for Serbia's tachinid fauna. The larvae of *Zygaena filipendulae* and *Melitaea trivia* were documented as new hosts for three tachinid species.

KEY WORDS: Serbia, fauna, Diptera: Tachinidae

Introduction

Tachinid flies (Diptera: Tachinidae) are among the most diverse families within the order Diptera, with an estimated 10,000 described species distributed across approximately 1,500 genera worldwide (Irwin *et al*., 2003). This significant diversity is reflected in both their wide range of ecological roles and life histories. Adult tachinid flies primarily feed on nectar, and thus play an important role in pollination networks.

The ecological significance of tachinid flies is, however, predominantly associated with their larval stage, where they act as endoparasitoids of a wide range of arthropod hosts. The broad host range of Tachinidae includes insect orders such as Lepidoptera, Coleoptera, and Heteroptera (Vincent, 1985). While most tachinid species parasitize insects, a few are known to parasitize other arthropods, including scorpions, spiders, and centipedes (Williams *et al*., 1990). This parasitism of diverse taxa indicates the adaptive radiation and evolutionary flexibility of Tachinidae, highlighting their significant role in parasitoid-host dynamics across various ecosystems. The

parasitic behavior of tachinid flies positions them as some of the most effective natural enemies, and their capacity to regulate pest populations has been widely utilized in agricultural biological control.

Most tachinid flies primarily target Lepidoptera species, showing a distinct preference for exophytophagous caterpillars, although some species also parasitize leafrollers and stem borers (Pfannenstiel *et al*., 2012). The Tachinidae family is divided into four subfamilies: Exoristinae, Dexiinae, Phasiinae, and Tachininae (Herting & Dely-Draskovits, 1993). Lepidopteran larvae serve are the primary hosts for the two largest subfamilies, Exoristinae and Tachininae, reflecting a strong evolutionary association with this insect order. The Dexiinae subfamily, while also targeting Lepidoptera, has a broader host range that includes various Coleoptera. In contrast, the smallest subfamily, Phasiinae, specializes exclusively in parasitizing Heteroptera (true bugs) (Stireman *et al*., 2006).

Tachinid flies are particularly valuable in integrated pest management (IPM) strategies due to their ability to parasitize economically significant pest insects (Grenier, 1988). For instance, *Compsilura concinnata* (Meigen, 1824), a generalist parasitoid, has been utilized in the United States as a biocontrol agent against the invasive gypsy moth, and *Lymantria dispar*, a destructive pest responsible for defoliating various forest types (Hajek, 2007; Elkinton & Boettner, 2012), most notably broadleaved deciduous forests. Similarly, *Trichopoda pennipes* (Fabricius, 1781) attacks the brown marmorated stink bug *Halyomorpha halys*, Stål, 1855 and the southern green stink bug *Nezara viridula*, Linnaeus, 1758, both of which are allochthonous pests with significant impacts on crop productivity (Joshi *et al*., 2019; Salerno *et al*., 2002).

European Tachinidae have been extensively documented through faunal surveys and taxonomic keys (Belshaw, 1993). Early taxonomic studies (e.g., Meigen, 1824) laid the groundwork for subsequent identification resources, which continued to serve as an authoritative framework in this research field (Herting, 1984). The European Tachinidae Database (Tschorsnig, 2017) and other resources facilitate biodiversity assessments and ecological research across the continent and provide a comprehensive record of host associations and distribution patterns. Despite a long tradition of research on European tachinid fauna, many ecological roles and potential applications of these parasitoids in IPM strategies remain underexplored and warrant further development.

Serbia has a strong tradition in tachinid studies as well, with research efforts spanning over a century. To date, 295 tachinid species have been documented within the country (Strobl, 1902; Baranov, 1926a, 1926b, 1927, 1929; Sisojević 1953a, 1953b, 1955, 1975; Sisojević & Čepelak, 1983, 1987, 1998a, 1998b, 1998c; Sisojević *et al*., 1991; Hubenov, 2008a, 2008b; Stanković *et al*., 2014, 2018). Despite extensive research, the tachinid fauna of Serbia remains poorly documented, with significant gaps in knowledge about species diversity and host associations. To address this gap, this study presents new findings on tachinid species in Serbia, offering updated records and additional information on their host associations. By building on existing research, this work contributes to a more comprehensive understanding of tachinid diversity and their ecological significance within the region, emphasizing their potential as biological control agents in sustainable pest management systems.

Materials and Methods

The material for this study was primarily collected from southern Serbia, encompassing a total of 16 localities (Fig. 1). All tachinid specimens were reared from lepidopteran hosts during the period from 2019 to 2022. During the fieldwork survey, caterpillar hosts of various instars were collected and placed in plastic, rearing containers together with their respective host plants. All containers were covered with muslin cloth, maintained at room temperature, and cleaned regularly, with additional host plant material provided as needed. Depending

on the timing of parasitism and the instar in which the caterpillar was collected, the emergence of adult flies typically occurred within a few weeks. All specimens were collected and conserved in vials with 96% ethanol. The material is stored at the Department of Biology and Ecology, Faculty of Science and Mathematics, University of Niš, Serbia.

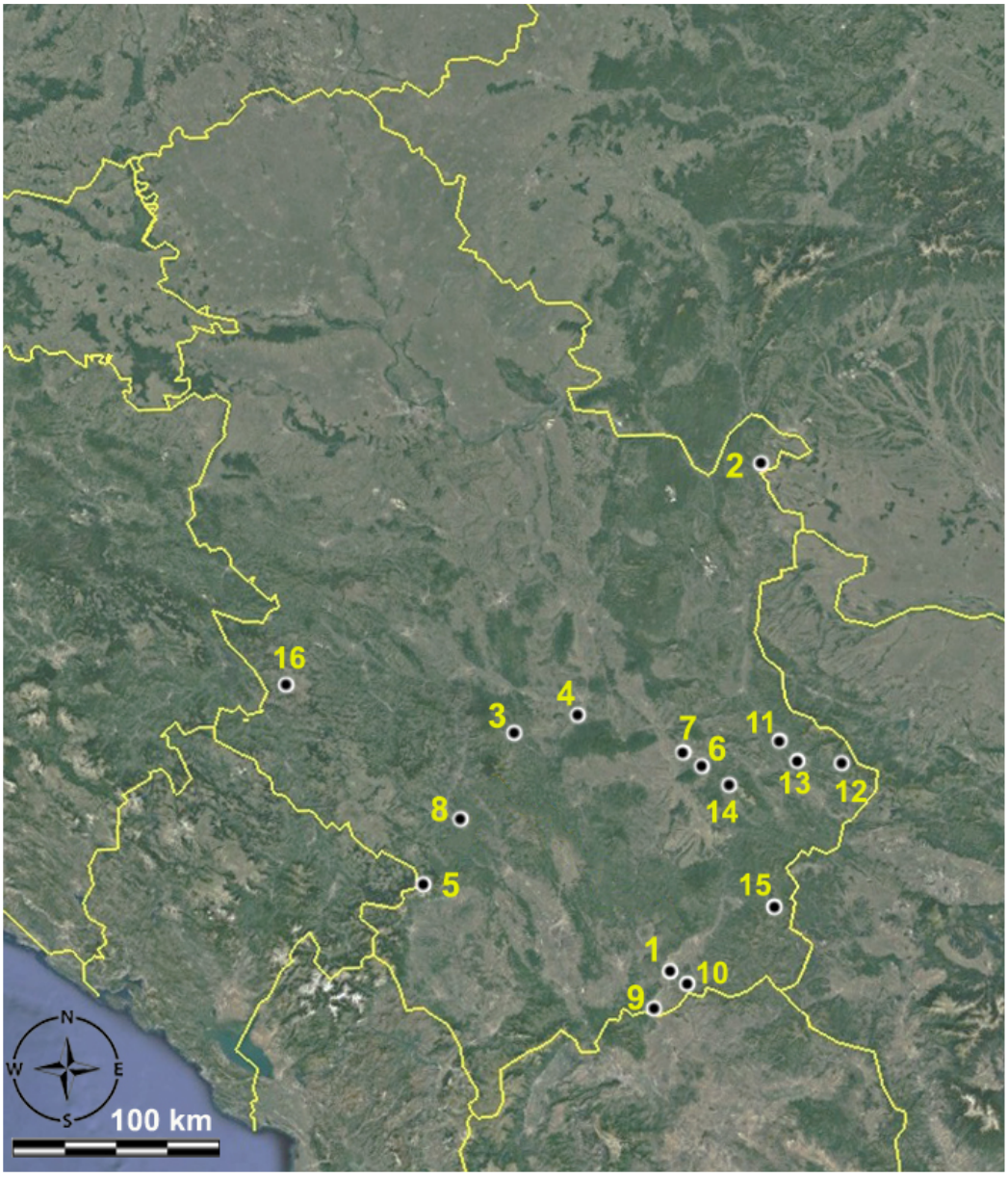

Figure 1. Map of Serbia showing sampling localities; the numbers of the localities correspond to those listed in Table I.

Table I. Details of sampling localities of Tachinidae in Serbia.

No	Locality	Latitude	Longitude	Altitude, m a.s.l.	Legator
1	Bujanovac, Levosoje	42°26'4.31"N	21°44'26.56"E	400	A. Trajković
2	Kladovo, Brza palanka	44°28'58.72"N	22°27'10.19"E	100	A. Trajković
3	Kopaonik mt., Koznik	43°27'20.25"N	20°56'10.56"E	1,000	A. Trajković
4	Kruševac, Donji Stepoš	43°31'20.11"N	21°18'23.70"E	215	M. Lazarević
5	Mokra gora mt, Beleg	42°50'0.83"N	20°21'21.05"E	2,140	A. Trajković
6	Niš, Kutinska reka	43°17'18.90"N	21°58'59.41"E	220	A. Trajković
7	Niš, Pantelej	43°20'23.69"N	21°54'29.85"E	235	V. Žikić
8	Novi Pazar, Pasji potok	43° 6'54.81"N	20°37'22.53"E	970	A. Trajković
9	Preševo, Miratovac	42°16'9.31"N	21°38'33.60"E	750	S. Stanković
10	Rujan planina mt	42°22'6.54"N	21°48'58.85"E	900	A. Trajković
11	Stara planina mt, Bigar	43°21'15.70"N	22°26'34.86"E	480	A. Trajković
12	Stara planina mt, Dojkinci	43°13'54.88"N	22°46'49.55"E	870	A. Trajković
13	Stara planina mt, Temska	43°15'56.76"N	22°33'10.19"E	450	A. Trajković
14	Suva planina mt	43°11'30.78"N	22° 8'22.97"E	900	S. Stanković
15	Vlasinsko jezero lake	42°40'42.39"N	22°21'10.83"E	1,200	V. Žikić
16	Zlatibor mt., Čavlovac	43°41'43.73"N	19°38'47.85"E	1,060	V. Žikić

Results

This study recorded a total of 16 tachinid species in Serbia. Notably, *Carcelia dubia* (Brauer & Bergenstamm, 1891) represents a new finding for the tachinid fauna of Serbia. Furthermore, the larvae of *Zygaena filipendulae* (Linnaeus, 1758) and *Melitaea trivia* Denis & Schiffermüller, 1775 were identified as new hosts for three tachinid species, as detailed below.

The recorded species are listed in alphabetical order, with relevant remarks provided for each finding.

Dexiinae

Voria ruralis (Fallén, 1810)

Examined material: Mokra Gora Mt, Beleg, 2,140 m a.s.l., 03.08.2021, 4♀♀, leg. A. Trajković, ex Plusiinae (Noctuidae), unknown plant; Niš, Pantelej, 235 m a.s.l., 04.10.2021, 2♂♂, 7♀♀, leg. V. Žikić, ex *Autographa gamma* (Linnaeus, 1758) on *Melissa officinalis*; Niš, Pantelej, 235 m a.s.l., 06.10.2021, 2♂♂, 2♀♀, leg. V. Žikić, ex *A. gamma* on *Coleus scutellarioides*.

Remark: Common parasitoid of Plusiinae (Noctuidae), most frequently reared from *A. gamma* (see Tschorsnig 2017: 307-309).

Exoristinae

Bessa parallela (Meigen, 1824)

Examined material: Preševo, Miratovac, 750 m a.s.l., 03.06.2020, 2♂♂, leg. S. Stanković, ex *Yponomeuta mahalebella* Guenee, 1845 on *Prunus mahaleb*.

Remark: Often reared from *Yponomeuta* species (*Y. mahalebella* is recorded as host, see Tschorsnig 2017: 44).

Buquetia musca Robineau-Desvoidy, 1847

Examined material: Niš, Kutinska Reka, 220 m a.s.l., 23.05.2020, 2♂♂, 1♀, leg A. Trajković, ex *Papilio machaon* Linnaeus, 1758 on *Foeniculum vulgare*; Kruševac, Donji Stepoš, 215 m a.s.l. 27.09.2020, 1♂, leg. M. Lazarević, ex *P. machaon*, unknown plant.

Remark: A specialist parasitoid, common on *P. machaon* (see Tschorsnig 2017: 113). There is only one recorded finding of this parasitoid from *P. alexanor* Esper, 1799, which is documented in Rikhter (1995).

Carcelia dubia (Brauer & Bergenstamm, 1891)

Examined material: Suva Planina Mt., 900 m a.s.l., 25.05.2021, 1♂, 1♀, leg. S. Stanković, ex *Callimorpha dominula* (Linnaeus 1758), unknown plant.

Remark: Commonly reared from larvae of *C. dominula* and several other Arctiinae (Erebidae) (see Tschorsnig 2017: 164). Newly registered species for Serbia.

Carcelia *lucorum* (Meigen, 1824)

Examined material: Rujan Planina Mt., 900 m a.s.l., 03.05.2021, 2♂♂, leg. A. Trajković, ex *Rhyparia purpurata* (Linnaeus, 1758), unknown plant.

Remark: Common parasitoid of Arctiinae, already known from this host (see Tschorsnig 2017: 170).

Chetogena filipalpis Rondani, 1859

Examined material: Vlasinsko Jezero lake, 1,200 m a.s.l., 22.06.2021, 1♀, leg. V. Žikić, ex Psychidae, unknown plant.

Remark: Common parasitoid of Psychidae, reared from many psychid species. Only one rearing is recorded from the Nolidae family (ex *Nycteola revayana* (Scopoli, 1772)). (see Tschorsnig 2017: 33).

Compsilura concinnata (Meigen, 1824)

Examined material: Zlatibor mt., Čavlovac, 1,060 m a.s.l., 25.06.2019, 1♀, leg. V. Žikić, ex *Zygaena filipendulae*, unknown plant; Kladovo, Brza Palanka, 100 m a.s.l., 30.05.2020, 1♀, leg. A. Trajković, *Nymphalis xanthomelas* (Denis & Schiffermüller, 1775) on *Salix* sp.; Stara Planina Mt., Dojkinci, 870 m a.s.l., 20.08.2020, 1♂, leg. A. Trajković, *Polygonia c-album* (Linnaeus, 1758), unknown plant; Stara Planina Mt., Bigar, 480 m a.s.l., 23.08.2020, 1♀, leg. A. Trajković, *P. c-album* on *Urtica dioica*; 20.8.2020; Niš, Pantelej, 235 m a.s.l., 18.10.2021, 1♂, leg. V. Žikić, *Chrysodeixis chalcites* (Esper, 1789) on *Chrysanthemum* sp.; Niš, Pantelej, 235 m a.s.l., 01.11.2021, 1♂, 1♀, leg. V. Žikić, *Autographa gamma* on *Chrysanthemum* sp.

Remark: Polyphagous, known from many hosts, including *Zygaena* spp., but not yet from *Z. filipendulae*. Common parasitoid of abundant hosts, see Tschorsnig 2017: 71 (also *N. xanthomelas* in known, see p. 83). Both hosts are known to be parasitized by this common parasitoid (see Tschorsnig 2017: 78).

Erycia fasciata Villeneuve, 1924

Examined material: Bujanovac, Levosoje, 400 m a.s.l., 03.05.2022, 1♂, leg. A. Trajković, ex *Melitaea trivia*, unknown plant.

Remark: Known from *Melitaea* spp. (see Tschorsnig 2017: 181), but not yet from *M. trivia.*

Eumea mitis (Meigen, 1824)

Examined material: Vlasinsko Jezero lake, 1,200 m a.s.l., 22.06.2019, 1♀, leg. V. Žikić, ex Psychidae, unknown grass plant.

Remark: For many hosts (see Tschorsnig 2017: 187-188), at least one species of Psychidae *Megalophanes viciella* (Denis & Schiffermüller, 1775) is known.

Eurysthaea scutellaris (Robineau-Desvoidy, 1848)

Examined material: Preševo, Miratovac, 750 m a.s.l., 03.06.2020, 3♂♂, 3♀♀, leg. S. Stanković, ex *Yponomeuta mahalebella* on *Prunus mahaleb*; Niš, Pantelej, 235 m a.s.l., 25.06.2021, 1♀, leg. V. Žikić, ex *Archips rosana* (Linnaeus, 1758) on *Symphoricarpos albus*.

Remark: Often reared from *Yponomeuta* (also *Y. mahalebella* is known as a host, see Tschorsnig 2017: 215). *Archips rosana* is also known as a host (see Tschorsnig 2017: 214).

Hubneria affinis (Fallén, 1810)

Examined material: Vlasinsko Jezero lake, 1,200 m a.s.l., 22.06.2021, 2♂♂, 3♀♀, leg. A. Trajković, ex *Arctia caja* (Linnaeus, 1758), unknown plant.

Remark: Common parasitoid of *Arctia caja* and other Arctiidae etc. (see Tschorsnig 2017: 160-161).

Nemorilla floralis (Fallén, 1810)

Examined material: Niš, Pantelej, 235 m a.s.l., 07.06.2021, 1♂, leg. V. Žikić, ex *Pleuroptya ruralis* (Scopoli, 1763) on *Urtica dioica*.

Remark: Common parasitoid of *Pleuroptya ruralis* (Tschorsnig 2017: 98).

Phryxe magnicornis (Zetterstedt, 1838)

Examined material: Kopaonik Mt., Koznik, 1,000 m a.s.l., 18.06.2021, 1♂, 1♀, leg. A. Trajković, ex *Melitaea trivia*, unknown plant; Suva Planina Mt., 900 m a.s.l., 26.05.2022, leg. S. Stanković, ex *Zygaena ephialtes* (Linnaeus, 1767), unknown plant.

Remark: *Melitaea trivia* is the new host for this tachinid which is already known from *Z. ephialtes* (see Tschorsnig 2017: 119). As a generalist, *P. magnicornis* is registered as a parasitoid of many other caterpillars (see Tschorsnig 2017: 117-120).

Phryxe nemea (Meigen, 1824)

Examined material: Novi Pazar, Pasji Potok, 970 m a.s.l., 23.5.2021, 1♂, leg. A. Trajković, ex *Zygaena filipendulae*, unknown plant.

Remark: A common parasitoid of many hosts, *Z. filipendulae* is a known host (see Tschorsnig 2017: 126).

Zenillia libatrix (Panzer, 1798)

Examined material: Suva Planina Mt., 26.05.2021, 900 m a.s.l., 3♂♂, 2♀♀, leg. S. Stanković, ex *Aporia crataegi* (Linnaeus, 1758), on *Crataegus monogyna*.

Remark: *A. crataegi* is well known host, among many others (see Tschorsnig 2017: 193-196).

Tachininae

Peribaea tibialis (Robineau-Desvoidy, 1851)

Examined material: Stara Planina Mt., Temska, 01.08.2021, 450 m a.s.l., 1♂, leg. A. Trajković, ex Noctuidae, unknown plant.

Remark: Already known from the family Noctuidae (see Tschorsnig 2017: 281).

Discussion

Analyzing the collected material revealed that most of the tachinid species recorded in this study belong to the subfamily Exoristinae (14), while Dexiinae and Tachininae are represented with one species each. As expected, no members of the Phasiinae family were collected, as this group exclusively parasitizes true bugs (Heteroptera), which were not the subject of investigation and thus not reared for this study. Unsurprisingly, Exoristinae are represented by the most species compared to the other two subfamilies, as it is the largest subfamily, with members primarily developing on Lepidoptera larvae (O'Hara, 2008).

The most frequently reared species in this survey was *Compsilura concinnata*, one of the most polyphagous tachinid species, known to parasitize nearly 300 host species (Herting, 1960; Tschorsnig, 2017). In this study, *C. concinnata* was reared from five host species, with *Zygaena filipendulae* identified as a new host. Despite being extensively studied due to its polyphagous nature and use as a biological control agent against *Lymantria dispar* in North America (Culver, 1919; Sabrosky *et al*., 1976), its extensive host range continues to expand with new records, indicating a broader host repertoire than previously documented (Kellogg *et al*. 2003; Elkinton & Boettner., 2012; Hammami *et al*., 2022). Additionally, despite being native to Europe and Asia, this species demonstrates ecological adaptability and thrives in diverse environments and climates (Tachi *et al*. 2021).

Interestingly, *Melitaea trivia* served as a host for two tachinid species in this survey: *Erycia fasciata* and *Phryxe magnicornis*, both recorded parasitizing *M. trivia* for the first time. While *P. magnicornis* is known to parasitize numerous lepidopteran families, it has not been reported on Nymphalidae. On the other hand, *E. fasciata*, typically associated with other *Melitaea* species, was recorded on *M. trivia* for the first time in this study. These findings highlight the potential for further discoveries of host associations within the region.

A significant discovery in this survey was *Carcelia dubia*, a relatively common parasitoid of many Arctiinae species, particularly *Callimorpha dominula*, which represents a new record for the Serbian tachinid fauna. Similarly, previous surveys of Serbian Tachinidae have reported several widespread European tachinid species for the first time in Serbia, despite their hosts being well-documented in the region (Stanković *et al*., 2018). These occasional new findings suggest that a significant number of species have yet to be documented in the studied region.

In summary, approximately 850 species of tachinid flies (Tachinidae) are known to inhabit Europe, with nearly 300 documented species in Serbia to date. Considering the rich diversity of exophytophagous caterpillar species in Serbia (though the exact number remains unknown), it is highly probable that Serbia harbors at least an additional 300 tachinid species. A better understanding of tachinid diversity, their range, and host spectra enhances our knowledge of natural pest regulation and can consequently optimize their integration into biological control strategies. This study provides a foundation for future research aimed at uncovering the full spectrum of Serbian tachinid diversity and their contributions to ecosystem services.

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НОВИ ПОДАЦИ ЗА ФАУНУ ТАХИНИДА (DIPTERA: TACHINIDAE) У СРБИЈИ

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Извод

Ова студија доприноси познавању фауне тахинида Србије, са материјалом првенствено прикупљеним из јужних крајева земље. Идентификовано је укупно 16 врста, укључујући *Carcelia dubia*, што представља нови податак у фауни тахинида Србије. Ларве *Zygaena filipendulae* и *Melitaea trivia* документоване су као нови домаћини за три врсте тахинида.

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