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A NEW CHECK LIST OF HOVERFLIES (Diptera: Syrphidae) OF THE REPUBLIC OF SERBIA

ABSTRACT: A checklist of the family Syrphidae (Diptera) of Serbia is provided in this paper. A total of 412 species and subspecies from 83 genera are reported. Moreover, three species are recorded for the first time from Serbia.
KEYWORDS: Fauna, first records, Serbia, syrphids, taxonomy

INTRODUCTION

Syrphids (Diptera: Syrphidae) are distributed throughout the world as a result of being adapted to numerous habitats. These flies have reached a high level of diversification, with about 6,000 species known (Rotheray & Gilbert, 2011). The current classification of the Syrphidae comprises three subfamilies, Eristalinae, Microdontinae and Syrphinae, and they can be separated by both adult and larva characters (Rotheray & Gilbert, 2011).

The first studies on the Balkan syrphids date from the second half of the nineteenth century and already included records of some Syrphidae species (Frauenfeld, 1860; Strobl, 1893, 1898). Strobl (1900, 1902) and Tögl and Fahringer (1911) also contributed to the knowledge of the Balkan syrphid fauna. From the early twentieth century, regional studies on the Balkan hoverflies proliferated: Glumac (1956b, 1972), Leclercq (1961), Lambeck (1968), De Groot and Govedič (2008) and De Groot et al. (2010), in Slovenia; Langhoffer (1919), Marcuzzi (1941), Coe (1956, 1960), Glumac (1956a, 1956b, 1972) and Leclercq (1961), in Croatia; Glumac (1955b, 1972) and Kula (1985), in Bosnia and Herzegovina; Glumac (1972), Šimić (1987) and Vujić et al. (1996), in Montenegro; Glumac (1968, 1972) and

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Krpač et al. (2001a, 2001b), in Macedonia; Drensky (1934), Bankowska (1967), in Bulgaria; Wayer and Dils (1999) and Vujić et al. (2000), in Greece.

Within the Balkans, Serbia has a relatively well studied hoverfly fauna and some sites have been profusely sampled: Beograd region (Glumac, 1955a), Fruška Gora Mt. (Glumac, 1959, Vujić and Glumac, 1994, Vujić et al., 2002, Šimić et al., 2008), Vršačke planine Mts. (Vujić and Šimić, 1994), Stara planina Mt. (Šimić and Vujić, 1996), Obedska bara marsh (Vujić et al., 1998a, Radenković et al., 2004), Deliblatska peščara sands (Vujić et al., 1998b) and Vojvodina Province (Nedeljković et al., 2009a, Šimić et al., 2009).

The first check list of Yugoslav Syrphidae was presented at The Fourth International Congress of Dipterology in Oxford (Šimić et al., 1998). This list included 414 species, as well as the names of excluded (synonyms and misidentifications) and doubtful species (unchecked or lost material). Šimić et al., 2001 presents the supplement to the previous check list with the new results based on the redeterminations of collections deposited in the Natural History Museum in Belgrade (NHMB) and Institute of Biology, Novi Sad (FSUNS). Since then some species have been added to Serbian fauna and various name changes have been introduced, so it seemed necessary to provide an up-to-date list for the benefit of the recorders. Based on previous and recent data, the presence of 412 species and subspecies in the area of Republic of Serbia is confirmed. This paper presents three newly discovered species in Serbia.

MATERIAL AND METHODS

The material analyzed in this study was collected over the course of more than 50 years of investigations (1955–2018). It is deposited in the collection of the Department of Biology and Ecology, Faculty of Natural Sciences, University of Novi Sad, Serbia (FSUNS). A part of the material analyzed in this study is deposited in the collection of the Natural History Museum in Belgrade (Serbia) (NHMB).

Specimens were collected by the standard sweep-netting method. The collected material was prepared, pinned and labelled. Identification of adults was based on external morphological features and male terminalia using a Nikon SMZ 745T and Ceti® binocular stereomicroscopes.

Taxonomic nomenclature. Genus and species names generally follow Speight (2017).

Abbreviations and comments

<u>in litt.</u> – taxon is recognized, but the analysis is not finished
<u>in prep.</u> – the description or manuscript is in process of preparation
<u>in press.</u> – the manuscript is accepted for publication (mentioned in references)

RESULTS AND DISCUSSION

CHECK LIST

ANASIMYIA Schiner, 1864

1. ***Anasimyia contracta*** Claussen & Torp, 1980
Radenković, 2008; Nedeljković et al., 2009a.
2. ***Anasimyia interpuncta*** (Harris, 1776)
Glumac, 1959 (as *Eurinomyia lunulata* and *E. transfuga*); Šimić and Vujić, 1987 (as *Eurinomyia lunulata*); Vujić and Glumac, 1994 (as *Helophilus lunulatus*); Vujić et al., 1998b (as *Anasimyia lunulata*); Vujić et al., 2002; Nedeljković et al., 2009a; Radenković, 2008.
3. ***Anasimyia lineata*** (Fabricius, 1787)
Glumac, 1955a (as *Eurinomyia lineata*); Šimić and Vujić, 1987 (as *Eurinomyia lineata*); Vujić and Glumac, 1994 (as *Helophilus lineatus*); Vujić and Šimić, 1994 (as *Eurinomyia lineata*); Vujić et al., 1998a (as *Helophilus lineatus*); Vujić et al., 1998b; Vujić et al., 2002; Radenković et al., 2004; Radenković, 2008; Nedeljković et al., 2009a; Tot et al., 2018.
4. ***Anasimyia transfuga*** (Linnaeus, 1758)
Radenković, 2008; Nedeljković et al., 2009a; Van Steenis et al., 2015.

ARCTOPHILA Schiner, 1860

5. ***Arctophila bequaerti*** Hervé-Bazin, 1913
Vujić et al., 2016.
6. ***Arctophila bombiformis*** (Fallen, 1810)
Glumac, 1955a; Radenković, 2008, Radenković et al., 2013.
7. ***Arctophila superbiens*** (Muller, 1756)
Radenković 2008; Radenković et al., 2013.

BACCHA Fabricius, 1805

8. ***Baccha elongata*** (Fabricius, 1775)
Glumac, 1959; Glumac, 1959 (as *Baccha elongata* and *Baccha obscuripennis*), 1972 (as *Baccha elongata* and *Baccha obscuripennis*); Kula, 1985; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Tot et al., 2018.
9. ***Baccha obscuripennis*** Meigen, 1822
Glumac, 1959; Šimić et al., 2008.

BLERA Billberg, 1820

10. ***Blera fallax*** (Linnaeus, 1758)
Radenković, 2008; Radenković et al., 2013.

BRACHYOPA Meigen, 1822

11. ***Brachyopa bicolor*** (Fallen, 1817)
Vujić, 1991; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Radenković et al., 2004, 2013; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.
12. ***Brachyopa dorsata*** Zettertedt, 1837
Vujić, 1991; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Radenković, 2008; Nedeljković et al., 2009a; Radenković et al., 2013.
13. ***Brachyopa insensilis*** Collin, 1939
Glumac, 1955a (partly); Vujić, 1991; Vujić and Glumac, 1994; Vujić et al, 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Radenković, 2008; Radenković et al., 2013.
14. ***Brachyopa maculipennis*** Thompson, 1980
Vujić, 1991; Šimić and Vujić, 1996; Radenković, 2008; Radenković et al., 2004, 2013; Nedeljković et al., 2009a; Šimić et al., 2009.
15. ***Brachyopa panzeri*** Goffe, 1945
Radenković, 2008; Radenković et al., 2013.
16. ***Brachyopa pilosa*** Collin, 1939
Glumac, 1955a (as *Brachyopa bicolor*); Vujić, 1991; Vujić and Glumac, 1994; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Radenković et al., 2013.
17. ***Brachyopa plena*** Collin, 1939
Vujić, 1991; Radenković, 2008; Radenković et al., 2013.
18. ***Brachyopa testacea*** (Fallen, 1817)
Radenković, 2008; Radenković et al., 2013.
19. ***Brachyopa vittata*** (Zetterstedt, 1843)
Radenković, 2008; Radenković et al., 2013.

BRACHYPALPOIDES Hippa, 1978

20. ***Brachypalpoides lentus*** (Meigen, 1822)
Strobl, 1902 (as *Xylota lenta*); Glumac, 1955a, 1959 (as *Zelima lenta*); Vujić and Glumac, 1994; Milankov et al., 1995; Šimić et al., 2008; Radenković, 2008; Nedeljković et al., 2009a; Radenković et al., 2013.

BRACHYPALPUS Macquart, 1834

21. ***Brachypalpus chrysites*** Egger, 1859
Vujić and Radović, 1990; Vujić and Milankov, 1999; Radenković, 2008; Radenković et al., 2013.
22. ***Brachypalpus laphriformis*** (Fallen, 1817)
Glumac, 1972; Vujić and Radović, 1990; Vujić and Glumac, 1994; Vujić et al., 1998a; Vujić and Milankov, 1999; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Radenković, 2008.

23. ***Brachypalpus valgus*** (Panzer, 1798)
Glumac, 1955a (as *Brachypalpus chrysites*), 1972; Kula, 1985; Vujić and Radović, 1990; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a, 1998b; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a; Radenković et al., 2013.

CALIPROBOLA Rondani, 1845

24. ***Caliprobola speciosa*** (Rossi, 1790)
Glumac, 1955a (as *Calliprobola speciosa*); Glumac, 1959 (as *Calliprobola speciosa*); Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994 (as *Calliprobola speciosa*); Vujić et al, 1998b; Šimić et al., 2008; Radenković, 2008; Nedeljković et al., 2009a; Radenković et al., 2013.

CALLICERA Panzer, 1809

25. ***Callicera aenea*** (Fabricius, 1777)
Nedeljković et al., 2009b, 2015a.
26. ***Callicera aurata*** (Rossi, 1790)
Nedeljković et al., 2015a.
27. ***Callicera spinolae*** Rondani, 1844
Nedeljković et al., 2015a.

CERIANA Rafinesque, 1815

28. ***Ceriana conopsoides*** (Linnaeus, 1758)
Glumac, 1955a (as *Cerioides conopoides*); Glumac, 1959 (as *Cerioides conopoides*); Šimić and Vujić, 1987 (as *Cerioides conopoides*); Vujić and Glumac, 1994; Vujić and Šimić, 1994 (as *Cerioides conopoides*); Šimić and Vujić, 1996; Vujić et al., 1998b (as *Ceriana conopoides*); Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Radenković, 2008; Markov et al., 2016; Radenković et al., 2013.

CHALCOSYRPHUS Curran, 1925

29. ***Chalcosyrphus eunotus*** (Loew, 1873)
Vujić and Radović, 1990; Vujić and Šimić, 1994 (as *Brachypalpus eunotus*); Milankov et al., 1995; Vujić et al., 1998b, 2002; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Radenković et al., 2013; Van Steenis at al., 2015.
30. ***Chalcosyrphus nemorum*** (Fabricius, 1805)
Coe, 1956 (as *Xylota nemorum*); Glumac, 1959 (as *Zelima nemorum*); Šimić and Vujić, 1987 (as *Xylota nemorum*); Vujić and Glumac, 1994; Milankov et al., 1995; Vujić et al., 1998a, 1998b; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Radenković et al., 2013.

31. ***Chalcosyrphus piger*** (Fabricius, 1794)
Nedeljković et al., 2009a; Radenković, 2008; Radenković et al., 2013.
32. ***Chalcosyrphus rufipes*** (Loew, 1873)
Glumac, 1959 (as *Zelima femorata*); Vujić and Glumac, 1994; Milankov et al., 1995; Nedeljković et al., 2009a; Šimić et al., 2008; Radenković, 2008.
33. ***Chalcosyrphus valgus*** (Gmelin, 1790)
Vujić and Milankov, 1999; Radenković, 2008; Radenković et al., 2013.

CHEILOSIA Meigen, 1822

34. ***Cheilosia aerea*** Dufour, 1848
Strobl, 1902; Glumac, 1955a (as *Cheilosia zetterstedti,* partly as *C. proxima, C. gemina* and *C. vernalis*); Glumac, 1959 (as *Cheilosia correcta* and *Cheilosia montana*; Glumac, 1972 (as *Cheilosia zetterstedti*); Šimić and Vujić, 1996 (as *Cheilosia zetterstedti*); Vujić and Glumac, 1994 (as *Cheilosia zetterstedti*); Vujić, 1996; Vujić et al., 2002; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Radenković, 2008.
35. ***Cheilosia alba*** Vujić et Claussen, 2000
Vujić and Glumac, 1994 (as *Cheilosia clama*); Vujić and Claussen, 2000; Vujić et al., 2002; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a.
36. ***Cheilosia albipila*** (Meigen, 1838)
Glumac, 1955a, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009.
37. ***Cheilosia albitarsis*** (Meigen, 1822)
Šimić and Vujić, 1987 (as *Cheilosia imperfecta*); Vujić and Glumac, 1994 (partly); Vujić and Šimić, 1994 (partly); Vujić, 1996; Vujić et al., 1998a (partly); Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a; Markov et al., 2016.
38. ***Cheilosia antiqua*** (Meigen, 1822)
Vujić, 1996 (as *Nigrocheilosia antiqua*); Radenković, 2008.
39. ***Cheilosia balkana*** Vujić, 1994
Vujić, 1994b; Radenković, 2008.
40. ***Cheilosia barbata*** Loew, 1857
Glumac, 1955a, 1959; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Markov et al., 2016; Tot et al., 2018.
41. ***Cheilosia bergenstammi*** Becker, 1894
Vujić, 1996; Radenković, 2008.
42. ***Cheilosia bracusi*** Vujić & Claussen, 1994
Vujić and Claussen, 1994b; Vujić, 1996; Radenković, 2008.
43. ***Cheilosia brunnipennis*** Becker, 1894
Vujić, 1996; Radenković, 2008; Nedeljković et al., 2009a.

44. ***Cheilosia canicularis*** (Panzer, 1801)
Glumac, 1955a (partly), 1959; Glumac, 1959; Kula, 1985; Vujić, 1996; Vujić and Šikoparija, 2001; Šimić et al., 2008; Radenković, 2008; Nedeljković et al., 2009a.
45. ***Cheilosia carbonaria*** Egger, 1860
Vujić, 1996; Radenković, 2008.
46. ***Cheilosia chrysocoma*** (Meigen, 1822)
Glumac, 1959, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009.
47. ***Cheilosia clama*** Claussen & Vujić, 1995
Claussen and Vujić, 1995; Radenković, 2008.
48. ***Cheilosia cumanica*** Szilady, 1938
Glumac, 1959 (as *Cheilosia gracilis*); Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Radenković, 2008; Šimić et al., 2008; Nedeljković et al., 2009a.
49. ***Cheilosia cynocephala*** Loew, 1840
Glumac, 1955a (as *Cheilosia cynocephala* and *Cheilosia carbonara*); Vujić, 1996; Radenković, 2008; Šimić et al., 2009; Nedeljković et al., 2009a; Markov et al., 2016.
50. ***Cheilosia fasciata*** Schiner & Egger, 1853
Vujić & Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.
51. ***Cheilosia flavipes*** (Panzer, 1798)
Glumac, 1959; 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Šimić et al., 2008; Radenković, 2008; Nedeljković et al., 2009a; Van Steenis et al., 2015.
52. ***Cheilosia fraterna*** (Meigen, 1830)
Vujić, 1996; Radenković, 2008.
53. ***Cheilosia frontalis*** Loew, 1857
Vujić, 1996; Radenković, 2008.
54. ***Cheilosia gagatea*** Loew, 1857
Vujić, 1996 (as *Nigrocheilosia gagatea*); Vujić and Radenković, 1996 (as *Nigrocheilosia gagatea*); Radenković, 2008.
55. ***Cheilosia gigantea*** (Zetterstedt, 1838)
Vujić, 1996; Radenković, 2008; Nedeljković et al., 2009a.
56. ***Cheilosia griseifacies*** Vujić, 1994
Vujić and Šimić, 1994 (as *Cheilosia* sp.); Vujić, 1994a; 1996; Vujić et al., 1998a; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Radenković, 2008.
57. ***Cheilosia grisella*** Becker, 1894
Vujić, 1996 (as *Nigrocheilosia grisella*); Radenković, 2008.
58. ***Cheilosia grossa*** (Fallen, 1817)
Glumac, 1955a; Glumac, 1959; Glumac, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a; Markov et al., 2016.

59. ***Cheilosia himantopa*** (Panzer, 1798)
Vujić, 1996 (partly as *Cheilosia canicularis*); Stuke and Claussen, 2000; Vujić and Šikoparija, 2001; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2009; Markov et al., 2016.
60. ***Cheilosia hypena*** Becker, 1894
Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Radenković, 2008; Markov et al., 2016; Nedeljković et al., 2009a.
61. ***Cheilosia illustrata*** (Harris, 1776)
Glumac, 1959; Glumac, 1972; Vujić and Glumac, 1994; Vujić, 1996; Radenković, 2008; Šimić et al., 2008, 2009; Tot et al., 2018.
62. ***Cheilosia impressa*** Loew, 1840
Glumac, 1955a; Glumac, 1959; Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a.
63. ***Cheilosia insignis*** Loew, 1857
Vujić and Radenković, 1996 (as *Nigrocheilosia insignis*); Radenković, 2008.
64. ***Cheilosia kerteszi*** Szilady, 1938
Vujić, 1996 (as *Nigrocheilosia kerteszi*); Radenković, 2008.
65. ***Cheilosia laticornis*** Rondani, 1857
Glumac, 1955a (as *Cheilosia latifacies*); Glumac, 1972; Kula, 1985; Vujić and Šimić, 1994 (as *Cheilosia latifacies* Loew, 1857); Vujić, 1996 (as *Cheilosia latifacies* Loew, 1857); Vujić et al., 1998b.
66. ***Cheilosia latifrons*** (Zetterstedt, 1843)
Glumac, 1955a (as *Cheilosia intonsa* and *Cheilosia maroccana*); Glumac, 1959 (as *C. intonsa*); Glumac, 1972; Vujić and Glumac, 1994 (as *C. intonsa*); Vujić and Šimić, 1994 (as *C. intonsa*); Vujić, 1996; Vujić et al., 1998b; Vujić et al., 2002; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Markov et al., 2016.
67. ***Cheilosia lenis*** Becker, 1894
Vujić et al., 1993–1994 (as *Cheilosia omissa*); Radenković, 2008.
68. ***Cheilosia lenta*** Becker, 1894
Vujić et al., 1993-1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Šimić et al., 2009; Radenković, 2008; Nedeljković et al., 2009a.
69. ***Cheilosia loewi*** Becker, 1894
Kula, 1985.
70. ***Cheilosia longula*** (Zetterstedt, 1838)
Vujić, 1996; Radenković, 2008; Tot et al., 2018.
71. ***Cheilosia melanopa*** (Zetterstedt, 1843)
Vujić, 1996; Radenković, 2008.
72a. ***Cheilosia melanura* ssp. *melanura*** Becker, 1894
Vujić, 1996; Radenković, 2008.
72b. ***Cheilosia melanura* ssp. *rubra*** Vujić, 1996
Vujić, 1996; Radenković, 2008.
73. ***Cheilosia morio*** (Zetterstedt, 1838)
Vujić, 1996; Radenković, 2008.

74. ***Cheilosia mutabilis*** (Fallen, 1817)
Glumac, 1959; Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998a; Šimić et al., 2008, 2009; Radenković, 2008; Markov et al., 2016.
75. ***Cheilosia nebulosa*** (Verrall, 1871)
Vujić and Šimić, 1994; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a; Markov et al., 2016.
76. ***Cheilosia nigripes*** (Meigen, 1822)
Glumac, 1955a; Glumac, 1959; Glumac, 1972; Kula, 1985; Šimić and Vujić, 1996; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996 (as *Nigrocheilosia nigripes*); Vujić et al., 1998b; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.
77. ***Cheilosia orthotricha*** Vujić et Claussen, 1994
Vujić and Claussen, 1994a; Vujić and Glumac, 1994; Vujić, 1996; Vujić and Šikoparija, 2001; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a; Markov et al., 2016.
78. ***Cheilosia pagana*** (Meigen, 1822)
Glumac, 1959; Glumac, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998a; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Markov et al., 2016.
79. ***Cheilosia pascuorum*** Becker, 1894
Vujić, 1996; Vujić et al., 1998b; Radenković, 2008; Nedeljković et al., 2009a.
80. ***Cheilosia personata*** Loew, 1857
Vujić, 1996 (as *Nigrocheilosia personata*); Radenković, 2008
81. ***Cheilosia pictipennis*** Egger, 1860
Glumac, 1955a; Vujić, 1996; Radenković, 2008.
82. ***Cheilosia proxima*** (Zetterstedt, 1843)
Glumac, 1955a (partly); Glumac, 1959; Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998a; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a; Markov et al., 2016; Tot et al., 2018.
83. ***Cheilosia psilophthalma*** Becker, 1894
Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Vujić et al., 2002; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009.
84. ***Cheilosia pubera*** (Zetterstedt, 1838)
Vujić, 1996 (as *Nigrocheilosia pubera*); Radenković, 2008.
85. ***Cheilosia ranunculi*** Doczkal, 2000
Vujić and Glumac, 1994 (as *Cheilosia albitarsis*, partly); Vujić and Šimić, 1994 (as *Cheilosia albitarsis*, partly); Vujić, 1996; Vujić et al., 2002; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009.
86. ***Cheilosia redi*** Vujić, 1996
Kula, 1985 (as *Cheilosia melanopa*); Vujić and Glumac, 1994 (as *Cheilosia melanopa*); Vujić and Šimić, 1994 (as *Cheilosia melanopa*); Vujić, 1996 (as *Cheilosia melanopa redi*); Vujić et al., 1998b (as *Cheilosia melanopa redi*); Vujić et al., 2002 (as *Cheilosia melanopa redi*); Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a (as *Cheilosia melanopa redi*).

87. ***Cheilosia rhynchops*** Egger, 1860
Vujić, 1996; Radenković, 2008.
88. ***Cheilosia rufimana*** Becker, 1894
Vujić, 1996; Radenković, 2008.
89. ***Cheilosia schnabli*** Becker, 1894
Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić, 1996; Vujić et al., 1998b; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a.
90. ***Cheilosia scutellata*** (Fallen, 1817)
Glumac, 1955a; Coe, 1960; Radenković, 2008; Šimić et al., 2008; Nedeljković et al., 2009a; Markov et al., 2016; Tot et al., 2018.
91. ***Cheilosia semifasciata*** Becker, 1894
Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić, 1996; Vujić et al., 1998b; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a.
92. ***Cheilosia soror*** (Zetterstedt, 1843)
Strobl, 1902; Glumac, 1955a; Glumac, 1959; Glumac, 1972; Coe, 1960; Kula, 1985; Vujić and Glumac, 1994 (as *C. rufipes*); Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Šimić et al., 2008; Radenković, 2008; Nedeljković et al., 2009a; Tot et al., 2018.
93. ***Cheilosia urbana*** (Meigen, 1822)
Glumac, 1959 (as *Cheilosia argentifrons*); Vujić and Glumac, 1994 (as *Cheilosia ruralis*); Vujić and Šimić, 1994 (as *Cheilosia ruralis*); Vujić, 1996 (as *Cheilosia praecox*); Vujić et al., 1998a (as *Cheilosia praecox*); Vujić et al., 1998b (as *Cheilosia praecox*); Vujić et al., 2002; Radenković et al., 2004; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Markov et al., 2016.
94. ***Cheilosia uviformis*** Becker, 1894
Vujić and Glumac, 1994; Vujić, 1996; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008.
95. ***Cheilosia variabilis*** (Panzer, 1798)
Glumac, 1955a; Glumac, 1959; Glumac, 1972; Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998a; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a; Tot et al., 2018.
96. ***Cheilosia vernalis*** (Fallen, 1817)
Glumac, 1959 (as *Cheilosia vernalis* and *Cheilosia brachysoma*); Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996; Vujić et al., 1998b; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008; Tot et al., 2018.
97. ***Cheilosia vicina*** (Zetterstedt, 1849)
Glumac, 1959 (as *Cheilosia mutabilis* and *Cheilosia nasutula*); Glumac, 1972 (as *Cheilosia nasutula*); Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1996 (as *Nigrocheilosia vicina*); Vujić et al., 1998b; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a.
98. ***Cheilosia vujici*** Claussen & Doczkal, 1998
Radenković, 2008.

99. ***Cheilosia vulpina*** (Meigen, 1822)
Glumac, 1955a; Glumac, 1959 (as *Cheilosia conops*, *Cheilosia vulpina*); Glumac, 1972; Kula, 1985; Vujić and Glumac, 1994; Vujić, 1996; Vujić et al., 1998b; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009.

CHRYSOGASTER Meigen, 1803

100. ***Chrysogaster basalis*** Loew, 1857
Glumac, 1955a (partly as *Chrysogaster chalybeata, C. macquarti* and *C. splendens*); Radenković, 2008; Vujić, 1999b.

101. ***Chrysogaster solstitialis*** (Fallen, 1817)
Glumac, 1955a; Glumac, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1999b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Radenković, 2008; Markov et al., 2016; Tot et al., 2018.

CHRYSOTOXUM Meigen, 1803

102. ***Chrysotoxum bicinctum*** (Linnaeus, 1758)
Glumac, 1955a; Glumac, 1959; Glumac, 1972; Vujić and Glumac, 1994; Vujić et al., 1998b; Vujić and Šimić, 1994; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Tot et al., 2018.

103. ***Chrysotoxum cautum*** (Harris, 1776)
Strobl, 1902; Glumac, 1955a, 1958, 1972; Šimić and Vujić, 1984a; Vujić and Šimić, 1994; Kula, 1985; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016; Tot et al., 2018.

104. ***Chrysotoxum elegans*** Loew, 1841
Glumac, 1955a, 1959, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016; Tot et al., 2018.

105. ***Chrysotoxum fasciatum*** (Muller, 1746)
Glumac, 1972 (as *C. arcuatum*); Vujić and Šimić, 1994 (as *C. arcuatum*); Šimić and Vujić, 1996; Vujić et al., 1998a (as *C. arcuatum*); Vujić et al., 1998b; Šimić et al., 2008 (as *C. arcuatum*); Nedeljković, 2011; Tot et al., 2018.

106. ***Chrysotoxum fasciolatum*** (De Geer, 1776)
Glumac, 1955a, 1972; Nedeljković, 2011.

107. ***Chrysotoxum festivum*** (Linnaeus, 1758)
Glumac, 1955a (as *C. arcuatum*), 1959, 1972; Šimić and Vujić, 1984; Kula, 1985; Šimić and Vujić, 1987; Vujić and Glumac, 1994 (as *Chrysotoxum arcuatum*); Vujić and Šimić, 1994; Šimić and Vujić, 1996 (as *Chrysotoxum arcuatum*); Vujić et al., 1998a (as *Chrysotoxum arcuatum*); Vujić et al., 1998b; Radenković et al., 2004; Nedeljković et al., 2009a; Šimić et al., 2009; Nedeljković, 2011; Nedeljković et al., 2013; Tot et al., 2018.

108. ***Chrysotoxum intermedium*** Meigen, 1822
Glumac, 1955a, 1959, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998a (as *C. aff. intermedium*); Vujić et al., 1998b;

Radenković et al., 2004; Nedeljković et al., 2009a; Šimić et al., 2009; Nedeljković et al., 2013.

109. ***Chrysotoxum lineare*** (Zetterstedt, 1819)
Vujić et al., 1998b; Vujić et al., 1998b; Vujić et al., 2001; Nedeljković et al., 2009a; Nedeljković, 2011; Markov et al., 2016.

110. ***Chrysotoxum montanum*** Nedeljković & Vujić, 2015
Nedeljković, 2011 (as *C.* aff *vernale*): Nedeljković et al., 2015b; Tot et al., 2018.

111. ***Chrysotoxum octomaculatum*** Curtis, 1838
Glumac, 1955a, 1959, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994 (as *Chrysotoxum arcuatum*); Šimić and Vujić, 1996; Vujić et al., 1998b; Nedeljković et al., 2009a; Nedeljković, 2011; Šimić et al., 2009; Tot et al., 2018.

112. ***Chrysotoxum orthostylum*** Vujić, 2015
Nedeljković, 2011 (as *C. orthostylus*); Nedeljković et al., 2015b.

113. ***Chrysotoxum tomentosum*** Giglio-Tos, 1890
Nedeljković et al., 2013; Tot et al., 2018.

114. ***Chrysotoxum vernale*** Loew, 1841
Strobl, 1902; Glumac, 1955a, 1959, 1972; Šimić and Vujić, 1984; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998a; Šimić and Vujić, 1996; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2009; Nedeljković, 2011; Markov et al., 2016; Tot et al., 2018.

115. ***Chrysotoxum verralli*** Collin, 1940
Vujić and Šimić, 1994 (as *C. elegans*); Vujić et al., 1998b; Nedeljković et al., 2009; Šimić et al., 2009; Nedeljković, 2011; Tot et al., 2018.

CRIORHINA Meigen, 1822

116. ***Criorhina asilica*** (Fallen, 1816)
Glumac, 1959 (as *Penthesilea asilica*); Vujić and Milankov, 1990 (as *Criorrhina asilica*); Vujić and Glumac, 1994; Vujić and Milankov, 1999; Radenković, 2008; Šimić et al., 2008; Nedeljković, 2009a; Van Steenis et al., 2015.

117. ***Criorhina berberina*** (Fabricius, 1805)
Glumac, 1955a (as *Penthesilea graeca*); Glumac, 1955a (as *Penthesilea graeca*); Vujić and Milankov, 1990 (as *Criorrhina berberina*); Vujić and Glumac, 1994 (as *Brachymyia berberina*); Šimić and Vujić, 1996; Vujić and Milankov, 1999 (as *Criorhina berberina*); Radenković, 2008; Nedeljković et al., 2009a; Radenković et al., 2013.

118. ***Criorhina floccosa*** (Meigen, 1822)
Glumac, 1959 (as *Penthesilea floccosa*); Vujić and Milankov, 1990 (as *Criorrhina floccosa*); Vujić and Glumac, 1994 (as *Brachymyia floccosa*); Nedeljković et al., 2009a; Radenković, 2008; Radenković et al., 2013; Markov et al., 2016.

119. ***Criorhina ranunculi*** (Panzer, 1804)
Vujić and Milankov, 1999; Radenković, 2008.

DASYSYRPHUS Enderlein, 1938

120. ***Dasysyrphus albostriatus*** (Fallen, 1817)
Glumac, 1955a, 1959 (as *Syrphus albostriatus*); Glumac, 1972; Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Tot et al., 2018.
121. ***Dasysyrphus friuliensis*** (van der Goot, 1960)
Nedeljković, 2011.
122. ***Dasysyrphus hilaris*** (Zetterstedt, 1843) sensu Doczkal & Ståhls, in. prep.
Vujić and Šimić, 1994 (partly as *D. arcuatus*); Šimić and Vujić, 1996; Nedeljković, 2011.
123. ***Dasysyrphus lenensis*** Bagatshanova, 1980
Vujić et al., 1993–1994; Nedeljković, 2011.
124. ***Dasysyrphus pauxillus*** (Willinston, 1886)
Nedeljković, 2011.
125. ***Dasysyrphus pinastri*** (De Geer, 1776) sensu Doczkal, 1996
Šimić and Vujić, 1984a (as *D. lunulatus*); Šimić and Vujić, 1996 (as *D. lunulatus*); Nedeljković, 2011; Tot et al., 2018.
126. ***Dasysyrphus postclaviger*** (Štys & Moucha, 1962)
Šimić and Vujić, 1984b; Nedeljković, 2011.
127. ***Dasysyrphus tricinctus*** (Fallen, 1817)
Glumac, 1959 (as *Syrphus tricinctus*); Glumac, 1972 (as *Syrphus tricinctus*); Kula, 1985; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011.

DIDEA Macquart, 1834

128. ***Didea alneti*** (Fallen, 1817)
Nedeljković, 2011.
129. ***Didea fasciata*** Macquart, 1834
Glumac, 1955a, 1959, 1972; Kula, 1985; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011.
130. ***Didea intermedia*** Loew, 1854
Glumac, 1955a, 1972; Nedeljković, 2011.

DOROS Meigen, 1803

131. ***Doros profuges*** (Harris, 1780)
Glumac, 1959 (as *D. conopeus*); Glumac, 1972 (as *D. conopeus*); Vujić and Šimić, 1994; Vujić et al., 1998b; Vujić et al., 2002; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011.
132. ***Doros destillatorius*** Mik, 1885
New to Serbia. 1♀, Dubašnica, Klisura Lazareve reke, 23.08.2013, leg. Ivošević.

EPISTROPHE Walker, 1852

133. ***Epistrophe diaphana*** (Zetterstedt, 1843)
Glumac, 1959; Glumac, 1972; Vujić and Šimić, 1994; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Tot et al., 2018.
134. ***Epistrophe eligans*** (Harris, 1780)
Glumac, 1955a, 1959, 1972 (as *E. bifasciatus*); Kula, 1985; Vujić and Šimić, 1994 (as *E. bifasciata*); Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016.
135. ***Epistrophe flava*** Doczkal & Schmid, 1994
Vujić and Glumac, 1994 (as *E. melanostomoides*); Vujić and Šimić, 1994 (as *E. ochrostoma, E. melanostoma, E. bifasciata, E. grossulariae*); Vujić et al., 2002; Vujić et al., 1998a; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011.
136. ***Epistrophe grossulariae*** (Meigen, 1822)
Glumac, 1959; Glumac, 1972; Kula, 1985; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998b; Šimić et al., 2008; Nedeljković et al., 2009a; Nedeljković, 2011; Tot et al., 2018.
137. ***Epistrophe melanostoma*** (Zetterstedt, 1843)
Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016.
138. ***Epistrophe nitidicollis*** (Meigen, 1822)
Glumac, 1955a (as *Syrphus nitidicollis*); Glumac, 1959 (as *S. nitidicollis*); Kula, 1985; Vujić and Šimić, 1994; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016.
139. ***Epistrophe obscuripes*** (Strobl, 1910)
Van Steenis et al., 2015.

EPISTROPHELLA Dušek & Láska, 1967

140. ***Epistrophella coronata*** (Rondani, 1857)
Doczkal and Vujić, 1998; Vujić et al., 2001; Nedeljković, 2011.
141. ***Epistrophella euchroma*** (Kowarz, 1885)
Glumac, 1955a (as *Epistrophe euchroma*); Glumac, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994 (as *Meligramma euchroma*- partly); Vujić et al., 1998b; Vujić et al., 2002; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016.

EPISYRPHUS Matsumura & Adachi, 1917

142. ***Episyrphus balteatus*** (De Geer, 1776)
Strobl, 1902 (as *Syrphus balteatus*); Glumac, 1955a, 1959 (as *Epistrophe balteata*), 1972 (as *Epistrophe balteatus*); Kula, 1985; Šimić and Vujić,

1987; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016; Tot et al., 2018.

ERIOZONA Schiner, 1860

143. ***Eriozona syrphoides*** (Fallen, 1817)
Nedeljković, 2011; Van Steenis et al., 2015.

ERISTALINUS Rondani, 1845

144. ***Eristalinus aeneus*** (Scopoli, 1763)
Glumac, 1955a (as *Lathyrophthalmus aeneus*); Glumac, 1959 (as *Lathyrophthalmus aeneus*); Glumac, 1972 (as *Lathyrophthalmus aeneus*); Šimić and Vujić, 1987 (as *Lathyrophthalmus aeneus*); Vujić and Glumac, 1994; Vujić and Šimić, 1994 (as *Lathyrophthalmus aeneus*); Vujić et al., 1998a; Vujić et al., 1998b; Radenković, 2008; Nedeljković et al., 2009a; Markov et al., 2016.
145. ***Eristalinus megacephalus*** (Rossi, 1794)
Šimić and Vujić, 1987 (as *Lathyrophthalmus quinquelineatus*); Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2009.
146. ***Eristalinus sepulchralis*** (Linnaeus, 1758)
Glumac, 1955a; Glumac, 1959; Glumac, 1972; Coe, 1960 (as *Eristalis sepulchralis*); Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić et al., 1998a; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Markov et al., 2016.

ERISTALIS Latreille, 1804

147. ***Eristalis alpina*** (Panzer, 1798)
Glumac, 1956c; Glumac, 1972 (as *Eristalis alpinus*); Kula, 1985 (as *Eristalis alpinus*); Šimić and Vujić, 1990 (as *Eristalis alpinus*); Vujić and Glumac, 1994; Vujić et al., 2004; Radenković, 2008; Šimić et al., 2008 (as *Eristalis alpine*); Nedeljković et al., 2009a.
148. ***Eristalis arbustorum*** (Linnaeus, 1758)
Strobl, 1902; Glumac, 1955a; Glumac, 1959; Glumac, 1972; Kula, 1985; Šimić and Vujić, 1987; Šimić and Vujić, 1990; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a, 1998b, 2004; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Markov et al., 2016; Tot et al., 2018.
149. ***Eristalis intricaria*** (Linnaeus, 1758)
Glumac, 1959; Glumac, 1972 (as *Eristalis intricarius*); Šimić and Vujić, 1990 (as *Eristalis intricarius*); Vujić and Glumac, 1994; Vujić et al., 2004; Radenković, 2008; Šimić et al., 2008; Nedeljković et al., 2009a.
150. ***Eristalis jugorum*** Egger, 1858
Glumac, 1955a; Glumac, 1972; Šimić and Vujić, 1990; Šimić and Vujić, 1996; Vujić et al., 2004; Radenković, 2008; Tot et al., 2018.

151. ***Eristalis lineata*** (Harris, 1776)
Glumac, 1955a (as *Eristalis horticola*); Glumac, 1972 (as *Eristalis horticola*); Kula, 1985 (as *Eristalis horticola*); Šimić and Vujić, 1990 (as *Eristalis horticola*); Vujić and Glumac, 1994 (as *Eristalis horticola*); Vujić and Šimić, 1994 (as *Eristalis horticola*); Šimić and Vujić, 1996 (as *Eristalis horticola*); Vujić et al., 1998a, 1998b (as *Eristalis horticola*); Radenković et al., 2004; Vujić et al., 2004; Radenković, 2008.

152. ***Eristalis nemorum*** (Linnaeus, 1758)
Strobl, 1902; Glumac, 1955a; Glumac, 1959; Glumac, 1972; Kula, 1985; Šimić and Vujić, 1987; Šimić and Vujić, 1990; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998b; Vujić et al., 2002; Vujić et al., 2004; Radenković, 2008 (as *E. interrupta*); Nedeljković et al., 2009a (as *E. interrupta*); Vujić et al., 1998a, 1998b (as *E. interrupta*).

153. ***Eristalis pertinax*** (Scopoli, 1763)
Glumac, 1955a; Glumac, 1959; Glumac, 1972; Kula, 1985; Šimić and Vujić, 1987; Šimić and Vujić, 1990; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998b; Radenković et al., 2004; Vujić et al., 2004; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a; Markov et al., 2016; Tot et al., 2018.

154. ***Eristalis picea*** (Fallen, 1817)
Šimić and Vujić, 1990 (as *Eristalis pigaliza* Violovitsh, 1977); Vujić and Glumac, 1994; Vujić et al., 1998a; Vujić et al., 2004; Nedeljković et al., 2009a.

155. ***Eristalis rupium*** Fabricius, 1805
Glumac, 1955a; Glumac, 1972; Kula, 1985; Šimić and Vujić, 1990; Šimić and Vujić, 1996; Vujić et al., 2004; Radenković, 2008.

156. ***Eristalis similis*** (Fallen, 1817)
Glumac, 1955a (as *Eristalis pratorum*); Glumac, 1959 (as *Eristalis pratorum*); Glumac, 1972 (as *Eristalis pratorum*); Kula, 1985 (as *Eristalis pratorum*); Šimić and Vujić, 1987 (as *Eristalis pratorum*); Šimić and Vujić, 1990 (as *Eristalis pratorum*); Vujić and Glumac, 1994 (as *Eristalis pratorum*); Vujić and Šimić, 1994 (as *Eristalis pratorum*); Šimić and Vujić, 1996 (as *Eristalis pratorum*); Vujić et al., 1998b (as *Eristalis pratorum*); Vujić et al., 2002; Radenković et al., 2004; Vujić et al., 2004; Radenković, 2008; Nedeljković et al., 2009a; Markov et al., 2016; Tot et al., 2018.

157. ***Eristalis tenax*** (Linnaeus, 1758)
Strobl, 1902; Glumac, 1955a (as *Eristalomyia tenax* var. *campestris*; *Eristalomyia tenax* var. *hortorum*; *Eristalomyia tenax* var. *tenax*); Glumac, 1959 (as *Eristalomyia tenax* var. *campestris*; *Eristalomyia tenax* var. *hortorum*; *Eristalomyia tenax* var. *tenax*); Glumac, 1972 (as *Eristalomyia tenax* var. *campestris*; *Eristalomyia tenax* var. *hortorum*; *Eristalomyia tenax* var. *tenax*); Kula, 1985; Šimić and Vujić, 1987; Šimić and Vujić, 1990; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Vujić et al., 2004; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a; Markov et al., 2016; Tot et al., 2018.

EUMERUS Meigen, 1822

158. ***Eumerus amoenus*** Loew, 1848
Vujić and Šimić, 1994; Vujić and Šimić, 1999; Vujić et al., 1998a; Nedeljković et al., 2009a; Šimić et al., 2009; Grković, 2018.
159. ***Eumerus argyropus*** Loew, 1848
Vujić and Šimić, 1999; Nedeljković et al., 2009a; Grković, 2018.
160. ***Eumerus banaticus*** Nedeljković, Grković & Vujić in press.
Grković et al., in press.
161. ***Eumerus basalis*** Loew, 1848
Vujić and Glumac, 1994; Vujić and Šimić, 1999; Vujić et al., 1998a; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Grković, 2018.
162. ***Eumerus clavatus*** Becker, 1923
Glumac, 1955a (as *Eumerus ornatus*); Vujić & Šimić, 1999; Markov et al., 2016; Grković, 2018.
163. ***Eumerus consimilis*** Šimić & Vujić, 1996
Grković, 2018.
164. ***Eumerus flavitarsis*** Zetterstedt, 1843
Vujić and Šimić, 1999; Nedeljković et al., 2009a; Grković, 2018.
165. ***Eumerus funeralis*** Meigen, 1822
Glumac, 1959 (as *Eumerus tuberculatus*); Glumac, 1972 (as *Eumerus tuberculatus*); Šimić and Vujić, 1987 (as *Eumerus tuberculatus*); Vujić and Glumac, 1994; Vujić and Šimić, 1999 (as *Eumerus tuberculatus*); Šimić et al., 2009; Nedeljković et al., 2009a; Grković, 2018.
166. ***Eumerus grandis*** Meigen, 1822
Grković, 2018.
167. ***Eumerus hungaricus*** Szilady, 1940
Grković, 2018.
168. ***Eumerus olivaceus*** Loew, 1848
Vujić and Šimić, 1999.
169. ***Eumerus ornatus*** Meigen, 1822
Glumac, 1959; Glumac, 1972; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić and Šimić, 1999; Vujić et al., 1998a; Nedeljković et al., 2009a; Grković, 2018.
170. ***Eumerus pannonicus*** Ricarte, Vujić & Radenković, 2016
Markov et al., 2016.
171. ***Eumerus richteri*** Stackelberg, 1960
Vujić and Radenković, 1996; Vujić and Šimić, 1999; Grković, 2018.
172. ***Eumerus sinuatus*** Loew, 1855
Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić and Šimić, 1999; Šimić et al., 2008; Nedeljković et al., 2009a; Grković, 2018.
173. ***Eumerus sogdianus*** Stackelberg, 1952
Vujić and Glumac, 1994; Šimić and Vujić, 1996; Vujić and Šimić, 1999; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Grković, 2018.

174. ***Eumerus strigatus*** (Fallen, 1817)
Glumac, 1955a; Glumac, 1972; Šimić and Vujić, 1984a; Kula, 1984; Šimić and Vujić, 1987; Vujić and Šimić, 1994; Vujić and Šimić, 1999; Nedeljković et al., 2009a; Šimić et al., 2009; Grković, 2018.

175. ***Eumerus tauricus*** (Stackelberg, 1952)
Glumac, 1955a (as *Eumerus sabulonum*); Glumac, 1972 (as *Eumerus sabulonum*); Vujić and Šimić, 1999.

176. ***Eumerus tricolor*** (Fabricius, 1798)
Strobl, 1902; Glumac, 1955a; Glumac, 1959; Glumac, 1972; Šimić and Vujić, 1987; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić and Šimić, 1999; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Grković, 2018.

EUPODES Matsumura, 1917

177. ***Eupeodes bucculatus*** (Rondani, 1847)
Glumac, 1955a, 1972 (as *Syrphus bucculatus*); Vujić and Šimić, 1994 (as *Postosyrphus latilunulatus*); Vujić et al., 1998b (as *E. latilunulatus*); Vujić et al., 2002; Nedeljković et al., 2009a; Nedeljković, 2011.

178. ***Eupodes corollae*** (Fabricius, 1794) Glumac, 1955a, 1959 (as *Syrphus corollae*); Kula, 1985; Šimić and Vujić, 1984 (as *Metasyrphus corollae*); Vujić and Šimić, 1994 (as *M. corollae*); Vujić and Glumac, 1994; Šimić and Vujić, 1996 (as *M. corollae*); Vujić et al., 1998a; Vujić et al., 1998b; Vujić et al., 2002; Radenković et al., 2004; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016; Tot et al., 2018.

179. ***Eupodes flaviceps*** (Rondani, 1857)
Vujić and Glumac, 1994 (as *Metasyrphus nuba*- partly); Vujić et al., 1998b; Nedeljković et al., 2009a; Nedeljković, 2011; Tot et al., 2018.

180. ***Eupeodes goeldlini*** Mazánek, Láska & Bičik, 1999
Radenković et al., 2004; Nedeljković et al., 2009a; Šimić et al., 2009; Nedeljković, 2011.

181. ***Eupodes latifasciatus*** (Macquart, 1829)
Glumac, 1955a, 1959, 1972 (as *Syrphus latifasciatus*); Kula, 1985; Vujić and Šimić, 1994 (as *Posthosyrphus latilunulatus*- partly); Vujić et al., 1998a (as *Metasyrphus latifasciatus*); Vujić et al., 1998b; Vujić et al., 2002; Radenković et al., 2004; Nedeljković et al., 2009; Šimić et al., 2008, 2009; Nedeljković, 2011.

182. ***Eupeodes lucasi*** (Marcos García & Láska, 1983)
Vujić and Glumac, 1994 (as *Metasyrphus nuba*); Vujić and Šimić, 1994 (as *Postosyrphus latilunulatus* (Collin, 1931)- partly); Vujić et al., 2002; Nedeljković et al., 2009a; Nedeljković, 2011.

183. ***Eupodes luniger*** (Meigen, 1822)
Glumac, 1955a (as *Syrphus luniger*), 1959 (as *Syrphus luniger*), 1972 (as *Syrphus luniger*); Šimić and Vujić, 1984 (as *Postosyrphus luniger*); Kula, 1985; Vujić and Šimić, 1994 (as *Posthosyrphus luniger*); Vujić and Glumac, 1994 (as *Metasyrphus luniger*); Šimić and Vujić, 1996 (as *Metasyrphus*

luniger); Vujić et al., 1998b; Vujić et al., 2002; Nedeljković et al., 2009; Šimić et al., 2008, 2009; Nedeljković, 2011; Tot et al., 2018.

184. ***Eupeodes nielseni*** (Dušek & Láska, 1976)
Nedeljković, 2011.

185. ***Eupodes nitens*** (Zetterstedt, 1843)
Glumac, 1955a, 1959, 1972 (as *Syrphus nitens*); Šimić and Vujić, 1996 (as *Metasyrphus nitens*); Nedeljković, 2011.

186. ***Eupeodes tirolensis*** (Dušek & Láska, 1973)
Nedeljković, 2011.

FERDINANDEA Rondani, 1844

187. ***Ferdinandea cuprea*** (Scopoli, 1763)
Glumac, 1955a (as *Ferdinandea nigrifrons*); Glumac, 1959; Kula, 1985; Šimić and Vujić, 1987 (as *F. nigrifrons*); Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998a; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009.

188. ***Ferdinandea ruficornis*** (Fabricius, 1775)
Coe, 1960; Šimić and Vujić, 1987; Vujić and Šimić, 1994; Radenković, 2008; Šimić et al., 2009; Nedeljković et al., 2009a.

HAMMERSCHMIDTIA Schummel, 1834

189. ***Hammerschmidtia ferruginea*** (Fallen, 1817)
Vujić, 1991; Radenković, 2008.

HELOPHILUS Meigen, 1822

190. ***Helophilus hybridus*** Loew, 1846
Nedeljković et al., 2009a; Šimić et al., 2009; Radenković, 2008.

191. ***Helophilus pendulus*** (Linnaeus, 1758)
Glumac, 1955a (as *Tubifera pendula*); Glumac, 1959 (as *Tubifera pendula*); Glumac, 1972 (as *Tubifera pendulus*); Kula, 1985; Glumac, 1972 (as *Tubifera pendula*); Vujić and Šimić, 1994; Vujić and Glumac, 1994; Šimić and Vujić, 1987; Vujić et al., 1988a; Vujić et al., 2002; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.

192. ***Helophilus trivittatus*** (Fabricius, 1805)
Glumac, 1955a (as *Tubifera trivittata*); Glumac, 1959 (as *Tubifera trivittata*); Glumac, 1972 (as *Tubifera trivittatus*); Kula, 1985; Šimić and Vujić, 1987; Vujić and Šimić, 1994; Vujić and Glumac, 1994 (as *Helophilus parallelus* syn. *trivittatus*); Vujić et al., 1998a; Vujić et al., 2002; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.

HERINGIA Rondani, 1856

193. ***Heringia heringi*** (Zetterstedt, 1843)
Glumac, 1959; Šimić and Vujić, 1987; Vujić and Glumac, 1994; Vujić et al., 1998a; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a.

LAPPOSYRPHUS Dušek & Láska 1967

194. ***Lapposyrphus lapponicus*** (Zetterstedt, 1838)
Kula, 1985 (as *Metasyrphus lapponicus*); Kula, 1985; Vujić and Glumac, 1994 (as *Metasyrphus lapponicus*); Vujić and Šimić, 1994 (as *Scaeva lapponica*); Šimić and Vujić, 1996 (as *Metasyrphus lapponicus*); Vujić et al., 1998a (as *Metasyrphus lapponicus*); Vujić et al., 1998b; Vujić et al., 2002; Radenković et al., 2004; Nedeljković et al., 2009a; Šimić et al., 2008; Nedeljković, 2011; Markov et al., 2016 (as *Eupeodes lapponicus*).

LEJOGASTER Rondani, 1857

195. ***Lejogaster metallina*** (Fabricius, 1776)
Glumac, 1972 (as *Liogaster metallina*); Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić, 1999b; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a.
196. ***Lejogaster tarsata*** (Megerle in Meigen, 1822)
Glumac, 1972 (as *Liogaster splendida*); Vujić and Glumac, 1994 (as *Lejogaster splendida*); Vujić, 1999b; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.

LEJOPS Rondani, 1857

197. ***Lejops vittata*** (Meigen, 1822)
Glumac, 1955a (as *Liops vittata*); Glumac, 1972 (as *Liops vittata*); Radenković, 2008; Šimić et al., 2009; Nedeljković et al., 2009a.

LEJOTA Rondani, 1857

198. ***Lejota ruficornis*** (Zetterstedt, 1843)
Radenković, 2008.

LEUCOZONA Schiner, 1860

199. ***Leucozona inopinata*** Doczkal, 2000
Nedeljković, 2011.
200. ***Leucozona laternaria*** (Muller, 1776)
Nedeljković, 2011.
201. ***Leucozona lucorum*** (Linnaeus, 1758)
Glumac, 1972; Vujić and Šimić, 1994; Vujić et al., 1998b; Nedeljković et al., 2009a; Nedeljković, 2011; Tot et al., 2018.

MALLOTA Meigen, 1822

202. ***Mallota cimbiciformis*** (Fallen, 1817)
Glumac, 1955a; Glumac, 1972; Vujić et al., 2002; Šimić et al., 2008; Radenković, 2008.

203. ***Mallota fuciformis*** (Fabricius, 1794)
Radenković, 2008; Nedeljković et al., 2009a.

MEGASYRPHUS Dušek & Láska, 1967

204. ***Megasyrphus erraticus*** (Linnaeus, 1758)
Kula, 1985 (as *Megasyrphus annulipes*); Nedeljković, 2011.

MELANGYNA Verrall, 1901

205. ***Melangyna barbifrons*** (Fallen, 1817)
Nedeljković, 2011.
206. ***Melangyna compositarum*** (Verrall, 1873)
Nedeljković, 2011; Tot et al., 2018.
207. ***Melangyna lasiophthalma*** (Zetterstedt, 1843)
Kula, 1985; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011.
208. ***Melangyna lucifera*** Nielsen 1980
Nedeljković, 2011.
209. ***Melangyna quadrimaculata*** (Verrall, 1873)
Nedeljković, 2011.
210. ***Melangyna umbellatarum*** (Fabricius, 1794)
Glumac, 1959, 1972 (as *Epistrophe umbellatarum*); Kula, 1985; Vujić and Glumac, 1994; Nedeljković et al., 2009a; Nedeljković, 2011.

MELANOGASTER Rondani, 1857

211. ***Melanogaster curvistylus*** Vujić et Stuke, 1998
Vujić and Stuke, 1998; Radenković, 2008.
212. ***Melanogaster nuda*** (Macquart, 1829)
Glumac, 1955a (partly as *Chrysogaster macquarti*); Šimić and Vujić, 1987 (as *Chrysogaster viduata*); Vujić and Glumac, 1994 (as *Chrysogaster lucida*); Vujić and Šimić, 1994 (as *Chrysogaster viduata*); Vujić, 1999b; Radenković, 2008; Šimić et al., 2009; Nedeljković et al., 2009a.

MELANOSTOMA Schiner, 1860

213. ***Melanostoma mellinum*** (Linnaeus, 1758)
Strobl, 1902; Glumac, 1955a, 1959, 1972; Kula, 1985; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić et al., 1998a; Vujić et al., 1998b; Šimić and Vujić, 1987; Šimić and Vujić, 1996; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Nedeljković, 2011.
214. ***Melanostoma scalare*** (Fabricius, 1794)
Glumac, 1955a; Nedeljković et al., 2009a; Nedeljković, 2011.

MELIGRAMMA Frey, 1946

215. ***Meligramma cincta*** (Fallen, 1817)
Glumac, 1959 (as *Epistrophe cincta*), 1972 (as *Epistrophe cinctus*); Kula, 1985; Vujić and Šimić, 1994; Vujić and Glumac, 1994 (as *Melangyna cincta*); Šimić and Vujić, 1996; Vujić et al., 1998b (as *F. cinctus*).; Vujić et al., 1998a; Vujić et al., 2002 (as *F. cinctus*); Radenković et al., 2004 (as *F. cinctus*); Nedeljković et al., 2009a; Šimić et al., 2008 (as *F. cinctus*), 2009; Nedeljković, 2011; Tot et al., 2018 (as *Melangyna cincta*).
216. ***Meligramma cingullata*** (Egger, 1860)
Glumac, 1955a (as *Melanostoma cingulatum*), 1972 (as *Melanostoma cingulatum*); Nedeljković, 2011.
217. ***Meligramma guttata*** (Fallen, 1817)
Vujić and Glumac, 1994 (as *Melangyna guttata*); Vujić et al., 2002; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Tot et al., 2018 (as *Melangyna guttata*).
218. ***Meligramma triangulifera*** (Zetterstedt, 1843)
Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998b; Vujić et al., 2002; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011.

MELISCAEVA Frey, 1946

219. ***Meliscaeva auricollis*** (Meigen, 1822)
Glumac, 1955a, 1959, 1972 (as *Epistrophe auricollis*); Kula, 1985 (as *Episyrphus auricollis*); Vujić and Šimić, 1994 (as *E. auricollis*); Vujić and Glumac, 1994; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016; Tot et al., 2018.
220. ***Meliscaeva cinctella*** (Zetterstedt, 1843)
Glumac, 1955a, 1959 (as *Epistrophe cinctella*), 1972 (as *Epistrophe cinctellus*); Kula, 1985 (as *Episyrphus cinctellus*); Vujić and Glumac, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Vujić and Šimić, 1994 (as *E. cinctellus*); Nedeljković, 2011; Tot et al., 2018.

MERODON Meigen, 1803

221. ***Merodon abberans*** Egger, 1860
Glumac, 1955a, 1959 (as *Lampetia aberrans*); Glumac, 1972; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Radenković and Vujić, 1995; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Markov et al., 2016.
222. ***Merodon aerarius*** Rondani, 1857
Glumac, 1955a (as *Lampetia aenea* var. *aurea*); Glumac, 1972 (as *Lampetia aenea* Meig. var. *aurea* Fabr.); Šimić and Vujić, 1996 (as *Merodon aeneus*); Radenković, 2008.

223. ***Merodon albifrons*** Meigen, 1822
Radenković, 2008.
224. ***Merodon ambiguus*** Bradescu, 1986
New to Serbia. Kladovo, 28.09.2013, 19♂, 15♀.
225. ***Merodon armipes*** Rondani, 1843
Strobl, 1902; Glumac, 1959 (as *Lampetia armipes*, partly as *Lampetia ruficornis*); Glumac, 1972; Kula, 1985; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Šimić et al., 2008; Radenković, 2008; Nedeljković et al., 2009a; Vujić et al., 2012; Markov et al., 2016; Tot et al., 2018.
226. ***Merodon aureus*** Fabricius, 1805
Šimić and Vujić, 1996 (as *Merodon aeneus*); Radenković, 2008; Milankov et al., 2008.
227. ***Merodon auripes*** Sack, 1913
Glumac, 1955a (as *Lampetia ruficornis*); Glumac, 1959 (partly as *Lampetia ruficornis*); Kula, 1985; Vujić and Glumac, 1994 (as *Merodon ruficornis*); Vujić and Šimić, 1994 (as *Merodon ruficornis*); Šimić and Vujić, 1996 (as *Merodon ruficornis*); Radenković and Vujić, 1994 (as *Merodon ruficornis*); Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Vujić et al., 2012.
228. ***Merodon avidus*** (Rossi, 1790)
Strobl, 1902 (as *Merodon spinipes*); Glumac, 1955a (as *Lampetia spinipes* var. *nigitarsis*; as *Lampetia spinipes* var. *spinipes*); Glumac, 1959 (as *Lampetia spinipes* var. *avida*; *Lampetia longicornis*); Glumac, 1972 (as *Merodon spinipes*); Vujić and Šimić, 1994 (as *Merodon spinipes*); Vujić and Glumac, 1994 (as *Merodon avidus*); Šimić and Vujić, 1987 (as *Merodon spinipes*); Šimić and Vujić, 1996 (as *Merodon spinipes*); Vujić et al., 1998a (as *Merodon avidus*); Radenković, 2008; Šimić et al., 2009; Nedeljković et al., 2009a; Markov et al., 2016; Aćanski et al., 2016.
229. ***Merodon balkanicus*** Šašić, Aćanski et Vujić, 2016
Šašić et al., 2016.
230. ***Merodon bessarabicus*** Paramonov, 1924
Glumac 1972 (as *Merodon bessarabica*).
231. ***Merodon chalybeatus*** Sack, 1913
Vujić et al., 1996 (as *Merodon albonigrum*); Vujić and Radenković, 1996, 1997 (as *Merodon albonigrum*); Radenković, 2008; Vujić et al., 2018.
232. ***Merodon cinereus*** (Fabricius, 1794)
Glumac, 1955a (as *Lampetia cinerea*); Glumac, 1972; Šimić and Vujić, 1996; Radenković, 2008.
233. ***Merodon clavipes*** (Fabricius, 1781)
Glumac, 1955a (as *Lampetia clavipes*); Glumac, 1959 (as *Lampetia clavipes* var. *clavipes*, *Lampetia clavipes* var. *senilis*); Glumac, 1972; Kula, 1985; Vujić and Glumac, 1994; Šimić and Vujić, 1987; Šimić and Vujić, 1996; Radenković, 2008; Šimić et al., 2008; Nedeljković et al., 2009a.
234. ***Merodon constans*** (Fabricius, 1781)
Glumac, 1959 (as *Lampetia constans* var. *analis*, *Lampetia constans* var. *constans*, *Lampetia constans* var. *rubidiventris*); Glumac, 1972; Vujić and

Glumac, 1994; Šimić et al., 2008; Radenković, 2008; Nedeljković et al., 2009a; Markov et al., 2016.

235. ***Merodon crassifemoris*** Paramonov, 1925
Glumac, 1955a (partly as *Lampetia femorata*); Radenković and Vujić, 1993-1994 (as *Merodon sp.*); Radenković, 2008.

236. ***Merodon desuturinus*** Vujić, Šimić et Radenković, 1995; Vujić et al., 1995; Radenković, 2008; Van Steenis et al., 2015.

237. ***Merodon erivanicus*** Paramonov, 1925
Glumac, 1955a (partly as *Lampetia spinipes* var. *nigritarsis*); Radenković and Vujić, 1993–1994 (as *Merodon nigritarsis*); Radenković, 2008.

238. ***Merodon equestris*** (Fabricius, 1794)
Van Steenis et al., 2015.

239. ***Merodon euri*** Vujić & Radenković, 2017
Radenković et al., 2017.

240. ***Merodon haemorrhoidalis*** Sack, 1913
Van Steenis et al., 2015.

241. ***Merodon loewi*** van der Goot, 1964
Radenković and Vujić, 1995; Radenković, 2008; Vujić et al., 2012.

242. ***Merodon italicus*** Rondani, 1945
Glumac, 1955a (as *Lampetia longicornis*).

243. ***Merodon moenium*** (Wiedemann in Meigen, 1822)
Šimić and Vujić, 1996 (as *Merodon avidus*); Popović et al., 2015; Markov et al., 2016; Ačanski et al., 2016; Tot et al., 2018.

244. ***Merodon natans*** (Fabricius, 1794)
New to Serbia. Pčinja, 10♂, 2♀, 6.9.2012, leg. Vujić.

245. ***Merodon nigritarsis*** Rondani, 1845
Glumac, 1955a, 1972 (as *Merodon spinipes* var *nigritarsis*); Radenković, 2008.

246. ***Merodon obscuritarsis*** Strobl, 1909
Glumac, 1955a (as *Lampetia distincta*); Glumac, 1956c (as *Lampetia tenera*); Radenković and Vujić, 1993-1994 (as *Merodon tricinctus*); Šimić and Vujić, 1996 (as *Merodon tricinctus*); Radenković, 2008.

247. ***Merodon rasicus*** Vujić et Radenković, 2015
Vujić et al., 2015.

248. ***Merodon ruficornis*** Meigen, 1822
Glumac, 1959 (partly as *Lampetia ruficornis*); Vujić and Šimić, 1994; Vujić and Glumac, 1994 (as *Merodon strobli*); Šimić and Vujić, 1996 (as *Merodon strobli*); Vujić et al., 1998a (as *Merodon recurvus*); Vujić et al., 2002 (as *Merodon recurvus*); Radenković et al., 2004; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Vujić et al., 2012.

249. ***Merodon rufus*** Meigen, 1838
Glumac, 1959 (as *Lampetia aenea* var. *unicolor*); Vujić and Glumac, 1994; Šimić et al., 2008; Radenković, 2008.

250. ***Merodon trebevicensis*** Strobl, 1900
Šimić and Vujić, 1984b (as *Merodon crymensis*); Vujić and Šimić, 1994 (as *Merodon crymensis*); Šimić and Vujić, 1996; Radenković, 2008; Šimić et al., 2009; Nedeljković et al., 2009a; Vujić et al., 2012.

251. ***Merodon virgatus*** Vujić et Radenković, 2016
Šašić et al., 2016.

MESEMBRIUS Rondani, 1857

252. ***Mesembrius peregrinus*** (Loew, 1846)
Glumac, 1955a; Glumac, 1959; Glumac, 1972; Šimić and Vujić, 1987; Vujić and Glumac, 1994; Vujić et al., 1998b; Radenković, 2008; Šimić et al., 2009; Nedeljković et al., 2009a.

MICRODON Meigen, 1803

253. ***Microdon analis*** (Macquart, 1842)
Vujić and Glumac, 1994 (as *M. latifrons*); Vujić et al., 1998a (as *M. latifrons*); Šimić et al., 2008, 2009; Nedeljković et al., 2009a.
254. ***Microdon devius*** (Linnaeus, 1761)
Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998a; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.
255. ***Microdon miki*** Doczkal & Schmid, 1999
Van Steenis et al., 2015.
256. ***Microdon mutabilis*** (Linnaeus, 1758)
Glumac, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.

MILESIA Latreille, 1804

257. ***Milesia semiluctifera*** (Villen, 1789)
Strobl, 1900; Glumac, 1955a; Glumac, 1972; Radenković, 2008.

MYATHROPA Rondani, 1845

258. ***Myathropa florea*** (Linnaeus, 1758)
Strobl, 1902; Glumac, 1955a; Glumac, 1959; Coe, 1960; Glumac, 1972; Kula, 1985; Šimić and Vujić, 1987; Vujić and Glumac; 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Markov et al., 2016; Tot et al., 2018.

MYOLEPTA Newman, 1838

259. ***Myolepta dubia*** (Fabricius, 1805)
Glumac, 1955a (as *Myolepta luteola*); Glumac, 1959 (as *Myolepta luteola*); Vujić and Glumac, 1994 (as *Myolepta luteola*); Šimić and Vujić, 1996 (as *Myolepta nigritarsis*); Šimić et al., 2008; Radenković, 2008; Nedeljković et al., 2009a; Van Steenis et al., 2015; Tot et al., 2018.

260. ***Myolepta nigritarsis*** Coe, 1957
Vujić and Radenković, 1996; Radenković, 2008; Van Steenis et al., 2015.

261. ***Myolepta obscura*** Becher, 1882
Vujić and Glumac, 1994; Vujić et al., 1998a; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.

262. ***Myolepta potens*** (Harris, 1780)
Vujić and Glumac, 1994; Radenković, 2008; Šimić et al., 2008; Nedeljković et al., 2009a; Van Steenis et al., 2015.

263. ***Myolepta vara*** (Panzer, 1798)
Glumac, 1955a; Glumac, 1959; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.

NEOASCIA Williston, 1886

264. ***Neoascia annexa*** (Muller, 1776)
Glumac, 1955a (as *Neoascia floralis*); Glumac, 1959 (as *N. dispar*); Vujić, 1990; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Radenković, 2008; Šimić et al., 2008; Nedeljković et al., 2009a.

265. ***Neoascia interrupta*** (Meigen, 1822)
Glumac, 1959 (partly as *Neoscia floralis*); Coe, 1956; Vujić, 1990; Vujić and Glumac, 1994; Vujić et al., 1998a, Vujić et al., 1998b; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Van Steenis et al., 2015.

266. ***Neoascia meticulosa*** (Scopoli, 1763)
Glumac, 1955a (partly as *Neoscia dispar*); Vujić, 1990; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.

267. ***Neoascia obliqua*** Coe, 1940
Glumac, 1956c; Glumac, 1959 (partly as *N. floralis*); Vujić, 1990; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Radenković, 2008; Šimić et al., 2008; Nedeljković et al., 2009a; Tot et al., 2018.

268. ***Neoascia podagrica*** (Fabricius, 1776)
Glumac, 1955a; Glumac, 1959; Šimić and Vujić, 1984; Šimić and Vujić, 1987; Vujić, 1990; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Markov et al., 2016.

269. ***Neoascia tenur*** (Harris, 1780)
Glumac, 1972 (as *Neoascia dispar*); Šimić and Vujić, 1987 (as *N. dispar*); Vujić, 1990; Vujić and Glumac,1994; Vujić et al., 1998a; Šimić et al., 2008, 2009; Radenković, 2008; Nedeljković et al., 2009a; Van Steenis et al., 2015; Tot et al., 2018.

270. ***Neoascia unifasiata*** (Strobl, 1898)
Vujić, 1990; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Radenković, 2008; Nedeljković et al., 2009a; Šimić et al., 2008, 2009.

NEOCNEMODON Goffe 1944

271. ***Neocnemodon brevidens*** (Egger, 1865)
Vujić and Glumac, 1994; Vujić and Radenković, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Vujić, 1999a; Radenković et al., 2004; Vujić and Glumac, 1994; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.
272. ***Neocnemodon larusi*** Vujić, 1999
Vujić, 1999a; Radenković, 2008.
273. ***Neocnemodon latitarsis*** (Egger, 1865)
Kula, 1985 (as *Neocnemodon latitarsis*); Vujić and Šimić, 1994 (as *Cnemodon latitarsis*); Vujić and Glumac, 1994; Vujić et al., 1998b; Vujić, 1999a; Radenković, 2008; Šimić et al., 2009; Nedeljković et al., 2009a.
274. ***Neocnemodon pubescens*** (Delucchi et Pschorn-Walcher, 1955)
Šimić and Vujić, 1996 (as *Neocnemodon pubescens*); Vujić, 1999a; Radenković, 2008.
275. ***Neocnemodon vitripennis*** (Meigen, 1822)
Vujić and Glumac, 1994 (as *Neocnemodon vitripennis*); Šimić et al., 2008; Radenković, 2008; Nedeljković et al., 2009a.

ORTHONEVRA Macquart, 1829

276. ***Orthonevra frontalis*** (Loew, 1843)
Glumac, 1955a (*Orthonevra frontalis*); Glumac, 1959 (as *Orthoneura nobilis*); Vujić and Glumac, 1994; Vujić, 1999b; Radenković, 2008; Šimić et al., 2008; Nedeljković et al., 2009a.
277. ***Orthonevra gemmula*** Violovitsh, 1979
Vujić and Šimić, 1994; Radenković, 2008; Nedeljković et al., 2009a.
278. ***Orthonevra montana*** Vujić, 1999
Vujić, 1999b; Radenković, 2008; Van Steenis et al., 2015.
279. ***Orthonevra nobilis*** (Fallen, 1817)
Vujić and Glumac, 1994; Vujić and Glumac, 1994; Vujić, 1999b; Radenković, 2008; Nedeljković et al., 2009a.

PARAGUS Latreille, 1804

280. ***Paragus absidatus*** Goeldlin de Tiefenau, 1971
Vujić et al., 1993-1994; Vujić et al., 2001; Nedeljković, 2011.
281. ***Paragus albifrons*** (Fallen, 1817)
Strobl, 1902; Glumac, 1955a, 1959, 1972, Kula, 1985; Vujić et al., 1998b; Nedeljković et al., 2009a; Nedeljković, 2011.
282. ***Paragus bicolor*** (Fabricius, 1794)
Strobl, 1902; Langhoffer, 1918; Glumac, 1955a (as *Paragus bicolor* var. *testaceus*), 1959, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998b; Nedeljković et al., 2009a; Nedeljković, 2011.
283. ***Paragus cinctus*** Schiner et Egger, 1853
Nedeljković, 2011.

284. ***Paragus constrictus*** Šimić, 1986
Šimić, 1986; Vujić and Šimić, 1994; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2009; Nedeljković, 2011.
285. ***Paragus finitimus*** Goeldlin de Tiefenau, 1971
Vujić et al., 2001; Nedeljković, 2011.
286. ***Paragus haemorrhous*** Meigen, 1822
Glumac, 1955a; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Tot et al., 2018.
287. ***Paragus majoranae*** Rondani, 1857
Vujić et al., 1999 (as *Paragus gorgus*); Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Radenković et al., 2004; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016 (as *P. pecchiolii*).
288. ***Paragus punctulatus*** (Zetterstedt, 1838)
Nedeljković, 2011.
289. ***Paragus quadrifasciatus*** Meigen, 1822
Glumac, 1955a (as *Paragus pulcherrimus* and *P. quadrifasciatus*); Glumac, 1972; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2009; Nedeljković, 2011.
290. ***Paragus testaceus*** Meigen, 1822
Glumac, 1955a, 1959 (as *P. bicolor* var. *testaceus*); Glumac, 1972 (as *Paragus bicolor*); Nedeljković, 2011.
291. ***Paragus tibialis*** (Fallen, 1817)
Strobl, 1902; Glumac, 1955a, 1959, 1972; Vujić and Glumac, 1994; Vujić et al., 1998b; Nedeljković et al., 2009a; Nedeljković, 2011.

PARASYRPHUS Matsumura, 1917

292. ***Parasyrphus annulatus*** (Zetterstedt, 1838)
Glumac, 1972 (as *Epistrophe annulatus*); Vujić and Glumac, 1994; Nedeljković et al., 2009a; Šimić et al., 2008; Nedeljković, 2011.
293. ***Parasyrphus lineolus*** (Zetterstedt, 1843)
Nedeljković, 2011; Tot et al., 2018.
294. ***Parasyrphus macularis*** (Zetterstedt, 1843)
Vujić and Šimić, 1994 (as *Mesosyrphus macularis*); Šimić and Vujić, 1996; Vujić et al., 1998a; Nedeljković et al., 2009; Nedeljković, 2011.
295. ***Parasyrphus malinellus*** (Collin, 1952)
Nedeljković, 2011.
296. ***Parasyrphus nigritarsis*** (Zetterstedt, 1843)
Nedeljković, 2011.
297. ***Parasyrphus punctulatus*** (Verrall, 1873)
Kula, 1985; Vujić and Šimić, 1994 (as *Mesosyrphus macularis*); Vujić and Glumac, 1994 (as *Parasyrphus macularis*); Vujić et al., 1998a (as *Parasyrphus macularis*); Vujić et al., 1998b; Vujić et al., 2002; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Tot et al., 2018.

298. ***Parasyrphus vittiger*** (Zetterstedt, 1843)
Šimić and Vujić, 1984a (as *Mesosyrphus vittiger*); Vujić and Glumac, 1994; Šimić and Vujić, 1996; Šimić et al., 2008; Nedeljković et al., 2009a; Nedeljković, 2011; Tot et al., 2018.

PARHELOPHILUS Girschner, 1897

299. ***Parhelophilus frutetorum*** (Fabricius, 1775)
Glumac, 1955a; Glumac, 1972; Šimić and Vujić, 1987; Kula, 1985 (as *Helophilus frutetorum*); Glumac, 1959; Vujić and Glumac, 1994 (as *Helophilus frutetorum*); Vujić and Šimić, 1994; Vujić et al., 1998b; Vujić et al., 2002; Radenković, 2008; Šimić et al., 2009; Nedeljković et al., 2009a.
300. ***Parhelophilus versicolor*** (Fabricius, 1794)
Glumac, 1955a; Glumac, 1959; Glumac, 1972; Šimić and Vujić, 1987; Vujić and Glumac, 1994 (as *Helophilus versicolor*); Vujić and Šimić, 1994; Vujić et al., 1998a; Vujić et al., 1998b (as *Helophilus Parhelophilus versicolor*); Vujić et al., 2002; Radenković et al., 2004; Radenković, 2008; Šimić et al., 2009; Nedeljković et al., 2009a.

PELECOCERA Meigen, 1822

301. ***Pelecocera tricincta*** Meigen, 1822
Radenković, 2008.
302. ***Pelecocera caledonica*** (Collin, 1940)
Radenković, 2008 (as *Chamaesyrphus escorialensis*)
303. ***Pelecocera scaevoides*** (Fallen, 1817)
Radenković, 2008.

PIPIZA Fallen, 1810

304. ***Pipiza austraca*** Meigen, 1822
Glumac, 1972; Vujić and Glumac, 1994; Šimić et al., 2008; Nedeljković et al., 2009a.
305. ***Pipiza carbonaria*** Meigen, 1822
Vujić and Šimić, 1994 (as *Pipiza lugubris*).
306. ***Pipiza fasciata*** Meigen, 1822
Glumac, 1972; Šimić and Vujić, 1987; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić et al., 2008.
307. ***Pipiza festiva*** Meigen, 1822
Glumac, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998a; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.
308. ***Pipiza luteibarba*** Vujić, Radenković & Polić, 2008
Vujić et al., 2008; Šimić et al., 2009; Nedeljković et al., 2009a.
309. ***Pipiza luteitarsis*** Zetterstedt, 1843
Vujić and Glumac, 1994; Vujić et al., 1998a (as *P. festiva*); Vujić et al., 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.

310. ***Pipiza lugubris*** (Fabricius, 1775)
Glumac, 1972; Vujić and Glumac, 1994 (as *P. signata*); Vujić and Šimić, 1994 (as *P. signata*), Šimić et al., 2008 (as *P. signata*); Nedeljković et al., 2009a (as *P. signata*).
311. ***Pipiza noctiluca*** (Linnaeus, 1758)
Glumac, 1972; Vujić and Šimić, 1994; Šimić et al., 2008.
312. ***Pipiza notata*** Meigen, 1822
Glumac, 1972 (as *P. bimaculata*); Vujić and Šimić, 1994 (as *P. bimaculata*); Vujićand Glumac (as *P. bimaculata*); Šimić et al., 2008 (as *P. bimaculata*), 2009; Markov et al., 2016.
313. ***Pipiza quadrimaculata*** (Panzer, 1802)
Glumac, 1972; Vujić et al., 2008.

PIPIZELLA Rondani, 1856

314. ***Pipizella annulata*** (Macquart, 1829)
Vujić, 1997.
315. ***Pipizella bispina*** Šimić, 1987
Vujić, 1997.
316. ***Pipizella divicoi*** (Goeldlin de Tiefenau, 1974)
Vujić, 1997; Nedeljković et al., 2009a.
317. ***Pipizella maculipennis*** (Meigen, 1822)
Glumac, 1972 (as *Heringia maculipennis*); Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.
318. ***Pipizella pennina*** (Goeldlin de Tiefenau, 1974)
Vujić, 1997.
319. ***Pipizella viduata*** (Linnaeus, 1758)
Glumac, 1972 (as *Heringia virens varipes*); Vujić and Glumac, 1994 (as *P. varipes*). Vujić and Šimić, 1994 (as *P. varipes*); Nedeljković et al., 2009a.
320. ***Pipizella virens*** (Fabricius, 1805)
Glumac, 1972 (as *Heringia virens virens*); Vujić and Glumac, 1994; Vujić and Šimić, 1994; Nedeljković et al., 2009a; Šimić et al., 2008, 2009.
321. ***Pipizella zloti*** Vujić, 1997
Vujić, 1997.

PLATYCHEIRUS Le Peletier & Serville, 1828

322. ***Platycheirus albimanus*** (Fabricius, 1781)
Glumac, 1959, 1972; Kula, 1985; Vujić et al., 1998a; Vujić and Glumac, 1994 (as *Platycheirus cyaneus*); Vujić and Šimić, 1994; Šimić and Vujić, 1996 (as *Platycheirus cyaneus*); Vujić et al., 2002; Šimić and Vujić, 1984b; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Tot et al., 2018.
323. ***Platycheirus ambiguus*** (Fallen, 1817)
Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998b; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić et al., 2008; Nedeljković et al., 2009a; Nedeljković, 2011.

324. ***Platycheirus angustatus*** (Zetterstedt, 1843)
Kula, 1985; Šimić and Vujić, 1987; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011.
325. ***Platycheirus angustipes*** Goeldlin, 1974
Van Steenis et al., 2015.
326. ***Platycheirus aurolateralis*** Stubbs, 2002
Nedeljković, 2011.
327. ***Platycheirus brunnifrons*** Nielsen, 2004
Nedeljković, 2011.
328. ***Platycheirus clypeatus*** (Meigen, 1822)
Glumac, 1955a; Nedeljković, 2011.
329. ***Platycheirus complicatus*** (Becker, 1889)
Nedeljković, 2011.
330. ***Platycheirus discimanus*** (Loew, 1871)
Nedeljković, 2011.
331. ***Platycheirus europaeus*** Goeldlin, Maibach & Speight, 1990
Vujić and Glumac, 1994 (as *Platycheirus clypeatus*, partly); Vujić et al., 2002; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Tot et al., 2018.
332. ***Platycheirus fulviventris*** (Macquart, 1829)
Strobl, 1902; Glumac, 1972; Šimić and Vujić, 1984a; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998a, Vujić et al., 1998b; Vujić et al., 2002; Nedeljković et al., 2009a; Šimić et al., 2009; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016.
333. ***Platycheirus manicatus*** (Meigen, 1822)
Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998b; Nedeljković et al., 2009a; Nedeljković, 2011.
334. ***Platycheirus melanopsis*** Loew, 1856.
Nedeljković, 2011.
335. ***Platycheirus nielseni*** Vockeroth, 1990
Nedeljković, 2011.
336. ***Platycheirus occultus*** Goeldlin, Maibach & Speight, 1990
Vujić and Glumac, 1994 (as *Platycheirus clypeatus*-partly); Vujić et al., 2002; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Van Steenis et al., 2015.
337. ***Platycheirus parmatus*** Rondani, 1857
Nedeljković, 2011.
338. ***Platycheirus peltatus*** (Meigen, 1822)
Šimić and Vujić, 1987; Nedeljković, 2011.
339. ***Platycheirus scutatus*** (Meigen, 1822)
Glumac, 1959, 1972; Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998b; Vujić et al., 2002; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011.
340. ***Platycheirus splendidus*** Rotheray, 1998
Nedeljković, 2011.

341. ***Platycheirus sticticus*** (Meigen, 1822)
Nedeljković, 2011.
342. ***Platycheirus tarsalis*** (Schummel, 1836)
Vujić and Glumac, 1994; Vujić et al., 2002; Nedeljković et al., 2009a.
343. ***Platycheirus tatricus*** Dušek & Láska, 1982
Nedeljković, 2011; Van Steenis et al., 2015.
344. ***Platycheirus transfugus*** (Zetterstedt, 1838)
Glumac, 1955a, 1959, 1972 (as *Melanostoma transfugum*); Nedeljković, 2011.

POKORNYIA Vujić et Radenković, 2018

345. ***Pokornyia latifrons*** (Loew, 1856)
Glumac, 1955a (as *Pelecocera*); Glumac, 1972 (as *Pelecocera*); Glumac, 1959 (as *Pelecocera*); Šimić and Vujić, 1987 (as *Pelecocera*); Vujić and Glumac, 1994; Vujić and Šimić, 1994; Radenković, 2008.

POCOTA Lepeletier & Serville, 1828

346. ***Pocota personata*** (Harris, 1780)
Glumac, 1959 (as *Pocota apiformis* Schrank); Glumac, 1972 (as *Pocota apiformis*); Šimić et al., 2008; Radenković, 2008; Nedeljković et al., 2009a; Radenković et al., 2013.

PSARUS Latreille, 1804

347. ***Psarus abdominalis*** (Fabricius, 1794)
Radenković, 2008.

PSILOTA Meigen, 1822

348. ***Psilota innupta*** Rondani, 1857
Vujić et al., 1998a (as *Psilota* sp.); Smit and Vujić 2007; Radenković, 2008; Nedeljković et al., 2009a.
349. ***Psilota nana*** Smit & Vujić, 2007
Smit and Vujić 2007; Radenković, 2008.

PYROPHAENA Schiner, 1860

350. ***Pyrophaena rosarum*** (Fabricius, 1787)
Strobl, 1902; Glumac, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011.

RHINGIA Scopoli, 1763

351. ***Rhingia borealis*** Ringdahl, 1928
Radenković, 2008; Van Steenis et al., 2015.

352. ***Rhingia campestris*** Meigen, 1822
Glumac, 1955a; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.
353. ***Rhingia rostrata*** (Linnaeus, 1758)
Kula, 1985; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.

RIPONNENSIA Maibach, 1994

354. ***Riponnensia morini*** Vujić, 1999
Vujić, 1999b; Radenković, 2008.
355. ***Riponnensia splendens*** (Meigen, 1822)
Vujić and Šimić, 1994 (as *Chrysogaster splendens*); Vujić and Glumac, 1994 (as *Orthonevra splendens*); Vujić, 1999b; Radenković, 2008, Nedeljković et al., 2009a.

SCAEVA Fabricius, 1805

356. ***Scaeva dignota*** (Rondani, 1857)
Kula, 1985; Radenković et al., 1995; Šimić and Vujić, 1996; Vujić et al., 1998b; Nedeljković et al., 2009a; Nedeljković, 2011; Tot et al., 2018.
357. ***Scaeva pyrastri*** (Linnaeus, 1758)
Glumac, 1955a (as *Lasiopticus pyrastri* and *Lasiopticus pyrastri* var. *unicolor*), 1959 (as *L. pyrastri* and *L. pyrastri* var. *unicolor*), 1972 (as *L. pyrastri* and *L. pyrastri* var. *unicolor*); Kula, 1985; Vujić and Šimić, 1994; Radenković et al., 1995; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2009; Nedeljković, 2011; Markov et al., 2016; Tot et al., 2018.
358. ***Scaeva selenitica*** (Meigen, 1822)
Glumac, 1955a (as *Lasiopticus seleniticus*) 1959 (as *L. seleniticus*), 1972 (as *L. seleniticus*); Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Radenković et al., 1995; Šimić and Vujić, 1996; Vujić et al., 1998a (as *Scaeva pyrastri*- partly); Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2009; Nedeljković, 2011; Tot et al., 2018.

SERICOMYIA Meigen, 1803

359. ***Sericomyia lappona*** (Linnaeus, 1758)
Glumac, 1955a (as *Cinxia lappona*); Glumac, 1972; Radenković, 2008.
360. ***Sericomyia silentis*** (Harris, 1776)
Glumac, 1955a (as *Cinxia borealis*); Glumac, 1972 (as *Sericomyia borealis*); Radenković, 2008; Radenković, 2018.

SPAZIGASTER Rondani, 1843

361. ***Spazigaster ambulans*** (Fabricius, 1798)
Glumac, 1959 (as *Spathiogaster ambulans* var. *coarctatus*), 1972; Vujić and Glumac, 1994 (as *S. ambulans coarctatus*); Nedeljković i sar., 2009a; Nedeljković, 2011; Tot et al., 2018.

SPHAEROPHORIA Le Peletier & Serville, 1828

362. ***Sphaerophoria bankowskae*** Goeldlin, 1989
Nedeljković, 2011.
363. ***Sphaerophoria batava*** Goeldlin de Tiefenau, 1974
Nedeljković, 2011.
364. ***Sphaerophoria interrupta*** (Fabricius, 1805)
Glumac, 1955a (as *Sphaerophoria menthastri* (Linnaeus, 1758)), 1959 (as *Sphaerophoria menthastri* var *philanthus*), 1972 (as *S. menthastri menthastri*, *S. menthastri melissae*, *S. menthastri philanthus*, *S. menthastri picta*).; Vujić and Šimić, 1994 (as *S. menthastri*); Vujić et al., 1998b (as *S. menthastri*); Nedeljković et al., 2009a; Šimić et al., 2009; Nedeljković, 2011.
365. ***Sphaerophoria laurae*** Goeldlin de Tiefenau, 1989
Nedeljković, 2011; Van Steenis et al., 2015.
366. ***Sphaerophoria rueppelli*** (Wiedemann, 1830)
Glumac, 1955a, 1959, 1972; Šimić and Vujić, 1987; Vujić and Šimić, 1994; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016.
367. ***Sphaerophoria scripta*** (Linnaeus, 1758)
Strobl, 1902 (as *Melithreptus scriptus*); Glumac, 1955a (as *Sphaerophoria scripta* var *nigricoxa, S. scripta* var. *dispar, S. scripta var scripta, S. scripta* var *strigata*), 1959 (as *Sphaerophoria scripta* var *nigricoxa*, *S. scripta* var. *dispar*, *S. scripta* var *scripta, S. scripta* var *strigata*), 1972 (as *S. scripta scripta* and *S. scripta dispar*, *S. scripta nigricoxa*, *S. scripta strigata*); Kula, 1985; Vujić and Šimić, 1987, Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016; Tot et al., 2018.
368. ***Sphaerophoria taeniata*** (Meigen, 1822)
Glumac, 1955a (as *Sphaerophoria menthasti* var *taeniata*), 1959 (as *Sphaerophoria menthastri* var *taeniata*), 1972 (as *S. menthastri taeniata*); Kula, 1985; Šimić and Vujić, 1987; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić et al., 1998b; Nedeljković et al., 2009a; Nedeljković, 2011; Šimić et al., 2008, 2009.

SPHEGINA Meigen, 1822

369. ***Sphegina clavata*** (Scopoli, 1763)
Vujić, 1987 (as *Sphegina miciki*); Vujić, 1990; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Šimić et al., 2008; Radenković, 2008; Nedeljković et al., 2009a; Van Steenis et al., 2016; Tot et al., 2018.

370. ***Sphegina clunipes*** (Fallen, 1816)
Glumac, 1955a (partly); Glumac, 1959; Glumac, 1972 (partly); Vujić, 1990; Vujić and Glumac, 1994; Radenković, 2008; Šimić et al., 2008; Nedeljković et al., 2009a.

371. ***Sphegina elegans*** Schummel, 1843
Vujić, 1990; Glumac, 1959 (as *Sphegina kimakowiczi*); Vujić and Glumac, 1994); Radenković, 2008; Nedeljković et al., 2009a; Van Steenis et al., 2016; Tot et al., 2018.

372. ***Sphegina latifrons*** Egger, 1865
Vujić, 1990; Šimić and Vujić, 1996; Radenković, 2008.

373. ***Sphegina sibirica*** Stackelberg, 1953
Vujić, 1990; Radenković, 2008.

374. ***Sphegina sublatifrons*** Vujić, 1990
Vujić, 1990; Šimić i Vujić, 1996; Radenković, 2008.

375. ***Sphegina verecunda*** Collin, 1937
Van Steenis et al., 2015.

SPHIXIMORPHA Rondani, 1850

376. ***Sphiximorpha garibaldii*** Rondani, 1860
Glumac, 1959 (as *Cerioides binominata*); Glumac, 1972 (as *Cerioides binominata*); Vujić and Glumac, 1994; Šimić et al., 2008 (as *Sphiximorpha binominata*); Radenković, 2008; Nedeljković et al., 2009a (as *Sphiximorpha binominata*).

377. ***Sphiximorpha subsessilis*** (Illiger in Rossi, 1807)
Radenković et al., 2013.

SPILOMYIA Meigen, 1803

378. ***Spilomyia manicata*** (Rondani, 1865)
Glumac, 1955a (as *Spylomyia saltuum*); Glumac, 1956c (as *Spilomyia integra*); Glumac, 1959 (as *Spilomyia integra*); Glumac, 1972 (as *Spilomyia integra*); Vujić and Glumac, 1994; Radenković, 2008; Šimić et al., 2008; Nedeljković et al., 2009a; Radenković et al., 2013.

379. ***Spilomyia saltuum*** (Fabricius, 1794)
Glumac, 1955a; Glumac, 1959; Glumac, 1972; Vujić and Glumac, 1994; Vujić et al., 1998a; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Radenković et al., 2013.

SYRITTA Le Peletier & Serville, 1828

380. ***Syritta flaviventris*** Macquart, 1842
Mudri Stojnić et al., 2012.

381. ***Syritta pipiens*** (Linnaeus, 1758)
Glumac, 1955a; Glumac, 1959; Glumac, 1972; Šimić and Vujić, 1984; Kula, 1985; Šimić and Vujić, 1987; Vujić and Glumac, 1994; Vujić and

Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.

SYRPHUS Fabricius, 1775

382. ***Syrphus nitidifrons*** Becker, 1921
Nedeljković et al., 2010; Nedeljković, 2011.
383. ***Syrphus ribesii*** (Linnaeus, 1758)
Glumac, 1955a, 1959, 1972; Kula, 1985; Šimić and Vujić, 1987; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Nedeljković et al., 2010; Nedeljković, 2011; Tot et al., 2018.
384. ***Syrphus torvus*** Osten Sacken, 1875
Glumac, 1956c, 1959, 1972; Kula, 1985; Vujić and Glumac, 1994; Šimić and Vujić, 1987; Vujić et al., 1998a; Vujić et al., 1998b; Vujić and Šimić, 1994, Šimić and Vujić, 1996; Šimić et al., 2009; Nedeljković i sar., 2008, 2009; Nedeljković et al., 2010; Nedeljković, 2011; Tot et al., 2018.
385. ***Syrphus vitripennis*** Meigen, 1822
Glumac, 1955a, 1959, 1972; Kula, 1985; Šimić and Vujić, 1987; Šimić and Vujić, 1996; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić et al., 1998b; Šimić et al., 2009; Nedeljković et al., 2009a; Nedeljković et al., 2010; Nedeljković, 2011; Tot et al., 2018.

TEMNOSTOMA Le Peletier & Serville, 1828

386. ***Temnostoma bombylans*** (Fabricius, 1805)
Glumac, 1959; Glumac, 1972; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Radenković et al., 2013.
387. ***Temnostoma meridionale*** Krivosheina et Mamaev, 1862
Vujić and Glumac, 1994 (as *Temnostoma vespiforme*); Vujić et al., 1998a; Vujić et al., 2002; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Radenković et al., 2013.
388. ***Temnostoma vespiforme*** (Linnaeus, 1758)
Coe, 1960; Glumac, 1972; Radenković, 2008; Nedeljković et al., 2009a; Radenković et al., 2013.

TRICHOPSOMYIA Williston, 1888

389. ***Trichopsomyia flavitarsis*** (Meigen, 1822)
Glumac, 1959 (as *Heringia flavitarsis*); Vujić and Glumac, 1994 (as *Trichopsomyia flavitarse*); Vujić et al., 1998b; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Van Steenis et al., 2015.
390. ***Trichopsomyia joratensis*** Goeldlin de Tiefenau, 1997
Radenković, 2008.
391. ***Trichopsomyia lucida*** (Meigen, 1822)
Vujić et al., 1998b; Vujić et al., 2001; Radenković, 2008.

TRIGLYPHUS Loew, 1840

392. ***Triglyphus primus*** Loew, 1840
Glumac, 1955a; Šimić and Vujić, 1987; Vujić, 1994c; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Vujić et al., 1998a; Vujić et al., 1998b; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.

TROPIDIA Meigen, 1822

393. ***Tropidia scita*** (Harris, 1776)
Glumac, 1955a; Glumac, 1972; Šimić and Vujić, 1987; Radenković, 2008; Šimić et al., 2009; Nedeljković et al., 2009a.

VOLUCELLA Geoffroy, 1762

394. ***Volucella bombylans*** (Linnaeus, 1758)
Strobl, 1902 (as *Volucella bombylans* var. *bombylans*, *Volucella bombylans* var. *mystacea*); Glumac, 1955a; Glumac, 1959 (as *Volucella bombylans* var. *bombylans*); Šimić and Vujić, 1987; Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998b; Nedeljković et al., 2003; Radenković, 2008; Šimić et al., 2008; Nedeljković et al., 2009a; Tot et al., 2018.
395. ***Volucella inanis*** (Linnaeus, 1758)
Glumac, 1955a; Glumac, 1959; Šimić and Vujić, 1987; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Nedeljković et al., 2003; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.
396. ***Volucella inflata*** (Fabricius, 1794)
Glumac, 1955a; Glumac, 1959; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Vujić et al., 1998a; Nedeljković et al., 2003; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a.
397. ***Volucella pellucens*** (Linnaeus, 1758)
Glumac, 1955a; Glumac, 1959; Kula, 1984; Šimić and Vujić, 1987; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Nedeljković et al., 2003; Radenković, 2008, Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Tot et al., 2018.
398. ***Volucella zonaria*** (Poda, 1761)
Glumac, 1955a; Glumac, 1959; Kula, 1984; Šimić and Vujić, 1987; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Nedeljković et al., 2003; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Tot et al., 2018.

XANTHANDRUS Verrall, 1901

399. ***Xanthandrus comtus*** (Harris, [1780])
Glumac, 1955a, 1959, 1972; Kula, 1985; Vujić and Glumac, 1994; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998b; Nedeljković et al., 2009a; Nedeljković, 2011; Markov et al., 2016; Tot et al., 2018.

XANTHOGRAMMA Schiner, 1861

400. ***Xanthogramma citrofasciatum*** (De Geer, 1776)
Tölg i Fahringer, 1911; Glumac, 1955a, 1959, 1972; Vujić and Šimić, 1994; Vujić and Glumac, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a (as *Xanthogramma festivum*); Vujić et al., 1998b; Vujić et al., 2002 (as *X. festiva*); Radenković et al., 2004; Nedeljković et al., 2009; Šimić et al., 2008 (as *X. festiva*), 2009; Nedeljković, 2011; Nedeljković et al., 2018.
401. ***Xanthogramma dives*** (Rondani, 1857)
Nedeljković, 2011; Nedeljković et al., 2018.
402. ***Xanthogramma laetum*** (Fabricius, 1794)
Glumac, 1955a, 1959 (as *Olbiosyrphus laetus*), 1972; Kula, 1985; Vujić and Glumac, 1994, Vujić et al., 1998a; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Nedeljković et al., 2018.
403. ***Xanthogramma pedissequum*** (Harris, 1776)
Glumac, 1955a, 1959, 1972 (as *Xanthogramma ornatum*); Kula, 1985; Vujić and Šimić, 1994; Šimić and Vujić, 1996; Vujić et al., 1998a; Vujić et al., 1998b; Nedeljković et al., 2009a; Šimić et al., 2008, 2009; Nedeljković, 2011; Markov et al., 2016; Nedeljković et al., 2018.
404. ***Xanthogramma stackelbergi*** Violovitsh, 1975
Nedeljković, 2011; Nedeljković et al., 2018; Tot et al., 2018.

XYLOTA Meigen, 1822

405. ***Xylota abiens*** Meigen, 1822
Vujić and Šimić, 1994; Vujić and Šimić, 1994; Milankov et al., 1995; Vujić and Milankov, 1999; Vujić et al., 2002; Radenković, 2008; Radenković et al., 2013; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Van Steenis et al., 2015.
406. ***Xylota florum*** (Fabricius, 1805)
Glumac, 1955a (as *Zelima florum*); Glumac, 1972; Milankov et al., 1995; Vujić and Milankov, 1999; Radenković, 2008; Nedeljković et al., 2009a.
407. ***Xylota ignava*** (Panzer, [1798])
Glumac, 1972; Kula, 1985; Milankov et al., 1995; Radenković, 2008, Radenković et al., 2013.
408. ***Xylota jakutorum*** Bagachanova, 1980
Milankov et al., 1995 (as *Xylota coeruleiventris*); Radenković, 2008.
409. ***Xylota segnis*** (Linnaeus, 1758)
Glumac, 1955a (as *Zelima segnis*); Coe, 1956; Glumac, 1959 (as *Zelima segnis*); Glumac, 1972; Kula, 1985; Šimić and Vujić, 1987; Vujić and Glumac, 1994 (as *Xylota segnis* and *Xylota florum*); Vujić and Šimić, 1994; Milankov et al., 1995; Šimić and Vujić, 1996; Vujić and Milankov, 1999; Radenković, 2008; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Radenković et al., 2013; Markov et al., 2016.
410. ***Xylota sylvarum*** (Linnaeus, 1758)
Glumac, 1955a (as *Zelima sylvarum*); Coe, 1956; Glumac, 1959 (as *Zelima sylvarum*); Glumac, 1972; Vujić and Glumac, 1994; Vujić and Šimić, 1994;

Milankov et al., 1995; Šimić and Vujić, 1996; Vujić et al., 1998a; Radenković et al., 2013; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Radenković et al., 2013; Van Steenis et al., 2015.

411. ***Xylota tarda*** Meigen, 1822
Glumac, 1955a (as *Zelima tarda*); Glumac, 1972; Milankov et al., 1995; Radenković et al., 2013; Radenković et al., 2013.

412. ***Xylota xanthocnema*** Collin, 1939
Glumac, 1955a (partly as *Zelima florum*, *Z. sylvarum* and *Z. xanthocnema*); Glumac, 1959 (as *Zelima xanthocnema*); Glumac, 1972; Vujić and Glumac, 1994; Milankov et al., 1995; Radenković et al., 2013; Šimić et al., 2008, 2009; Nedeljković et al., 2009a; Radenković et al., 2013.

CONCLUSION

A checklist of the family Syrphidae (Diptera) of Serbia consists 412 species and subspecies from 83 genera. Moreover, three species are recorded for the first time in Serbia.

Compared with other European countries, Serbia has less recorded species than Spain (417 spp), France (540 spp), Italy (495 spp), Germany (461 spp), Switzerland (454 spp) and Romania (453 spp) (Speight et al. 2015). Taking into account that the surface of Serbia is much smaller than other Europaean countries we can conclude that hoverfly diversity of Serbia is very rich.

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НОВА ЧЕК ЛИСТА ОСОЛИКИХ МУВА (Diptera: Syrphidae) РЕПУБЛИКЕ СРБИЈЕ

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РЕЗИМЕ: У раду је презентована чек листа врста из фамилије Syrphidae (Diptera: Syrphidae) Србије. Забележено је укупно 412 врста и подврста из 83 рода. Од тога, три врсте су први пут забележене за фауну Србије.

КЉУЧНЕ РЕЧИ: фауна, нови налази, осолике муве, Србија, таксономија

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STRICTLY PROTECTED SPECIES OF HOVERFLIES (Diptera: Syrphidae) IN SERBIA IN THE FACE OF CLIMATE CHANGE

ABSTRACT: Climate change is happening. Due to a spectrum of possible consequences, numerous studies examine the effects of global warming on species distribution. This study examines the effects of changing climate on distribution of selected strictly protected species of hoverflies in Serbia, by using species distribution modelling. Ten species were included in the analysis. Three species were predicted to lose a part of their range across time, while for seven species the range expansion was predicted. Both in the present time and in the future, mountainous regions have the highest species richness, such as Golija, Kopaonik, and Prokletije in the western Serbia, and mountains Stara Planina, Besna Kobila, Suva Planina, and Dukat in the southeastern part of the country. However, beside climate change, there are several other factors that might influence the distribution of strictly protected hoverflies in Serbia, such as intensive land use and degradation of habitats. Additionally, global warming also affects flowering plants that syrphids are dependent on, which could present another obstacle to their future range expansions. These results can contribute to planning future steps for the conservation of strictly protected hoverfly species.
KEYWORDS: global warming, insects, strictly protected species, species distribution modelling

INTRODUCTION

Over the past 100 years, the global average temperature has increased by approximately 0.6 °C (Root et al., 2003; Bale et al., 2010). This is an undisputable evidence that climate change is happening. Numerous researches deal with the effects of changing climate on biodiversity (Ramsfield, 2016; Westhpal et al., 2016; Miličić et al., 2018; Radenković et al., 2018). Studies showed that

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regional climate changes can influence species in different ways: they can move their area of occupancy in order to find suitable environment, alter their phenology in the attempt to adapt to new conditions, or become extinct (Thuiller et al., 2008; Lurgi et al., 2012). Narrow geographic range, limited dispersal capacity, low reproductive output and a high degree of habitat specialization are traits that make species particularly prone to environmental changes (Isaac et al., 2009). These characteristics are almost certainly present in species with restricted distribution, which makes them particularly sensitive to ecosystem changes.

Hoverflies represent an important pollinator group (Jauker et al., 2012; Inouye et al., 2015) with more than 6,000 described species. Beside pollination, this Dipteran family can be significant as indicator of environmental changes (Meyer et al., 2009; Sommagio and Burgio, 2014). Additionally, hoverflies have an important role in decomposition of materials such as dead wood, compost, dung, rotting aquatic vegetation, and so on, but can also be used for decomposition of organic material from agricultural and industrial processes.

One of the steps in preserving species is their legal protection. Under the national legislation of Serbia 44 species of hoverflies are listed as protected, while 33 species are categorised as being strictly protected. The aim of this study was to estimate the potential effects of climate change on the distribution of strictly protected hoverfly species in Serbia by using species distribution modelling. This method is successfully applied in numerous studies dealing with the effects of climate change on species distributions (Guo et al., 2016; Wang et al., 2018).

MATERIAL AND METHODS

Distribution data for all species listed as protected in Serbia were extracted from the database of the Department of Biology and Ecology of the University of Novi Sad. The species that had more than five different occurrence points were kept and used for further analyses, while others were dropped out. For building species distribution models, 19 bioclimatic variables were used describing current climate obtained from the WorldClim dataset (Hijmans et al., 2005) in 30 arc sec resolution. Regarding the future bioclimatic variables, climate projections were used at the same resolution from the global climate models used in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2014).

To reduce collinearity, modelling was conducted in two stages. In the first stage, all bioclimatic variables were used for model building, while in the second step, modelling was repeated using only stronger predictor variables (with more than 10% contribution in the initial run). Modelling was conducted using the Maxent function of the dismo R package (Hijmans et al., 2016). The idea of Maxent is to estimate target distributions by finding the distributions of maximum entropy using species occurrences and environmental variables (Phillips et al., 2006). Entire dataset was used for model building, without splitting. Maxent default settings were maintained. True Skill Statistic (TSS) was used as an evaluation measure, as recommended in Allouche et al., 2006. TSS values range from − 1 to + 1, where + 1 indicates perfect model agreement, while values of zero or less indicate a performance no better than random (Allouche et al., 2006).

Maps of current and future potential distributions for the year 2070 (average 2061–2080) were created. By applying the threshold maximizing the sum of sensitivity and specificity (Liu et al., 2013), maps were then transformed to binary format (showing suitable/unsuitable areas for species). Based on these maps, the potential area of occupancy (pAOO) for selected strictly protected species was calculated both for the present time and the future. By subtracting pAOO present from pAOO future, the potential range change for analysed hoverflies caused by global warming was assessed. Map visualization was conducted using DIVA-GIS version 7.5 software (Hijmans et al., 2012).

RESULTS AND DISCUSSION

A total of 10 species were included in the analysis. TSS values ranged from 0.53–0.98 (Table 1), which indicated generally a good fit of the models. Three out of 10 analyzed species were predicted to reduce their range in the future, while for 7 species models anticipated range expansion. Species showing the highest absolute loss of range for 2070 was *Neocnemodon larusi* (Vujić, 1999), while the highest relative loss was predicted for *Trichopsomyia flavitarsis* (Meigen, 1822), which will lose around 73% of its current range, according to the models. As for the gainers, *Cheilosia griseifacies* Vujić, 1994 was predicted to have the greatest absolute increase in range, while *Cheilosia melanura rubra* Vujić, 1996 was the species with the highest relative gain (Table 1).

Table 1. TSS values and pAOO values for the present time and 2070, absolute and relative change in pAOO between the present and projected future scenario for 10 strictly protected species of hoverflies in Serbia.

Species	TSS	pAOO present	pAOO 2070	absolute change	relative change
Cheilosia griseifacies Vujić, 1994	0.84	8,234.33	20,596.86	12,362.53	150.13
Cheilosia insignis Loew, 1857	0.69	26,101.42	8,981.19	-17,120.23	-65.59
Cheilosia melanura rubra Vujić, 1996	0.98	1,808.74	9,751.65	7,942.91	439.14
Cheilosia schnabli Becker, 1894	0.72	1,372.52	2,976.09	1,603.57	116.83
Merodon desuturinus Vujić, Simić, & Radenković, 1995	0.88	3,510.38	12,259.69	8,749.31	249.24
Orthonevra montana Vujić, 1999	0.93	5,703.60	5,832.95	129.34	2.27
Sericomyia superbiens (Muller), 1776	0.88	10,669.91	13,570.98	2,901.07	27.19
Sphegina sublatifrons Vujić, 1990	0.93	5,707.84	6,274.23	566.40	9.92
Trichopsomyia flavitarsis (Meigen), 1822	0.75	21,960.13	5,893.43	-16,066.70	-73.16
Neocnemodon larusi (Vujić), 1999	0.53	42,135.04	19,224.14	-22,910.90	-54.37

In general, more species were predicted to gain range across time, but differences between individual species are present, indicating the significance of biology and ecology for the response of the species to the changing climate. Several studies have already addressed the effects of climate change on hoverfly distribution across the Balkan Peninsula. Radenković et al. (2017) analysed genus *Cheilosia*, Kaloveloni et al. (2015) focused their research on the genus *Merodon*, while Miličić et al. (2018) forecasted the effects of climate change on 44 hoverfly species from southeastern Europe with restricted range. All these studies indicated the significance of altitude and habitat type for the species distribution. This premise is shown in this study as well.

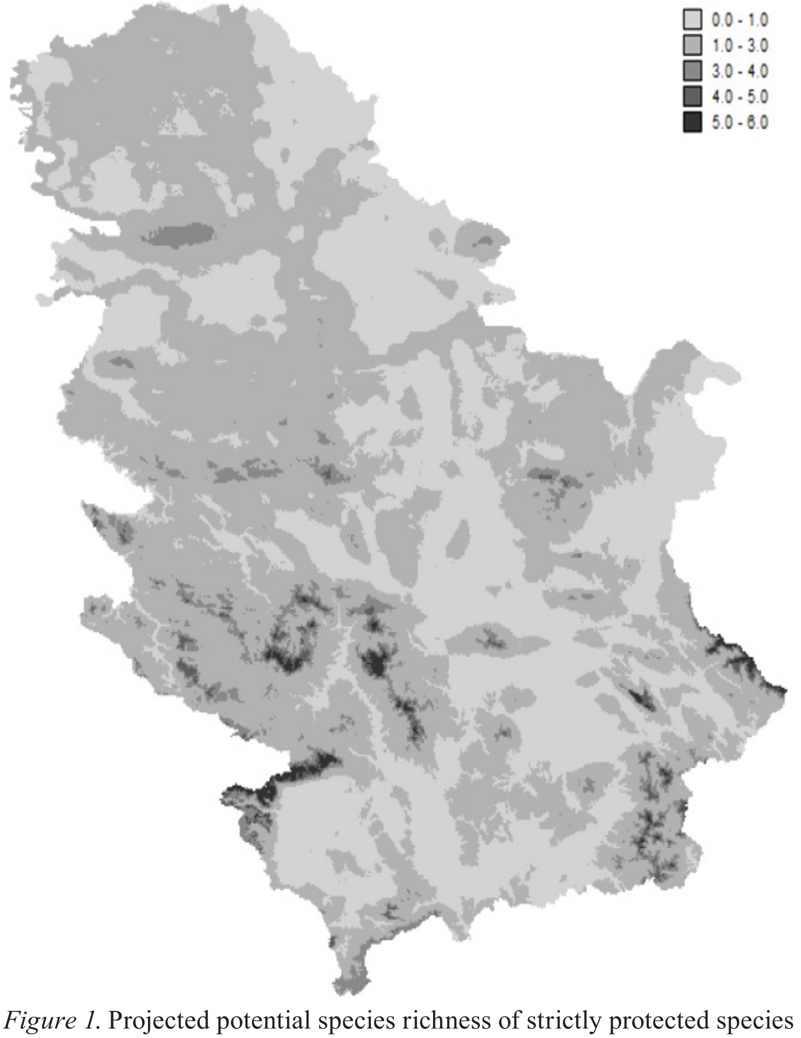

Figure 1. Projected potential species richness of strictly protected species of hoverflies for the present time. Each cell represents the total number of species in defined grid cells.

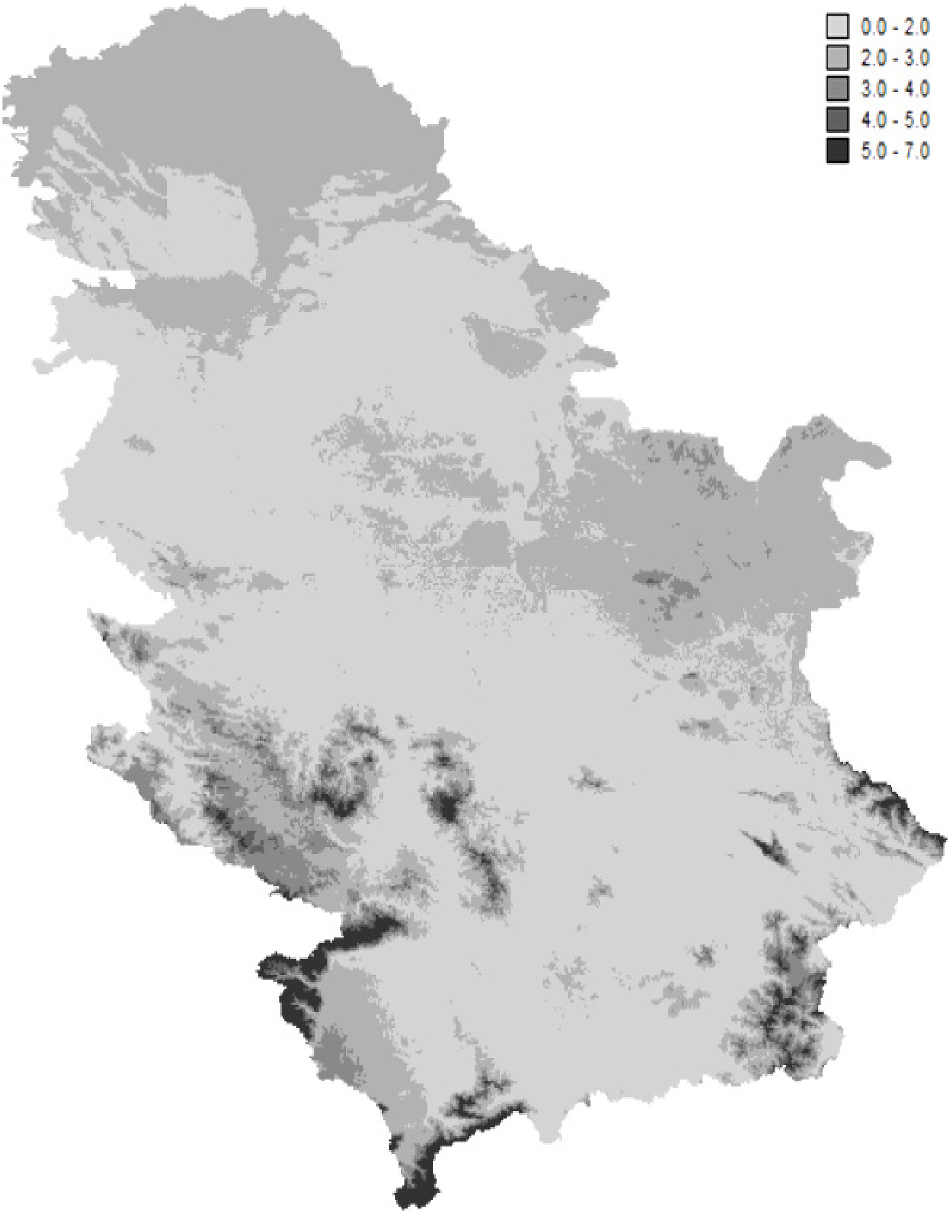

Figure 2. Projected potential species richness of strictly protected species of hoverflies for 2070. Each cell represents the total number of species in defined grid cells.

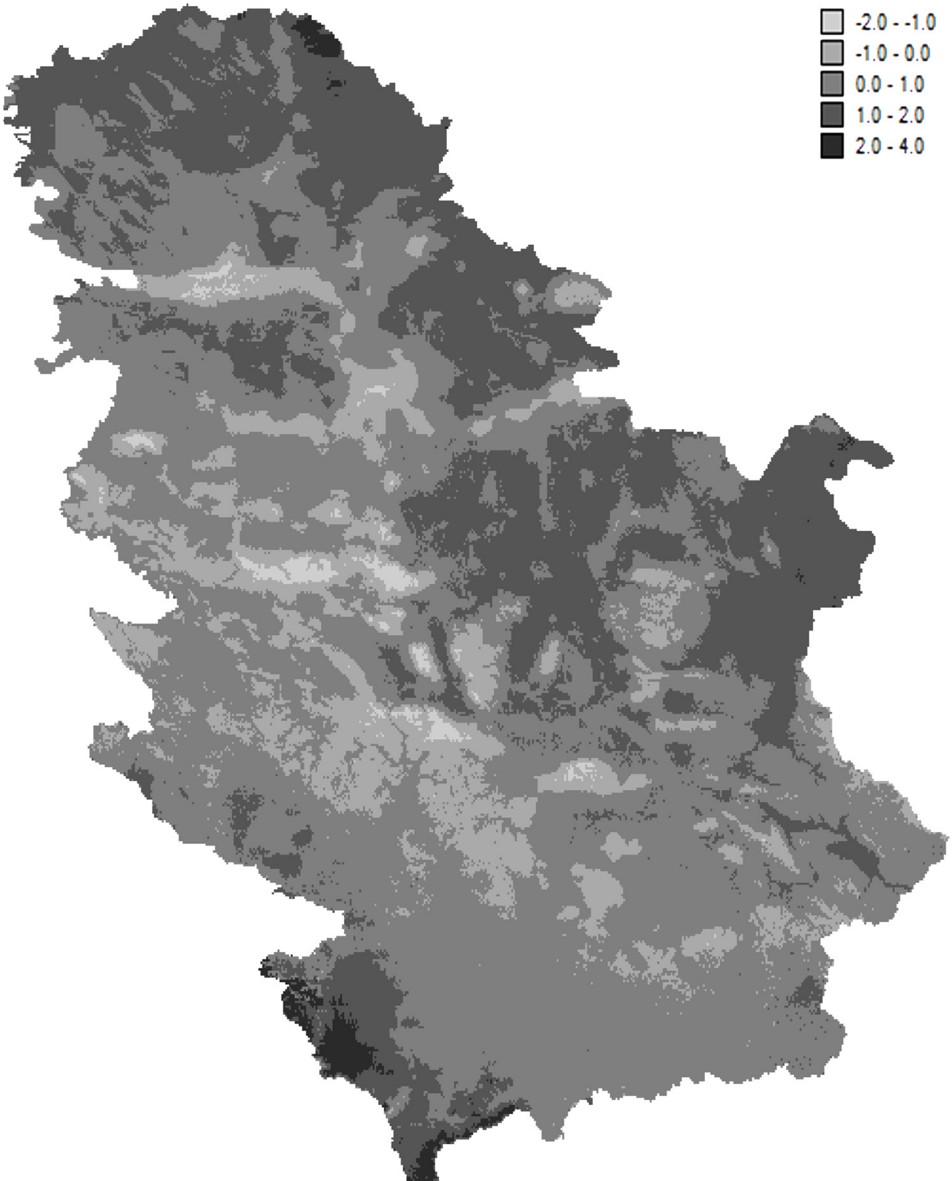

Figure 3. Differences in species richness of hoverflies between 2070 and the present. Each cell represents the total number of species in defined grid cells.

Figure 1 shows current cumulative species richness, while the cumulative species richness for 2070 is presented in Figure 2. In both cases, similar areas were predicted to be most species rich, and these areas are mostly mountainous, such as mountains Golija, Kopaonik and Prokletije in western Serbia and mountains Stara Planina, Besna Kobila, Suva Planina and Dukat in southeastern part of the country. Several studies indicated that climate change caused altitudinal range shifts (Hickling et al., 2006; Moritz et al., 2008; Kaloveloni et al., 2015; Radenković et al., 2017; Coals et al., 2018), because species follow favourable conditions, which become available only on the highest mountain peaks, as the temperature increases.

In Figure 3, changes in species richness between the present and 2070 are depicted. Mountains in southeastern Serbia are predicted to gain species over the time, as well as a patch in northwestern part of the Province of Vojvodina. Fruška Gora mountain and several mountains in central Serbia with lower altitudes are predicted to lose a part of their species.

Beside climate change, there are several other factors that may influence the future distribution of strictly protected syrphid species in Serbia. Land use and degradation of habitats represent some of the major threats for species survival in general (Novecek and Clevland, 2001; Foley et al., 2005; Newbald et al., 2015), and this is the case with hoverflies as well. Considering that high mountain habitats are very often amongst the most threatened ones (Diaz et al., 2003), question arises whether these areas will have the capacity to support future hoverfly assemblages.

Additional argument that should be taken into consideration is the connection of syrphids with flowering plants. Hoverflies use flowering plants as a source of food. For some species (e.g. *Cheilosia* and *Merodon* species), the dependence on plants is even stronger, considering that larvae of these species develop in plant tissue (Speight, 2017). Climate change undoubtedly will affect plant species, and consequently the plant-insect networks as well.

CONCLUSION

Based on the results of this study, it is predicted that climate change will have different effects on specific species of hoverflies designated as strictly protected in Serbia. Part of the species will experience range loss, while for others range expansions are predicted. High mountain areas are predicted to have the highest species richness over the time. The results of this study can contribute to planning future steps for the conservation of strictly protected hoverfly species.

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СТРОГО ЗАШТИЋЕНЕ ВРСТЕ ОСОЛИКИХ МУВА (Diptera: Syrphidae) У ОГЛЕДАЛУ КЛИМАТСКИХ ПРОМЕНА

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РЕЗИМЕ: Због спектра могућих последица, услед климатских промена које се дешавају, бројне студије се баве испитивањем ефеката глобалног загревања на дистрибуцију врста. У оквиру ове студије, испитали смо утицај промене климе на дистрибуцију одабраних строго заштићених врста осоликих мува у Србији, користећи моделе потенцијалне дистрибуције. У анализу је било укључено 10 врста. За три врсте је предвиђено да током времена изгубе део свог ареала, док је за седам врста предвиђено проширење ареала. И у садашњости и у будућности, региони с највећим богатством врста су планински, као што су Голија, Копаоник и Проклетије у западној Србији, и Стара планина, Бесна кобила, Сува планина и планина Дукат у југоисточном делу земље. Ипак, поред климатских промена постоји више фактора који могу утицати на дистрибуцију строго заштићених врста у Србији: интензивно коришћење земљишта и деградација станишта. Додатно, глобално загревање утиче и на биљке цветнице, од којих су сирфиде зависне, што може представљати још једну препреку будућем ширењу њиховог ареала. Ови резултати могу допринети планирању будућих корака за конзервацију строго заштићених врста осоликих мува.

КЉУЧНЕ РЕЧИ: глобално загревање, инсекти, моделовање потенцијалне дистрибуције врста, строго заштићене врсте

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NEW FINDINGS ON PROTECTED AND STRICTLY PROTECTED SPECIES CONFIRM THE VALUE OF THE PRIME HOVERFLY AREA NETWORK

ABSTRACT: With environmental pressures on the rise, the establishment of protected areas is a key strategy for preserving biodiversity. The fact that many species are losing their battle against extinction despite being within protected areas raises the question of their effectiveness. The aim of this study was to evaluate established Priority Hoverfly Areas (PHAs) and areas that are not yet but could potentially be included in the PHA network, using data from new field surveys. Additionally, species distribution models have been created for two new species recognized as important and added to the list of key hoverfly species. Maps of potential distribution of these species were superimposed on maps of protected areas and PHAs to quantify percentages of overlap. The results of this study are not statistically significant, which could be influenced by a small sample size. However, the results of species distribution models and the extent of overlap with PHAs confirm the utility of these expert-generated designations.

KEYWORDS: Hoverflies, Prime Hoverfly Areas, evaluation, conservation

INTRODUCTION

Biodiversity is under immense anthropogenic pressure globally, with the increasing number of natural habitats being converted to agricultural land or urban areas every day. Establishment of protected areas (PA) is probably the most common strategy for nature conservation (Groom et al., 2006; Primack, 2008). An important role of PAs is preserving natural habitats (Bruner et al., 2001; Chape et al., 2005), maintaining existing populations, as well as reducing species extinction risks, especially in the light of growing concern of climate

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change. However, many species are losing the battle with extinction, despite being within PAs, mostly due to poor management and only partial overlap of their distribution with PAs, which is a big issue especially for many invertebrate groups. Additionally, protected areas are sometimes established for political or economical reasons, rather than based on ecological principles (Kati et al., 2004). Thus, it is of great relevance to evaluate their effectiveness.

Important areas for many biotic groups have been identified, using different approaches for site choice, in order to strengthen conservation efforts and to encourage better protected area designations (Vujić et al., 2016). However, most efforts have been focused on well-known species, leaving most invertebrate groups under-represented.

Insects have enormous functional significance because of the large number of individuals and their great intra- and interspecific variability. Additionally, insect pollinators play an important ecological and economic role but, despite this fact, they are still receiving a disproportionally small amount of attention.

Hoverflies are a diverse insect group that play many important roles in ecosystems. The widespread distribution of hoverflies, the availability of excellent taxonomic keys for species identification (particularly for European species), and differences in the environmental requirements of larvae are features that make Syrphidae potentially good bioindicators (Sommaggio, 1999). Hoverflies are recognized as the second most important pollinator group after bees (Larson et al., 2001). Moreover, they function in the decomposition of various materials, adults represent an important part of the diets of many species, and larvae can be used as biological control agents.

At European level, some hoverfly species have been recognized as threatened and some of them have been listed in the national Red Lists (Jentzsch, 1998; Ssymank and Doczkal, 1998; Stuke et al., 1998; Doczkal et al., 1999; Cederberg et al., 2010; Ssymank et al., 2011). Additional efforts are needed in order to take the conservation of hoverflies to a higher level, since they are still completely absent from international lists such as IUCN Red List, or legal instruments such as Annexes of the EU Habitats Directive.

In Serbia, 77 hoverfly species have been protected by national law *Code of Regulations on the Declaration and Protection of Strictly Protected and Protected Wild Species of Plants, Animals and Fungi* (Official Gazette of RS, No. 5/2010). In order to improve the status of hoverflies, based on long-term monitoring data, Vujić et al. (2016) identified species of conservation interest and proposed priority areas for their conservation in Serbia. The selection process relied on expert opinion and it was part of an ongoing national project (Conservation strategy for the preservation of protected and strictly protected hoverflies [Diptera: Syrphidae] in Serbia).

The aim of this study was to evaluate the established Prime Hoverfly Areas (PHAs) and areas that are not included in the PHA network but could be potentially added, using data from new field surveys. Additionally, species distribution models were created for two new species recognized as important and added to the list of key hoverfly species.

MATERIAL AND METHODS

Specimens were collected from April to September, over a two year period (2016–2017). Localities were surveyed by transect walks. Hoverflies were identified to species level.

In order to evaluate established Prime Hoverfly Areas (PHAs) and potential new ones, data on key hoverfly species was extracted from a database hosted by the Department of Biology and Ecology, Faculty of Sciences, Novi Sad, Serbia. Species distribution models (SDMs), previously reported in Vujić et al. (2016), were consulted to determine if these key species had been predicted to occur in the sampled localities. Students *t* tests were conducted to test the predictive power of SDMs. Statistical analysis was performed using the R statistical platform (version 3.3.1, R Core Team, 2016).

Species distribution data for selected species occurring in Serbia were extracted from the database of the Department for Biology and Ecology, University of Novi Sad. Occurrence points for species that will be suggested for protection are mainly the result of systematic field collecting in the period 2016–2017. In order to reduce bias caused by oversampling in some areas, a species occurrence record thinning procedure was applied using the 'thin' function within the R package *red* (Cardoso, 2017) (R Development Core Team, 2016). Only species that met the criteria for being suggested for protection and with more than five different occurrence points after the thinning procedure were selected, which resulted in only two species for which it was possible to build the models. The dismo R package (Hijmans et al., 2016) for Maximum Entropy Modelling (Maxent) was used for conducting species distribution modelling. For preliminary model building 19 bioclimatic variables plus elevation data were used (30 arc-second resolution), generated for each locality based on the WorldClim dataset (Hijmans et al., 2005). First run was made with all variables for separate species. In the second step, the modelling procedure using only variables with contribution above 10% in the initial model was performed. A map showing the potential current distribution was created for each species. True skill statistic (TSS) as a measure of model accuracy was used (ranging from -1 to +1, where +1 indicates perfect agreement, while values of zero or less indicate a model performance not better than random) (Allouche et al., 2006).

To assess the efficiency of Protected Areas and Prime Hoverfly Areas, we overlapped the projected species distribution maps of two new key species with a map of The World Database of Protected Areas (http://www.wdpa.org) and map of Prime Hoverfly Areas. Only protected areas of IUCN categories I–VI were considered. We calculated the percentage of a projected species range that overlapped with nationally protected areas (PA) and Prime Hoverfly Areas (PHA). All analyses were carried out with ArcGIS vs. 10.1.

RESULTS AND DISCUSSION

A total of 44 key hoverfly species were assessed across 28 localities in Serbia (Table 1). Fifteen of these species were found in each of the localities in which they were predicted to occur by SDMs, four species were found in most of the SDM-predicted localities, three occurred in just a few of their predicted localities, and 19 were not found in any of their predicted localities. *Chrysotoxum montanum* Nedeljković & Vujić, 2015*, C. orthostylum* Vujić, 2015*,* and *Merodon illiricus* in litt. were each found at five localities but, due to the lack of data, these species had not been modelled in SDMs, so it was impossible to draw further conclusions on the predictive power of their respective SDMs.

Table 1. List of key hoverfly species found in surveyed localities

Species	Locality
Arctophila bombiformis (Fallen, 1810)	Zlatar – Karaula; Ozren – towards Tičje Polje
Arctophila superbiens (Muller, 1776)	Zlatar – Drmanovići
Blera fallax (Linnaeus, 1758)	Golija – Odvraćenica 2
Brachyopa maculipennis Thompson, 1980	Stara Planina – Dojkinci 1
Cheilosia bracusi Vujić & Claussen, 1994	Dubašnica – Dubašnica 1 and 2; Stara Planina – Dojkinci 1 and 2
Cheilosia carbonaria Egger, 1860	Odvraćenica 2
Cheilosia cumanica (Szilady, 1938)	Dubašnica – Dubašnica 2, Demizlok; Malinik – Malinik, Zlot
Cheilosia frontalis Loew, 1857	Stara Planina – Dojkinci 2; Besna Kobila – Besna Kobila 2.1, 2.2 and 2.3
Cheilosia griseifacies Vujić, 1994	Vojvodina – Bezdan 2
Cheilosia hypena (Becker, 1894)	Dubašnica – Dubašnica 1, Lazar River gorge, Malinik – Malinik, Zlot; Besna Kobila – Kriva Feja
Cheilosia insignis Loew, 1857	Malinik – Malinik
Cheilosia longula (Zetterstedt, 1838)	Besna Kobila – Besna Kobila 1
Cheilosia morio (Zetterstedt, 1838)	Stara Planina – Dojkinci 1
Cheilosia personata Loew, 1857	Zlatar – Karaula, Panorama; Ozren – towards Tičje Polje; Stara Planina – Dojkinci 2
Cheilosia redi Vujić, 1996	Malinik – Zlot; Besna Kobila – Besna Kobila 1
Cheilosia rhynchops Egger, 1860	Stara Planina – Dojkinci 2
Chrysotoxum montanum Nedeljković & Vujić, 2015	Zlatar – Drmanovići; Golija – Čeka
Chrysotoxum orthostylum Vujić, 2015	Zlatar – Drmanovići, Karaula
Chrysotoxum tomentosum Giglio-Tos, 1890	Zlatar – Drmanovići, Panorama; Golija – Čeka

Criorhina asilica (Fallen, 1816)	Stara Planina
Dasysyrphus lenensis Bagatshanova, 1980	Dubašnica – Dubašnica 2; Golija – Odvraćenica 2
Dasysyrphus pauxilus (Williston, 1887)	Dubašnica – Dubašnica 2
Eumerus clavatus Becker, 1923	Malinik – Zlot
Eupeodes nielseni (Dusek & Láska, 1976)	Stara Planina – Dojkinci 2
Merodon aerarius Rondani, 1857	Zlatar – Drmanovići, Panorama; Prijepolje – Kamena Gora 1; Golija – Čeka, Odvraćenica 1 and 2, Golijska Reka, Potok, Karalići, Toranj; Besna Kobila – Besna Kobila 1
Merodon desuturinus Vujic, Simic & Radenkovic, 1995	Stara Planina – Dojkinci 2
Merodon illiricus in litt.	Zlatar – Drmanovići, Panorama; Stara Planina – above Topli Do
Merodon loewi van der Goot, 1964	Malinik – Malinik, Zlot
Merodon moesiacus in litt.	Zlatar – Drmanovići, Panorama; Golija – Čeka, Odvraćenica 1, Čeka, Golijska reka, Karalići, Toranj
Merodon trebevicensis Strobl, 1900	Golija – Čeka
Myolepta potens Harris, 1776	Besna Kobila – Besna Kobila 1
Orthonevra montana Vujić, 1999	Golija – Odvraćenica 2
Paragus finitimus Goeldlin, 1971	Zlatar – Panorama
Pelecocera tricincta Meigen, 1822	Zlatibor – Zlatibor 1 and 2
Pipizella bispina Šimić, 1987	Golija – Karalići
Pipizella zloti Vujić, 1997	Dubašnica – Lazar River gorge; Malinik – Malinik
Pocota personata (Harris, 1780)	Malinik – Malinik
Sericomyia lappona (Linnaeus, 1758)	Golija – Odvraćenica 1, Golijska Reka, Potok
Sphegina sibirica Stackelberg, 1953	Dubašnica – Dubašnica 1
Temnostoma vespiforme (Linnaeus, 1758)	Golija – Čeka
Trichopsomyia flavitarsis (Meigen, 1822)	Stara Planina – Dojkinci 2; Prijepolje – Kamena Gora 1
Xylota florum (Fabricius, 1805)	Golija – Odvraćenica 1
Xylota jakutorum Bagachanova, 1980	Golija – Odvraćenica 2
Xylota tarda Meigen, 1822	Dubašnica – Demizlok; Malinik – Malinik; Vojvodina – Bezdan

When it comes to testing the predictive power of SDMs, results of t test were not statistically significant ($t=0.6983$, $df=76.37$, $p=0.17$). However, this could be due to relatively small sample size. Another possible cause that could influence the structure of the sample is the fact that some species are simply more rare and therefore more difficult to find.

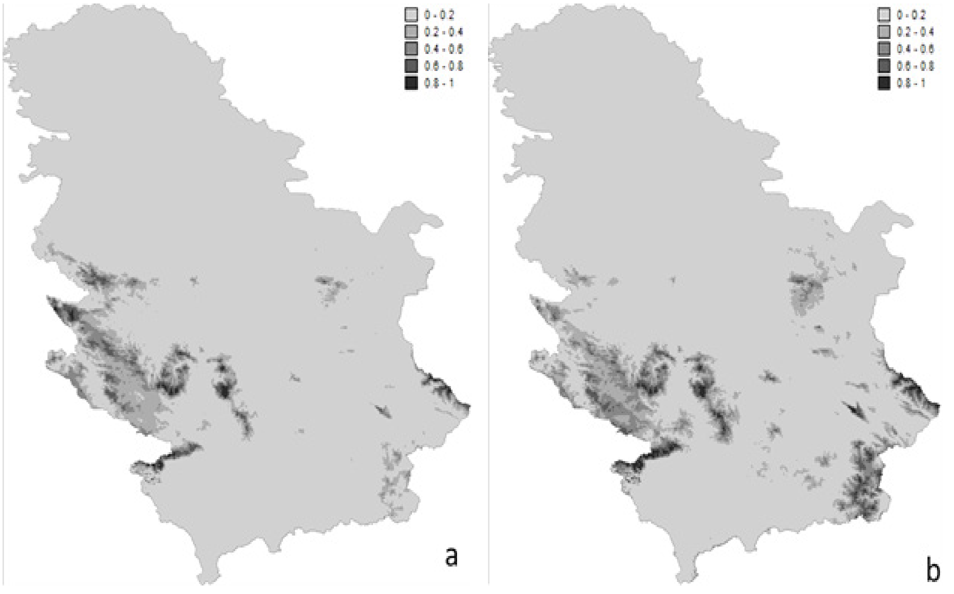

Figure 1. Maps of potential current distribution of species:
a) *C. tomentosum*, b) *M. moesiacus*

According to the models (Figure 1), the highest suitability for species *M. moesiacus* is on high peaks of mountains Tara, Golija, Kopaonik and Stara Planina, where the species was found previously, but also on the mountain Prokletije in southwestern part of Serbia. As far as *C. tomentosum* is concerned, most suitable areas for this species are the same as for *M. moesiacus*, with additional mountain peaks on Suva Planina and Besna Kobila in eastern part of Serbia being marked as suitable. Some areas identified as suitable and therefore important by the SDMs (e.g. mountains in the southern Serbia like Besna Kobila or Dukat) are not part of any PA or PHA. Additionally, findings of key hoverfly species in those areas, confirm their potential significance for survival of these species.

Maps of projected distribution for *Chrysotoxum tomenstosum* and *Merodon moesiacus* were superimposed on maps of Protected Areas and Prime Hoverfly Areas in order to quantify the percentage of overlapping. Our results showed high percentage of overlapping with PHA network, while percentage of overlapping with PAs was significantly lower (Table 2), which could be interpreted as an additional confirmation of validity of expert generated network and, on the other hand, indicate the need for evaluation of Protected Areas in Serbia.

Table 2. Percentage of protected areas that overlapped with projected species distribution (%PASD) and Percentage of Prime Hoverfly Area that overlapped with projected species distribution (%PHAD)

Species	%PASD	%PHAD
M. moesiacus	20.45	92.03
C. tomentosum	14.91	93.11

Many rare and endangered species occur in areas that have some form of legal protection. Nevertheless, a decline in those species has been noted in many countries. Establishment of protected and/or prime areas for various species is an important step for species conservation. However, many studies have indicated the need for further assessments of such areas. For instance, the European Union's Natura 2000 network is one of the most important conservation efforts being implemented across Europe. Nonetheless, no comprehensive evaluation of the effectiveness of this network has been conducted (Maiorano et al., 2007), with only a few published studies on this topic, most of which are focused on plants (Dimitrakipoulos et al., 2007; Chiarucci at al., 2008) or vertebrates (Maiorano et al., 2007), meaning that invertebrates remain underrepresented.

Climate change is another issue that needs to be addressed in assessing the effectiveness of protected areas and the creation and evaluation of management strategies. Species ranges cannot be considered static under environmental change (Klorvuttimontara et al., 2011), so protected areas and conservation networks must be properly designed to facilitate responses to those changes. While expert knowledge is fundamental, SDMs can aid in decision-making and the implementation of strategies to protect species, thus accounting for the uncertainty of future climate scenarios.

CONCLUSION

The results of this study confirm the validity of expert generated PHA network. While proper designation of such networks is of great importance, evaluation of their effectiveness is a part of the conservation process that is usually neglected.

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НОВИ НАЛАЗИ ЗАШТИЋЕНИХ И СТРОГОЗАШТИЋЕНИХ ВРСТА ПОТВРЂУЈУ ЗНАЧАЈ ПОДРУЧЈА ЗНАЧАЈНИХ ЗА ОПСТАНАК ОСОЛИКИХ МУВА (PHA)

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РЕЗИМЕ: С порастом антропогеног притиска на животну средину, успостављање заштићених подруча једна је од најзначајних стратегија за очување биодиверзитета. Чињеница да многе врсте губе битку са изумирањем, без обзира на то што се налазе у оквиру заштићених подручја, потеже се питање њихове евалуације. Циљ ове студије је процена Подручја значајних за опстанак осоликих мува (PHA) и подручја која то још нису, а потенцијално би могла бити у будућности, користећи податке из нових теренских истраживања. За ову сврху је искоришћен Т-тест. Поред тога, модели потенцијалне дистрибуције врста креирани су за две нове врсте које су препознате као значајне и додате на списак кључних врста. Креиране мапе су преклопљене с мапама заштићених подручја и PHA подручја како би се уочио проценат преклапања. Резултати Т-теста нису статистички значајни, али би то могла бити последица других фактора, као што је мала величина узорка. С друге стране, резултати моделовања потенцијалне дистрибуције врста и преклапања мапа би се могли тумачити као додатна потврда значаја PHA мреже.
КЉУЧНЕ РЕЧИ: осолике муве, Подручја значајна за опстанак осоликих мува, евалуација, конзервација

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HOVERFLIES (Diptera: Syrphidae) IN PROTECTED AREAS OF GREECE

ABSTRACT: Greece hosts a highly diverse hoverfly fauna. The high diversity in this area arises primarily due to its position in the Mediterranean region, which is located at the junction of Europe, Asia and Africa and acts as a transition zone between three major biogeographic regions. Sites with the richest hoverfly fauna in Greece are mostly protected. Species richness in selected protected areas were estimated using biodiversity indices. According to the results, the most important categories for conservation and survival of hoverfly populations in Greece are national parks and Ramsar sites.

KEYWORDS: diversity indices, Greece, hoverfly, national park, Natura 2000, Ramsar site

INTRODUCTION

The unique richness of the flora and fauna of the Balkan Peninsula is a reflection of its exceptional ecological and biogeographical history. As one of the most important biodiversity centers of the Balkan and Mediterranean regions, Greece hosts a broad spectrum of important ecosystems. Among them are forests, since they harbor the largest diversity of hoverfly species (Speight, 2017). However, a large percentage of forest cover is under threat of being destroyed by human activity (Vujić et al., 2000). Precise data on species can be crucial for programs aimed to protect and recover the endangered species, as well as to define new protected areas or to introduce new measures in the existing natural protected areas.

Hoverflies (Order Diptera, Family Syrphidae) are a diverse insect group, comprising about 6,000 species of 188 genera worldwide. Approximately 800 species have been recorded in Europe. The most speciose genera in Europe in

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general and in Greece specifically are *Cheilosia* Meigen, 1822 and *Merodon* Meigen, 1803 (Speight, 2017).

Over recent years, a great effort has been being made to protect nature in Europe by safeguarding habitats, linking them with surrounding transition zones, and restoring damaged areas through, for example, the Natura 2000 network. By consolidating special protected areas designated by the European Union (EU) Birds Directive (2009/147/EC) and the Special Protection Areas under the EU Habitats Directive (92/43/EEC), Natura 2000 is intended to represent an ecological network that harbours a significant diversity of habitats and species throughout Europe (Papageorgiou and Vogiatzakis, 2005).

Greece is a part of the Mediterranean biodiversity hotspot, representing an area essential for biodiversity conservation. Greece first endeavoured to protect its biological resources by naming its first two national parks in 1937. In subsequent years, five legal categories (national parks, marine parks, aesthetic forests, nature monuments and Ramsar sites) were defined, covering 1.83% of the area of Greece. Then, in 1992, the EU initiated an integrated and innovative approach to nature protection in the form of its Natura 2000 network, which resulted in the introduction of new laws in Greece (Papageorgiou & Vogiatzakis, 2005). Today, approximately 35% of the 133,012 km^2 of mainland Greece and 1.5% of the 500,000 km^2 Greek maritime area are protected.

MATERIAL AND METHODS

In this paper, we assessed data on 9,252 hoverfly specimens (of 321 different species) recorded in selected natural parks and Ramsar sites in Greece (for which we had sufficient data). The material had been collected in the period between 1901 and 2017 by many legators. The data is both published and unpublished, and is part of a database (generated in FileMaker Pro® 9.0 v3) stored by the Department of Biology and Ecology, Faculty of Sciences, Novi Sad, Serbia.

All protected areas in Greece are part of the Natura 2000 network (Figure 1), classified into 21 categories of protection, including 1,256 protected areas of national, international and regional designations (UNEP–WCMC, 2016), among which are the following most important categories:

- National designations: national parks (including national woodland parks) (22), aesthetic forests (19), natural monuments (9), national marine parks (2) and nature reserve areas (11);
- International designations: Ramsar sites (10);
- Regional designation: Special Protection Areas (Birds Directive) (202) and Site of Community Importance (Habitat Directive) (241).

PAST software (v 3.14) was used with a variety of standard numerical analyzes and operations (such as univariate and multivariate statistics, curve and graph analysis, and phylogenetic analysis), many of its functions being specific to paleontology, biology and ecology (Hammer et al., 2001). Basic diversity indices were calculated, such as species dominance (D), Simpson's (1-D) and Shannon's (H) diversity indices, Buzas and Gibson's evenness (e^H/S), Brillouin's index, and the Chao1 estimator. A dendrogram of Jaccard similarity indices between 10 national parks was also generated.

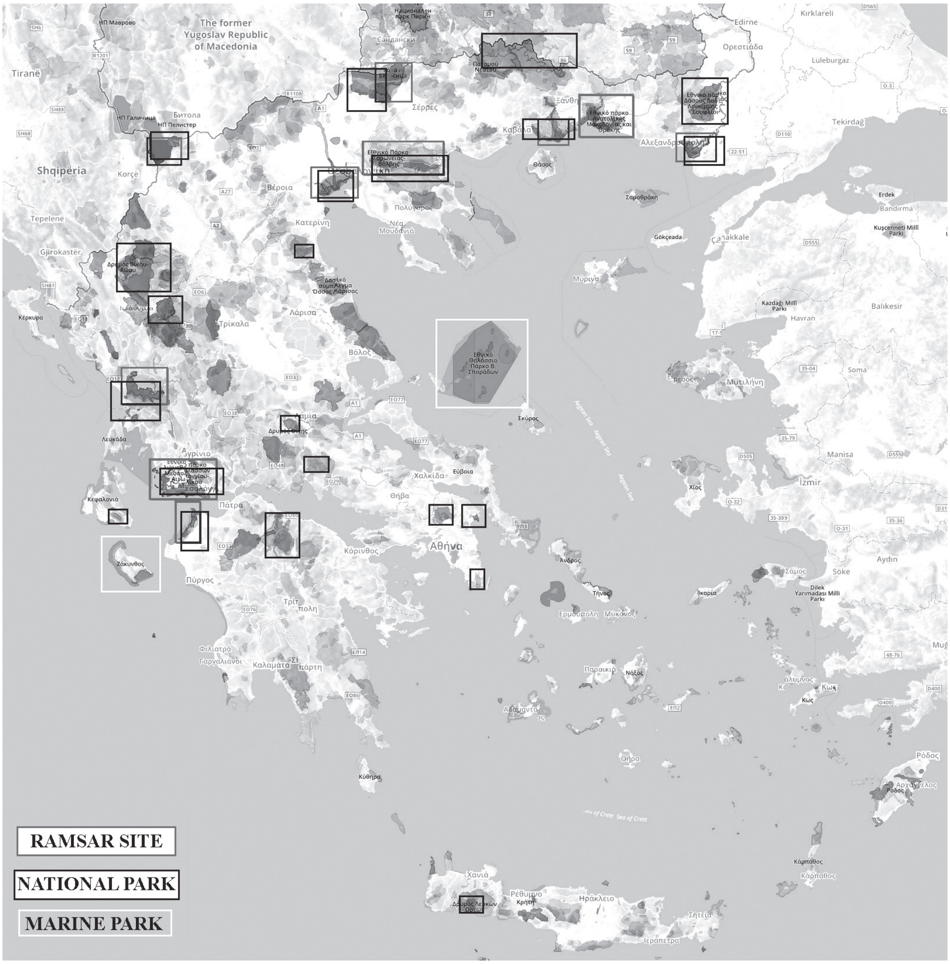

Figure 1. Map of Natura 2000 network areas (designated with dark patches), of natural parks (framed black), natural marine parks (framed white), and Ramsar sites (framed grey) in Greece (available on https://www.protectedplanet.net/country/GRC).

The most important protected areas in Greece in terms of hoverfly species richness are national parks (with 332 species) and Ramsar sites (with 109 species).

National parks with the greatest diversity of registered species are those of Pindos, Rodopi, Dadia and Olimp. The most important Ramsar sites for hoverfly diversity are near the lakes of Prespa, Volvi and Koronia, as well as the delta of the Nestos River. There is a small number of hoverfly species in aesthetic forests. For example, only one species (*Eumerus pusillus* Loew, 1848) occurs in Vai Palm Aesthetic Forest on the island of Crete, and 22 species have been recorded in aesthetic forests along the Nestos River. In contrast, 33 species have been reported from the Natural Monument of Western Lesbos Island, and more than 40 species (44 in Karvouni and 45 in Kerkis) have been collected in the nature reserves of Samos Island.

Based on our statistical analysis, the national parks with the highest number of species are NP Rodopi (S=177), NP Pindos (S=162), and NP Olimp (S=103), whereas the lowest is recorded in the Evros delta (S=7) and the surroundings of Volvi and Koronia lakes (S=14). Similar results were obtained regarding the number of individuals, with the exception of NP Pindos where a relatively small number of individuals (N=759) have been recorded relative to its high number of species and compared to numbers of specimens from other national parks (Table 1).

In terms of species diversity of Syrphidae in Greek national parks, NP Chelmos (D=0.0458), NP Olimp (D=0.0575), and NP Pindos (D=0.0137) are the richest based on the values of the dominance index, whereas the Evros delta (D=0.4298) and NP Parnass (D=0.2902) are the poorest. These results are supported by the analyses of Shannon's and Brillouin's diversity indices, both of which identified the same national parks (as the dominance index) as having the richest and poorest diversity.

Table 1. Diversity indices for 10 national parks in Greece

	NP Dadia	NP Chelmos	NP Olimp	NP Pindos	Nestos Delta	Evros delta	NP Pra-nassos	Prespa	NP Rodopi	Volvi & Koronia
Taxa (S)	84	53	103	162	40	7	21	49	177	14
Individuals	802	159	1546	759	340	22	94	215	4493	44
Dominance (D)	0.1075	0.04577	0.05751	0.01366	0.1537	0.4298	0.2902	0.07764	0.1374	0.1105
Simpson (1-D)	0.8925	0.9542	0.9425	0.9863	0.8463	0.5702	0.7098	0.9224	0.8626	0.8895
Shannon (H)	2.877	3.528	3.405	4.647	2.547	1.286	2.011	3.108	3.087	2.398
Evenness (e^H/S)	0.2114	0.6426	0.2923	0.6439	0.3193	0.5167	0.3557	0.4568	0.1238	0.786
Brillouin	2.734	3.108	3.295	4.331	2.379	0.9952	1.745	2.813	3.022	2.013
Chao-1	125.2	86.33	119.7	187.1	50.11	9	27	70.08	221	14.43

The analysis of Buzas and Gibson’s evenness index identified NP Rodopi (He=0.1238) as having the most uniform sample, whereas the lowest uniformity of fauna was obtained for NP Chelmos (He=0.6426) and NP Pindos (He=0.6439). The Chao1 index revealed minimal species richness in the Evros delta (9) and around lakes Volvi and Koronia (14 and 43, respectively), whereas the same index highlighted NP Pindos (187) and NP Rodopi (221) as having the greatest species richness (Table 1).

Statistical analyses of the four other types of protected areas in Greece revealed that the highest numbers of species were registered in two nature reserve areas on Samos Island (S=44 and S=45, respectively), and 22 species were collected from aesthetic forests along the Nestos River. The lowest number of individuals were collected from the Karvouni Nature Reserve Area (N=181). Shannon's and Brillouin's diversity indices identified the two protected areas on Samos Island as being the richest (H=3.24 and H=3.33 for Karvouni and Kerkis, respectively), and that Vai Palm Aesthetic Forest on Crete Island is the poorest based on the same indices (H=1.96). Based on Buzas and Gibson's evenness index, the two nature reserve areas on Samos Island exhibit the greatest pattern unevenness (He=0.5672 and He=0.6348 for Karvouni and Kerkis, respectively). The highest species richness was obtained for Karvouni Nature Reserve Area based on the Chao1 index (72.5), whereas the lowest richness was registered for the aesthetic forest on Crete Island (25.5) (Table 2).

Table 2. Diversity indices for 4 protected areas in Greece.

	Lesvos	Kerkis Samos	Karvouni Samos	Kavala – Xanthi
Taxa (S)	33	45	44	22
Individuals	217	269	181	210
Dominance (D)	0.1408	0.05582	0.04814	0.2422
Simpson (1-D)	0.8592	0.9442	0.9519	0.7578
Shannon (H)	2.578	3.24	3.33	1.953
Evenness (e^H/S)	0.3989	0.5672	0.6348	0.3205
Brillouin	2.369	2.994	3.001	1.808
Chao-1	55.75	50.08	72.5	25.5

To evaluate similarities among the hoverfly faunas of ten Greek national parks, their Jaccard indices were calculated. We found that the most similar faunas occur in NP Dadia and the Nestos River delta. The next most similar grouping of national parks comprised NP Chelmos, the Evros River delta, and the surroundings of lakes Volvi and Koronia. The most dissimilar grouping consisted of NP Rodopi and NP Pindos (Figure 2).

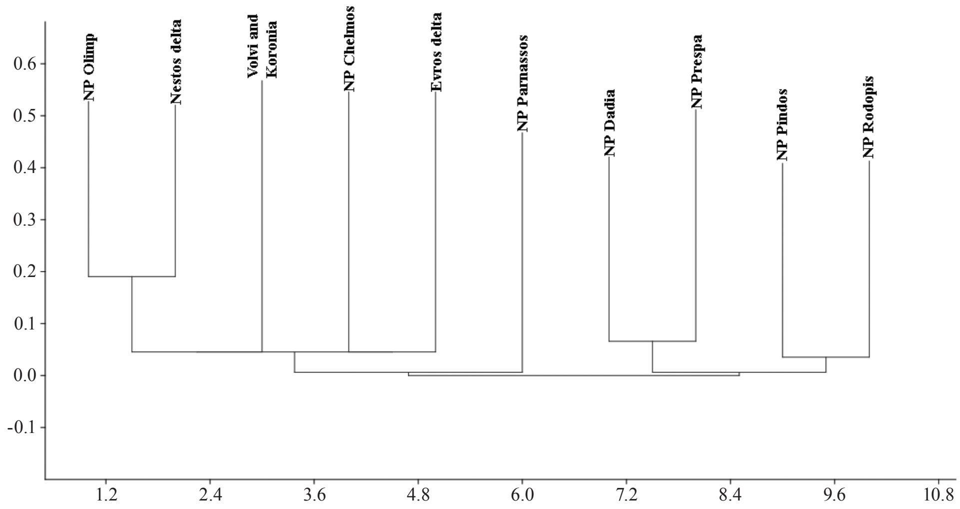

Figure 2. Dendrogram of Jaccard similarity index for hoverfly fauna in ten Greek national parks

DISCUSSION

Research on the biodiversity of the Balkan Peninsula (including Greece) has highlighted the exceptional endemicity and species richness of the biota in this region, which is the result of its complex geological history and long-term interactions between populations, species and ecosystems (Dapporto, 2010; Balletto and Casale, 1991). Greece is one of the most biodiverse countries in Europe. Thus far, between 30,000 and 50,000 species of invertebrates have been recorded in Greece, including an exceptionally high percentage of endemic species (http://www.iucn.org). Regarding the insects, the Greek hoverfly fauna is particularly noteworthy, comprising 418 species from 83 genera. It is likely that the various high mountains and numerous islands that partly constitute the Greek territory have served as particularly important refugia and hotspots for diversification of many taxa over geological history (Georghiou and Delipetro, 2010).

Establishing protected areas is one of the oldest and most prevalent strategies for conserving biodiversity (Vujić et al., 2016). Detailed monitoring of particular localities helps identify new areas for the protection and conservation of the living world. In Greece, Mediterranean evergreen forests and Central European-type deciduous forests are the most common types of vegetation, but most of its varied forest ecosystems are covered by some category of protected area.

Based on our research, the most important categories of protected areas in Greece are the national parks, Ramsar sites, marine parks and Natura 2000 areas, in which a large number of hoverfly species have been recorded. Regarding the national parks, highest hoverfly richness was registered in NP Olimp, NP Pindos, and NP Chelmos, whereas the richest Ramsar sites are the Nestos River delta and the surroundings of lakes Volvi and Koronia. The higher species richness documented in national parks and Ramsar sites compared to other protected areas (aesthetic forests, natural monuments, and nature reserve areas) is likely related to the larger sizes of the former and the greater degree of exploitation within the boundaries of the latter.

However, our results do not provide a complete picture of hoverfly diversity in the protected areas of Greece owing to biased sampling effort across the country and lack of sufficient data from all potentially suitable sites. Further detailed surveys within and outside the boundaries of protected areas are needed to obtain a more realistic picture of hoverfly diversity in Greece and to take appropriate measures to preserve hoverfly populations and the ecosystems crucial for their survival.

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ОСОЛИКЕ МУВЕ (Diptera: Syrphidae)
У ЗАШТИЋЕНИМ ПОДРУЧЈИМА ГРЧКЕ

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РЕЗИМЕ: Грчку одликује богата фауна осоликих мува. Висока разноврсност на овом подручју првенствено је резултат положаја Грчке у медитеранској области, на граници Европе, Азије и Африке као прелазне зоне између три велика биогеографска региона. Подручја са најбогатијом фауном осоликих мува у Грчкој већином спадају под одређени степен заштите. Помоћу индекса биодиверзитета процењено је богатство врста у одабраним заштићеним подручјима. Добијени резултати истичу значај националних паркова и рамсарских подручја за очување и опстанак популација сирфида.

КЉУЧНЕ РЕЧИ: индекси диверзитета, Грчка, осолике муве, национални парк, NATURA 2000, рамсарско подручје

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QUALITY ASSESSMENT OF HABITATS USING PHYTOPHAGOUS HOVERFLIES (Diptera: Syrphidae)

ABSTRACT: Biodiversity has strongly declined throughout the world mainly due to human activities. Thus, standardized indicators are needed more than ever before to effectively monitor anthropogenic disturbance and its impact on ecosystems. In this study, hoverfly species of two largest phytophagous genera (*Cheilosia* and *Merodon*) were chosen as bioindicators to assess the quality of 15 sites located in Serbia; in or around mountains Fruška Gora, Kopaonik, Stara Planina, Dubašnica and Pčinja region. Sufficiently close associations with particular habitats (each having its own characteristic assemblage) make phytophagous hoverflies perfect candidates for such a role. Syrph the Net database was used as a useful tool for assessing quality of habitats and detecting differences between them.

KEYWORDS: biodiversity, bio indicators, conservation, diversity, insects, Syrph the Net

INTRODUCTION

The damage to biodiversity caused by human activities is rapidly increasing (Souza et al., 2014), and the negative impacts are mainly associated with the increase in cultivated land surfaces and urbanization. More than ever, standardized indicators are needed to monitor responses of human-modified ecosystems to disturbances, which would allow designing effective conservation measures.

The family Syrphidae is the most species-rich (Rotheray and Gilbert, 2011) and among the most diverse Dipteran insect families regarding habitat preferences and larval biology (Thompson and Rotheray, 1998). Hoverflies can be found in almost every terrestrial and many aquatic habitats, having considerable importance in ecosystems by providing crucial ecosystem services such as pollination (van Rossum 2010; Petanidou et al., 2011) and biological pest

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control (Thomson and Hoffmann, 2009). The larvae are zoophagous (especially aphids) (30%), saprophagous (30%) or phytophagous (20%), while the diet of the remainder is mixed (Castella, 2008). In this paper, we focus on two large phytophagous genera, *Cheilosia* Meigen, 1822 with nearly 300 species present in the Palaearctic (Peck, 1988) and *Merodon* Meigen, 1803 with 160 species distributed over the Palaearctic and Afrotropical regions (Ståhls et al., 2009). Adults of various species of the genus *Merodon* have a preference for flowers of the family Apiaceae (Hurkmans, 1993), while adults of the genus *Cheilosia* predominantly feed on flowers of *Salix* spp. in early spring and, during the summer, species visit various white and yellow flowers (Ståhls et al., 2008). More than 50% of European species of *Cheilosia* are present on the Balkan Peninsula (Vujić, 1996). On the other hand, genus *Merodon* is predominantly distributed in Mediterranean region in Europe (Speight, 2014).

The role of hoverflies as bioindicators has been particularly recognized through the Syrph the Net (StN) database which has been successfully used for habitat evaluations (Speight and Castella, 2001; Velli et al., 2010; Sommaggio and Burgio, 2014; Petremand et al., 2017). The database compiles habitat preferences and other ecological, biological and distribution information for more than 900 European hoverfly species (Petremand et al., 2017). The main output of StN is "biodiversity maintenance function" (BDMF), representing the ratio between the observed number of species to the total number predicted by StN (Speight, 2000). It is used as an estimator of site quality: if BDMF is less than 50% (less of 50% expected species were recorded for a given site), the site may be considered degraded (Speight et al., 2000).

Brown (1991) identified 12 "desirable qualities" for insect indicator taxa in order to be efficient: taxonomically and ecologically highly diversified, species have high ecological fidelity, relatively sedentary, species narrowly endemic, or if widespread, well differentiated, taxonomically well known, easy to identify, well studied, abundant, non-furtive, easy to find in the field, damped fluctuations (always present), easy to obtain large random samples of species and variation; functionally important in ecosystem, response to disturbance predictable, rapid, sensitive, analyzable and linear, and associates closely with and indicates other species and specific resources. In addition to a majority of these criteria hoverflies met, hoverflies of Serbia are particularly well studied (Glumac, 1955, 1959; Vujić and Glumac, 1994; Vujić, 1996; Vujić and Šimić, 1994; Šimić et al., 2009; Šimić and Vujić, 1984, 1996; Radenković, 2008; Nedeljković et al., 2009; Vujić et al., 2013; Vujić et al., 2016). This is of the utmost importance when applying StN analysis.

General aims of this study were (I) to calculate biodiversity maintenance function and (II) to assess and compare habitat quality of 15 different study sites in Serbia. Specific aim was to inspect the relationship between two indices (BDMF and Shannon diversity index) often used in environmental assessment studies.

MATERIAL AND METHODS

To select our research sites, we looked for ecological preferences of species from the genera *Merodon* and *Cheilosia*. Thus, the sites were selected to represent a range of lowland and highland landscapes, covering broad spectrum in micro and macro-habitats diversity, as well as land-use intensity. A more detailed description of the site selection process can be found in Popov (2017). Overall, we selected 15 sites located in or around mountains Fruška Gora, Kopaonik, Stara Planina, Dubašnica and Pčinja Region (Figure 1).

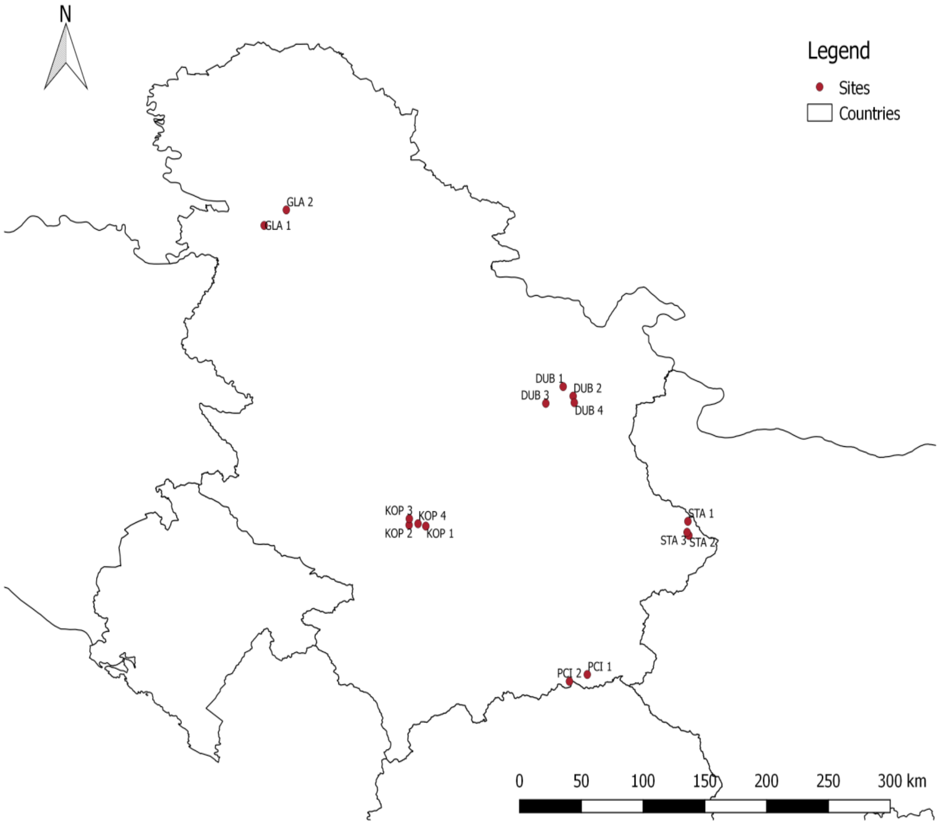

Figure 1. Map showing location of study sites in Serbia

Hoverflies were surveyed along transects between 09:00 and 01:00 p.m. on sunny days with little or no wind. Specimens were counted during peak flight periods, from April to the end of August, using entomological net. The StN database consists of information on adult hoverfly species collected using Malaise traps; however use of entomological net has also been successfully applied in StN analyses (Kassebeer, 1993; Marcos-Garcia, 1990). Entomological net is the most common method used for capturing hoverflies and several papers suggest it to be more reliable than trapping. For example, a 4-year study conducted in Balkan area using Malaise trap sampling showed that out of 50 hoverfly species collected, only one belonged to the genus *Cheilosia* (Šimić and Vujić, 1984). Moreover, one study in the Mediterranean revealed net sampling to be more representative than trapping – 40 of 59 species (67.8%) sampled using Malaise traps and 45 of 59 (76.3%) by netting (Petanidou et al., 2011). In addition, entomological net is a suitable technique for recording rare species and to obtain species lists, the latter being one of the objectives of this research study.

Inventory completeness, defined as observed species richness in relation to estimated richness, was calculated using a non-parametric species richness estimator, CHAO2 (Chao et al., 2000).

We calculated BDMF for each of the 15 analyzed sites. Firstly, list of predicted species was produced by considering regional list of species and pairing the habitat preferences of each species with the habitats available at a given site (Speight and Castella, 2001). Afterwards, we compared the list of hoverflies caught on the study sites with the list of species predicted for an identical environment for a given region. A detailed description of the process of calculating BDMF can be found in Speight et al. (2000).

Thereafter, we analyzed the relationship between BDMF and Shannon diversity index. Considering the relatively small sample size (n=15), a non parametric statistical test was used for the analysis of relationship between the two indices. For this purpose, the Spearman's rank correlation coefficient was calculated in MATLAB.

RESULTS AND DISCUSSION

Estimates for inventory completeness (CHAO2) ranged from 85.1 to 100% of the potential species richness within the sites (Table 1). These findings show that we managed to collect sufficient samples for characterising hoverfly assemblages.

Table 1. Inventory completeness: observed richness as a percentage of total expected richness according to the CHAO2 estimator. S=observed species of *Merodon* and *Cheilosia* genera

Site	S	CHAO2	Completeness (%)
DUB 1	41	42.20	97.10
DUB 2	22	23.00	95.60
DUB 3	41	41.40	99.00
DUB 4	21	21.10	100.00
GLA 1	6	6.00	100.00

GLA 2	33	33.20	100.00
KOP 1	35	36.30	96.40
KOP 2	52	52.40	99.20
KOP 3	23	23.30	98.70
KOP 4	30	30.20	99.30
PCI 1	7	7.20	97.20
PCI 2	14	14.00	100.00
STA 1	19	19.20	98.90
STA 2	4	4.70	85.10
STA 3	30	31.20	96.10

The results presented in the Table 2 and Figure 2 were analysed processing the collected phytophagous hoverfly species with StN. Mean BDMF was 50.7%; the highest value (75.9) was observed for site KOP2, whereas the lowest value was found for site PCI1 (16.7%). According to the BDMF values, more than 70% of investigated sites currently can be considered as degraded habitats, with BDMF values < 50%. Only one site (KOP2, Samokovska reka river) presented a sufficiently high BDMF to be considered as a site of a high habitat quality, with BDMF value > 75%.

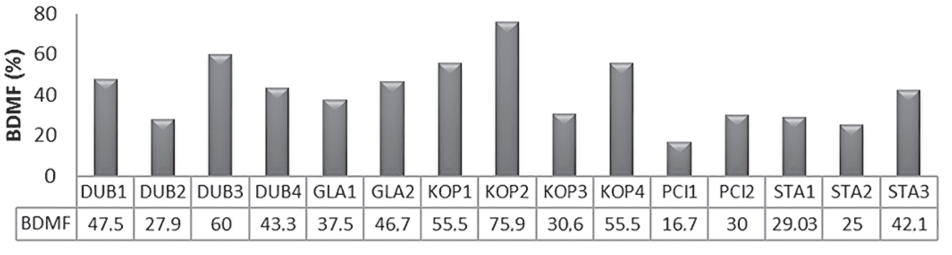

Figure 2. BDMF values for 15 sites in Serbia (BDMF = biodiversity maintenance function; the ratio between observed and predicted species).

If we take into account all the investigated sites, the SyrphTheNet analysis has predicted total of 72 species of the genera *Cheilosia* and *Merodon*. The highest number of species (61) was predicted for sites DUB1 and DUB2. An additional parameter StN analysis provides is the ratio between the observed, but not predicted species and the observed species. A high number of species observed but not predicted can be found when there is a migration from surrounding habitats and / or where additional habitats have not been included in the analysis. The highest number of species observed, but not predicted (23) was found for site DUB3 (Lazareva reka canyon), most probably due to the unique variety of pre-glacial habitats.

Table 2. Summary of results obtained with Syrph the Net.

Sites	Expected species by StN	Observed not expected	Observed not expected (%)
DUB 1	61	12	29.3
DUB 2	61	5	22.7
DUB 3	30	23	56.1
DUB 4	30	8	38.1
GLA 1	8	3	50.0
GLA 2	30	19	57.6
KOP 1	36	15	42.8
KOP 2	54	11	21.1
KOP 3	36	11	50.0
KOP 4	36	10	33.3
PCI 1	30	2	28.6
PCI 2	30	5	35.7
STA 1	31	10	52.6
STA 2	8	2	50.0
STA 3	57	6	20.0

The lowest value of Shannon's diversity index (Figure 3) was calculated for the site on Stara planina (STA2 1.33). This site is located near a human settlement and it is characterized by the presence of crop farming and grazing. The highest values of the Shannon index (over 3) were calculated for the sites in Kopaonik and Dubašnica Region (DUB1 = 3.56, DUB3 = 3.28, KOP4 = 3.22 and KOP = 2 3.6).

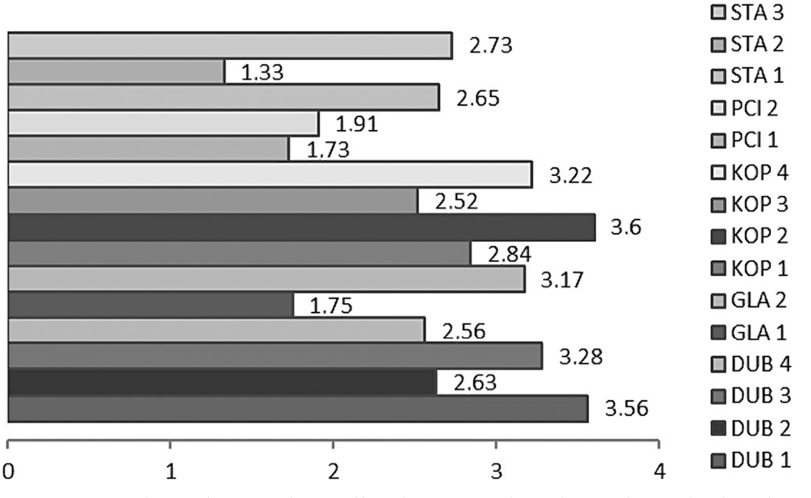

Figure 3. Phytophagous hoverfly Shannon Diversity Index calculated for 15 study sites in Serbia.

To address the specific objective, we examined the correlation between BDMF and Shannon index. The results showed a statistically significant positive correlation between the two indices ($r = 0.85791$, $p<0.05$). Shannon index is one of the most widely used diversity indices in ecological research. Beside species richness, it takes the relative abundances of different species into account. On the contrary, StN analysis is based only on the absence or presence of species in a given environment, which may be an advantage when having a restricted dataset.

It has been shown that *Cheilosia* species are sensitive to environmental disturbance, especially within forests (Jovičić et al., 2017). Undisturbed forest habitats characterized by high BDMF and Shannon index values (e.g. Samokovska reka river) enable species to have continuity of the microclimate they prefer. If the microclimate changes, these species may become endangered. In order to preserve species, we have to protect broad forested areas, while also controlling for other direct human impacts, including environmental disturbance in open areas.

CONCLUSION

Our results show that some sites (i.e. Samokovska reka river and Lazareva reka canyon) support populations of various hoverfly species that are recognized as playing an important role in ecosystem functioning. Developing a long term monitoring program for the target hoverfly species which will reflect the diversity of other taxa within a given habitat is of the utmost importance for species protection and conservation. Syrph the Net database of European hoverflies seems to be an appropriate tool for quality assessment of habitats and biodiversity management.

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ПРОЦЕНА КВАЛИТЕТА СТАНИШТА ПРИМЕНОМ ФИТОФАГНИХ ОСОЛИКИХ МУВА (Diptera: Syrphidae) КАО БИОИНДИКАТОРА

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РЕЗИМЕ: У последњих неколико деценија биодиверзитет опада у целом свету. Таква ситуација изискује постојање стандардних индикатора помоћу којих ћемо моћи ефикасно да пратимо промене у екосистемима које се дешавају, пре свега, као последица негативног утицаја антропогеног фактора. У овом истраживању за биоиндикаторе су изабрана два највећа фитофагна рода осоликих мува

(родови *Cheilosia* и *Merodon*) и урађена је процена квалитета 15 локалитета у Србији који се налазе на планинама Копаоник, Фрушка гора, Стара планина, Дубашница и у долини реке Пчиње. Фитофагни родови су се показали као одлични кандидати за биоиндикаторску улогу, пре свега због своје повезаности са специфичним стаништима. У анализи је коришћена Syrph The Net база, предиктивна алатка за процену квалитета станишта.
КЉУЧНЕ РЕЧИ: биодиверзитет, биоиндикатори, диверзитет, инсекти, конзервација, Syrph The Net база

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HOVERFLY DIVERSITY ASSESMENT IN GRASSLAND AND FOREST HABITATS IN AUTONOMOUS PROVINCE OF VOJVODINA BASED ON A RECENT MONITORING STUDY

ABSTRACT: Pollination is a required process for survival of numerous plant species and crops. Hoverflies (Diptera: Syrphidae) play a significant role in this phenomenon. Due to raising environmental pressures, pollinator diversity and pollination services are at risk. Faunistic studies and biodiversity research are the essential elements and steps in the process of species preservation. This study aimed to analyze diversity of hoverflies in two CORINE land cover types (Broad-leaved forest and Natural grasslands), based on a recent one-year study. To achieve this goal, Shannon's diversity index (H), Shannon's equitability (E_H), and Jaccard similarity coefficient (J_t) were calculated. Values of indices and coefficients indicate which parts of Vojvodina and what land cover types can be considered as hoverfly reservoirs.

KEYWORDS: hoverflies, pollinators, diversity index, land cover type, Vojvodina, forest, grassland

INTRODUCTION

Pollination is a process of pollen transmission from the anther to pistil, which enables the survival of plants reproduced in this way (Breeze, 2011). Insects are the most common pollinators and reproduction of numerous plant species and crops depends on their presence (Carreck and Williams, 1998). Among other insect species, hoverflies are very important because of their pollinator role (Petanidou et al., 2011, Rader et al., 2015).

The decline in the number and diversity of insect pollinators, which includes syrphids, has been recorded in the last two decades (Dias et al., 1999, Kremen and Ricketts ,2000, Biesmeijer et al., 2006, Klein et al., 2007, Potts et

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al., 2010). The reasons for this trend are the intensification of agricultural production, the use of pesticides, the cultivation of monocultures, the spread of diseases and parasites, urbanisation and the disappearance of ecological niches suitable for insect pollinators (Potts et al., 2010).

It is well-known that biology and ecology of syrphids is vital for their survival (Markov, 2017). The biodiversity and distribution analyses of hoverflies are of equal importance and can help in prevention of the disappearance of certain plant species, reduction of crop production that depends on insects pollination, maintenance of other ecosystem services, etc. (Rotheray and Gilbert, 2011). Finally, different researches serve to increase interest of decision-makers, farmers, and other stakeholders in conserving certain species (Vanbergen1 et al., 2013). During the research, specific steps are taken to make a checklist of pollinators and conduct analyses for the assessment of diversity, distribution and other aspects necessary for the protection of this group of organisms.

The presence of more than 250 hoverfly species is documented in Vojvodina (Nedeljković et al., 2009). In some parts of this area, the fauna of Syrphidae has been studied in detail. For example, 210 species are present in Fruška Gora Mountain (Vujić et al., 2002), and 151 hoverfly species have been recorded in Vršac Mountains (Vujić and Šimić, 1994).

The general aim of this study was to analyse diversity of hoverflies in ten localities (in forest and grassland land cover type) in the Autonomous Province of Vojvodina, the northern part of the Republic of Serbia. Based on recent monitoring of pollinators in Vojvodina and the hoverfly checklist obtained during this study (Markov et al., 2016), Shannon's diversity and equitability index and Jaccard similarity coefficient were calculated and analyzed.

MATERIAL AND METHODS

Hoverflies (Diptera: Syrphidae) were studied in ten localities (Table 1) which belong to two habitat types according to CORINE Land Cover classification (Markov, 2017). Localities are categorised as land cover classes with codes 3.1.1 Broad-leaved forest and 3.2.1 Natural grasslands (EEA, 2016). These two types are chosen because of their high importance for the researched group of organisms. Five localities were selected for both habitat types, and they also belong to protected areas. Syrphids in these sites were recorded and collected with hand-nets during five rounds from 30 March to 10 October 2014. Detailed sampling methodology, which is standardized according to the protocol, is described in the paper Markov et al. (2016).

Table 1. Description of the localities surveyed

Name	Latitude and longitude	Altitude	CORINE code
Fruška Gora Mountain	45.1846°N 19.8515°E	239–253 m	3.1.1
Vršac Mountains I	45.1246°N 21.3285°E	343–354 m	3.1.1
Subotica Sands	46.1217°N 19.7646°E	109–112 m	3.1.1
Deliblato Sands	44.9944°N 20.9464°E	148–157 m	3.1.1
Gornje Podunavlje	45.5375°N 19.0823°E	76–82 m	3.1.1
Okanj Bara	45.5348°N 20.2138°E	73–75 m	3.2.1
Pašnjaci Velike Droplje	45.9317°N 20.2939°E	73–73.5 m	3.2.1
Slano Kopovo	45.6030°N 20.2251°E	73–74 m	3.2.1
Selevenjske Pustare	46.14142°N 19.9357°E	80–82 m	3.2.1
Vršac Mountains II	45.1030°N 21.3888°E	149–157 m	3.2.1

In this paper, for the quantification of diversity, several indexes were used. The first one is a mathematical representation of species diversity in a particular community – Shannon's diversity index (Shannon, 1948). It depends on the number of species present in the given area and on their number, so it gives us a complete picture of the biodiversity of the researched area. The following formula was used for calculating *H* index:

$$H = -\sum_{i=1}^{s} pi \cdot \ln pi$$

where *H* denotes Shannon's diversity index, *S* – a total number of species, *Ni* – the number of individuals of the *i*-th species, and *pi* – the proportion of *S* made up of the *i*-th species ($Ni / \Sigma Ni$).

Shannon's equitability has a value between 0 and 1 and represents uniformity in the number of individuals of different species of the same community. It is calculated according to the following formula:

$$Eh = \frac{H}{H\max} = \frac{H}{\ln S}$$

where *Eh* denotes Shannon's equitability, *H* – Shannon diversity index, and *S* – a total number of species in the community.

The similarity of the fauna of the researched sites was compared with the Jaccard similarity coefficient and calculated according to the following formula:

$$Jt = \frac{m11}{m11 + m01 + m10}$$

t – fauna of the area to compare
*m*11 – the number of species common to both compared fauna
*m*10 – the number of species present in the first of the compared fauna
*m*01 – the number of species present in the second fauna.

RESULTS AND DISCUSSION

There are numerous ways to present biological diversity, and we used in this paper Shannon's diversity index and Shannon's equitability for each locality (Table 2). In this way, we provided answers to the questions where the highest and where the lowest value of hoverfly diversity is. On the other hand, equitability index shows regularity in the distribution of individuals within each species. In other words, it explains whether the found species are represented by approximately similar number of individuals.

Table 2. Values of Shannon's diversity index (*H*), Shannon's equitability (E_H), number of species in the community (*S*), and a total number of individuals of recorded species (ΣNi).

Name	*H*	*S*	$\sum N_i$	E_H
Code according to CORINE LC – 3.1.1.				
Fruška Gora Mountain	2.922	45	250	0.685
Vršac Mountains I	2.751	29	95	0.664
Subotica Sands	1.545	11	176	0.404
Deliblato Sands	1.502	9	97	0.384
Gornje Podunavlje	1.937	8	18	0.671
Code according to CORINE LC – 3.2.1.				
Okanj Bara	1.921	16	241	0.507
Pašnjaci Velike Droplje	2.146	18	195	0.599
Slano Kopovo	2.133	19	225	0.574
Selevenjske Pustare	1.836	9	35	0.521
Vršac Mountains II	2.506	20	127	0.617

Among the localities in the CORINE class 3.1.1, the highest index of diversity was calculated for Fruška Gora Mountain, while in class 3.2.1 the highest index was for Vršac Mountains II. Regarding the class level, diversity index for the whole 3.1.1 class is 2.843 (Figure 1), where a large number of species were recorded (64), and a relatively large number of specimens were collected (647). A slightly lower index of diversity was calculated for Natural grassland (2.576), the number of registered species is smaller than in 3.1.1 (43 in total), but the number of specimens is higher (851).

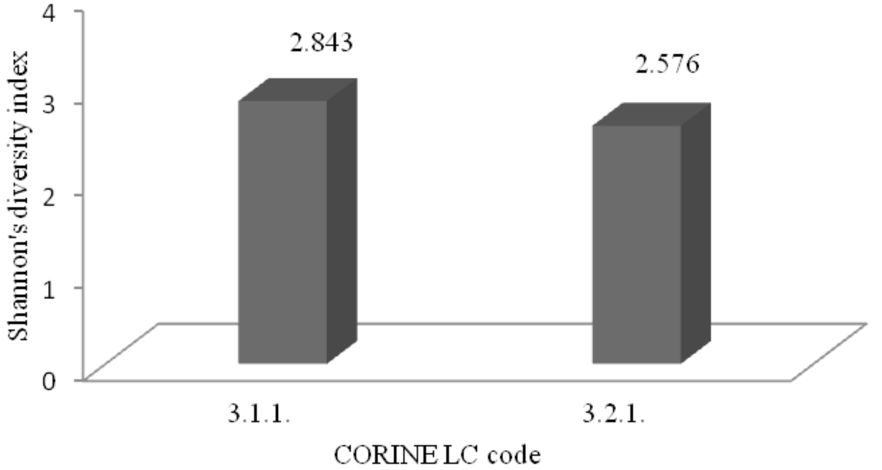

Figure 1. Values of Shannon's diversity index calculated at the class level

In general, values of Shannon's diversity index are in the range from 1.5 to 3.5 in most environmental studies, and the index rarely exceeds 4 (Magurran, 2004). The value of the index increases with the increase in the number of species or equity of the community. The more species and individuals present in the community, the community is more diverse and contains more information (Magurran, 2004). Shannon's diversity index is suitable for comparison because it is relatively independent of the sample size. Likewise, it provides further information that merely a comparison of the number of species found in localities or habitat types could be considered as a good indicator of the numerical structure of communities.

In this research, we calculated annual and usual values of diversity index for all localities. By considering the narrow range of the index value for several localities, it is hard to discuss the real diversity of species. For example, Okanj Bara has index 2.146 and Slano Kopovo 2.133. In other words, the range of the index value in the classes 3.1.1 and 3.2.1 is between 1.8 and 2.9, and it is difficult to conclude whether they differ significantly.

Among forest localities, Fruška Gora Mountain has the highest diversity index (2.922), the largest number of found species (45), and the highest number of individuals within the found species (250). The next locality on the list is Vršac Mountains I with an index value 2.751 and 29 found species, but with a lower number of individuals (95). Fruška Gora Mountain and Vršac Mountains belong to the island mountain type (Hrnjak et al., 2014), but because of the more diverse habitat types and the more massive area it covers, it was considered that Fruška Gora has more suitable conditions for hoverflies. According to these results, the significance of these two mountains in Vojvodina is clearly emphasized, and they should be considered as two essential hoverfly reservoirs in this area. Low values in number of individuals of found species were detected in locality Gornje Podunavlje. The result is surprising, given the diversity of the microhabitats (Basarin et al., 2014), the presence of grassland fragments, forests, floodplain, and wetlands. On the other hand, near Gornje Podunavlje planted poplars are located, and intensive forestry practice is noticeable, which lead us to conclude that the anthropogenic impact in this area is present. Such circumstances to a certain extent justify for the low values of the species found and the number of collected individuals.

Locality Vršac Mountains II is distinguished from other localities in the class Natural grassland by the high value of the diversity index (2.506). Considering the geographical context of this site, the explanation of this value can be the similar to the one for Vršac Mountains I. Conversely, Selevenjske Pustare as well Gornje Podunavlje with relatively high values of indices, but low numbers of found species and individuals within them, indicate the need for further research.

Regarding the diversity index for entire land cover classes in Figure 1, it can be seen that there are slightly more stable populations in forest habitats. This result points to an already mentioned, crucial fact: hoverflies prefer preserved, the original type of habitat (Nedeljković et al., 2009, Markov et al., 2016), so they are expected to have a high value of diversity in natural habitat (3.1.1 and 3.2.1)

Table 3. Jaccard similarity coefficient in Forest and Grassland land cover classes in Vojvodina. Abbreviations: FG – Fruška Gora Mountain, VM I – Vršac Mountains I, SUP – Subotica Sands, DS – Deliblato Sands, OB – Okanj Bara, PVD – Pašnjaci Velike Droplje, SK – Slano Kopovo, SEP – Selevenjske Pustare, GP – Gornje Podunavlje, and VM II – Vršac Mountains II.

	FGM	VM I	SUS	DS	OB	PVD	SK	SEP	GP	VM II
FGM	100	27	14	15	14	16	21	10	15	25
VM I	27	100	11	15	21	20	26	12	12	32
SUS	14	11	100	54	28	26	30	25	36	24
DS	15	15	54	100	38	35	37	28	41	28
OB	14	21	28	38	100	31	40	39	26	33
PVD	16	20	26	35	31	100	42	28	24	26
SK	21	26	30	37	40	42	100	30	23	30
SEP	10	12	25	28	39	28	30	100	31	26
GP	15	12	36	41	26	24	23	31	100	27
VM II	25	32	24	28	33	26	30	26	27	100

In order to express the similarity of the fauna in the research localities, we used the Jaccard coefficient, which is shown in Table 3. When it comes to forest habitats, we found that the most similar faunas are those of Deliblato and Subotica Sands (54%), and the high similarity was also recorded between Gornje Podunavlje and Deliblato Sands (41%), and Gornje Podunavlje and Subotica Sands (36%). A high percentage of fauna similarity was calculated for specific localities in class 3.2.1, thus the most similar are faunas of Pašnjaci Velike Droplje and Slano Kopovo (42%). We found slightly lower similarity between faunas of Okanj Bara and Slano Kopovo (40%), as well as between Okanj Bara and Selevenjske Pustare (39%). Most of the other indices within these two CORINE classes had a similarity between 20 and 30%. The lowest similarity was shown between Fruška Gora Mountain and Selevenjske Pustare (10%), and Vršac Mountains I and Subotica Sands (11%).

The most similar fauna between Deliblato and Subotica Sands is a logical result due to the similarity of numerous ecological factors in these sandy areas. Relatively high Jaccard coefficients in Natural grasslands were expected as well, considering similar environmental conditions in these localities. The obtained results indicate a high similarity of fauna in Vršac Mountains I and Vršac Mountains II. We assume that this result comes from the geographical proximity of these two sites and their belonging to Vršac Mountains.

CONCLUSION

This paper provides a faunistic analysis of hoverflies (Diptera: Syrphidae) in two land cover types, Broad-leaved forest and Natural grassland, according to CORINE land cover classification in the Autonomous Province of Vojvodina. Based on a recent one-year study, Shannon's diversity and equitability index and Jaccard similarity coefficient were calculated.

Shannon's diversity index for the forest is higher (2.843), as well as a number of recorded species (64). A slightly lower index of diversity was calculated for grasslands (2.576), likewise the number of registered species (43), but the number of collected specimens is higher (851 compared to 647 specimens in forest localities). Regarding the localities within the class 3.1.1, the highest index of diversity was calculated in Fruška Gora Mountain (2.922), while in class 3.2.1 it was the case with the locality Vršac Mountains II (2.506). According to Jaccard coefficient, most similar are faunas of Deliblato and Subotica Sands (54%), while most of the other similarity indices have a value between 20 and 30%.

Based on the conducted analyses, a rough picture of the hoverfly diversity in Broad-leaved forest and Natural grassland in Vojvodina is created, giving the basis for further research both in these and other types of habitats, thus offering the possibility to create a more precise picture and a more complex survey of Syrphidae in this area.

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ПРОЦЕНА ДИВЕРЗИТЕТА ОСОЛИКИХ МУВА НА СТЕПСКИМ И ШУМСКИМ СТАНИШТИМА У ВОЈВОДИНИ БАЗИРАН НА СКОРАШЊЕМ МОНИТОРИНГУ

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РЕЗИМЕ: Процес полинације неопходан је у циљу опстанка бројних цветница у природним екосистемима, као и многих пољопривредних култура. Осолике муве (Diptera: Syrphidae) имају значајну улогу у полинацији. Услед све интензивнијег деловања притисака спољне средине, диверзитет полинатора као и екосистемска услуга полинације имају опадајући тренд. Фаунистичка истраживања и процене биодиверзитета су неопходни како би се заштитила поменута група организама.

Циљ овог рада је анализа диверзитета сирфида на два типа земљишног покривача по CORINE класификацији (Листопадне шуме и Природни травњаци) на основу једногодишњег истраживања. У ту сврху рачунати су *Shannon*-ов индекс диверзитета, *Shannon*-ов индекс равномерности и *Jaccard*-ов коефицијент сличности. Вредности ових индексâ и коефицијената указали су који делови Војводине и на ком типу станишта могу да се сматрају резервоарима сирфида.

КЉУЧНЕ РЕЧИ: сирфиде, полинатори, индекс диверзитета, земљишни покривач, Војводина, шуме, пашњаци

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INTEGRATIVE TAXONOMY OF *Merodon caerulescens* COMPLEX (Diptera: Syrphidae) – EVIDENCE OF CRYPTIC SPECIATION

ABSTRACT: In this research, we applied integrative taxonomy approach in order to delimit species of *Merodon caerulescens* species complex. Molecular analyses confirmed COI sequence divergence between the Rhodes and Crete populations. Additionally, ITS2 sequences show certain differences which should be additionally tested. 28S rRNA gene sequences once again proved to be too conserved for closely related species delimitation. Geometric morphometry results indicate differences in wings shape between males and females of the two islands populations. Additionally, subtle differences between the two populations in the body coverage and colouration of hairs are also observed. Thus, based on the all presented evidence we concluded that taxon *Merodon caerulescens* is a complex of two species, *M. caerulescens* (Rhodes) and *M. atricapillatus* sp. n. (Crete).

KEYWORDS: 28S rRNA, COI, ITS2, geometric morphometrics, island speciation, *Merodon caerulescens* complex

INTRODUCTION

Hoverflies comprise a high number of described species and they have a worldwide distribution. The species inhabit very diverse habitats from the sea level up to 3500 metres (Vujić et al., 2002; Barkalov and Ståhls, in preparation). Beside morphologically clearly defined species, Syrphidae family comprise morphologically very similar or almost identical species. So far, the largest number of cryptic species of syrphids has been recorded in the subfamily Eristalinae (Marcos-García et al., 2011; Popović et al., 2015; Ačanski et al., 2016;

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Šašić et al., 2016; Radenković et al., 2018), but also occur in the subfamily Syrphinae (Nedeljković et al., 2013, 2015; Vujić et al., 2013) and Microdontinae (Schönrogge et al., 2002).

An important improvement in the taxonomy of Syrphidae was achieved due to the application of molecular markers. The sequences of 3' and 5' regions of cytochrome c oxidase subunit I (COI) gene are mostly used and many researchers combine them with sequential data of nuclear molecular markers such as nuclear genes for ribosomal RNA (rRNA) and the internal transcribed spacer 2 region (ITS2) (e.g. Pérez-Bañón et al., 2003; Massetti, 2006; Mengual et al., 2006, 2008a, b, 2015; Haarto and Ståhls, 2014). Further, the synergy of morphology, molecular data and geometric morphometry has made a significant contribution to the taxonomy of hoverflies (Nedeljković et al., 2013, 2015; Vujić et al., 2013; Aćanski et al., 2016; Šašić et al., 2016; Radenković et al., 2018).

Merodon aureus species group comprise 30 species distributed in Mediterranean region and mountain areas of southern Europe (Marcos-García et al., 2007; Vujić et al., 2007; Milankov et al., 2008; Radenković et al., 2011; Speight, 2014; Šašić et al., 2016; Veselić et al., 2017; Radenković et al., 2018). According to Šašić et al. (2016), the group comprise five subgroups (*M. aureus*, *M. dobrogensis*, *M. bessarabicus*, *M. chalybeus* and *M. cinereus* subgroup) and the two, independent species, *M. unguicornis* and *M. caerulescens*. The taxonomy of the *Merodon aureus* species group has long been considered a major challenge for taxonomists, taking into account the absence of consistent morphological differences between taxa. The structure of male genitalia is very simple and similar in all representatives of the group (Radenković et al., 2011, 2018; Šašić et al., 2016; Veselić et al., 2017), thus, it is not possible to determine species with certainty. However, recent studies indicate a high diversity of species of the *Merodon aureus* group due to the presence of cryptic species and/or species complexes (Šašić et al., 2016; Veselić et al., 2017; Radenković et al., 2018). In Šašić et al. (2016) and Radenković et al. (2018) the application of molecular methods together with geometric morphometry contributed to the description of two new species of *M. atratus* species complex and six new species of *M. luteomaculatus* species complex.

In this research, we focus on *Merodon caerulescens*, which is a species complex within *M. aureus* species group. The aim of this research is to explore the diversity of *Merodon caerulescens* species complex and to perform species delimitation in the spirit of integrative taxonomy by applying COI, ITS2, 28S rRNA gene sequences analyses and geometric morphometry of wings, in addition to morphological description.

MATERIAL AND METHODS

Morphological studies

The present study is based on examination of all available material (459 specimens) of the *Merodon caerulescens* complex found in collections, both published and unpublished, deposited in the museums and universities collections listed below. The following acronyms of museums and entomological collections are used in the text:

FSUNS – Faculty of Sciences, Department of Biology and Ecology, University of Novi Sad, Serbia

RMNH – Naturalis, National Museum of Natural History, Leiden, Netherlands

MZH – Finnish Museum of Natural History, Helsinki, Finland

NHMW – Museum of Natural History, Wien, Austria

ZHMB – Zoological Museum of Humboldt University, Berlin, Germany

ZMUC – Zoological Museum, Natural History Museum of Denmark, University of Copenhagen, Copenhagen, Denmark

DNA extraction

For molecular analyses, the fresh adult specimens were collected using an entomological net while they were feeding on flowers or resting on leaves of terrestrial vegetation. The specimens data are presented in Table 1.

The genomic DNA was extracted using SDS extraction protocol described by Chen et al. (2010), with slight changes to the protocol.

We amplified 3' and 5'-regions of COI gene, D2-3 region of the 28S rRNA gene and ITS2 region. For 3'COI we used C1-J-2183 (also known as Jerry) and TL2-N-3014 (also known as Pat) primer pair (Simon et al., 1994), for 5'COI LCO1490 and HCO2198 primer pair (Folmer et al., 1994), for 28S rRNA gene region F2 and 3DR primer pair (Belshaw et al., 2001) and for ITS2 we used ITS2A and ITS2B primer pair (Beebe & Saul, 1995). The PCR reactions were performed as described in Radenković et al. (2018). PCR products were enzymatically purified using exonuclease I and shrimp alkaline phosphatase enzymes and sequenced in forward direction using the BigDye Terminator v.3.1 cycle sequencing kit (Applied Biosystems, Foster City, Ca, USA) on ABI 3730*xl* DNA Analyzer (Applied Biosystems, Foster City, Ca, USA) at the Sequencing Service Laboratory of the Finnish Institute for Molecular Medicine (FIMM), Helsinki, Finland.

Sequence analyses

Sequences were aligned using the Clustal W algorithm as implemented in BioEdit 7.0.9.0 (Hall, 1999) with final adjustments by eye. The sequence diversity parameters, COI haplotypes and genotypes of the 28S sequences were calculated using DnaSP 5 software (Librado and Rozas, 2009), while the Median-joining (MJ) haplotype network (Bandelt et al., 1999) was constructed using PopART (http://popart.otago.ac.nz). We calculated average uncorrected sequence divergence value (p distance) and the best substitution model for sequence matrix (Tamura-3-parameter model, T92) using the MEGA 6 software

(Tamura et al., 2013). The software ABGD (Automatic Barcode Gap Discovery) (Puillandre et al., 2012) was used for COI sequences partitioning into hypothetical species based on distance calculation (uncorrected p distance, T92 distances and Kimura-2-parameter, K80 distances) and by applying default parameters (Pmin=0.001, Pmax=0.1, Steps =10, X (relative gap width) =1.5, Nb bins =20).

The parsimony analyses (MP) and phylogenetic tree construction were performed using NONA software (Goloboff, 1999) implemented in Winclada ASADO (Nixon, 2008) using the heuristic search algorithm (settings: mult*1000, hold/100, max trees 100000, TBR option enabled). Statistical support for the topology of the constructed phylogenetic trees was evaluated using the non-parametric bootstrap method with 1000 replicates calculated using Winclada. The Maximum Likelihood (ML) phylogenetic tree was constructed using RAxML 8.2.8 (Stamatakis, 2014) by applying the general time-reversible (GTR) evolutionary model with a gamma distribution (Rodriguez et al., 1990), while statistical support for the clades was assessed using rapid bootstrap method with 1000 replicates. The trees were rooted on *Merodon albifasciatus* Macquart, 1842 (accession numbers for 3'COI and 5'COI: KU365486, KU365422).

Geometric morphometric analysis

Geometric morphometric analysis of wing shape was conducted on 36 specimens of the *M. caerulescens* complex (Table 1). The right wing of each specimen was used in the geometric morphometric analysis. Wings are archived and labelled with a unique code in the FSUNS collection, together with other data relevant to the specimens. Eleven homologous landmarks at vein intersections or terminations, –that could be reliably identified– were selected using TpsDig v2.05 (Rohlf, 2006).

Generalised least squares Procrustes superimposition was performed on the raw coordinates to minimise non-shape variations in location, scale and orientation of wings, and to superimpose the wings in a common coordinate system (Rohlf and Slice, 1990; Zelditch *et al*., 2004) by employing MorphoJ v2.0 (Klingenberg, 2011). Principal component analysis (PCA) was carried out on the Procrustes shape variables to reduce the dimensionality of the dataset. Then, the stepwise discriminant analysis was employed to extract the subset of principal components (PCs) that are describing the highest overall classification percentage.

To explore wing shape variation among the taxa canonical variate (CVA) and discriminant function (DA) analyses were used. Superimposed outline drawings produced by MorphoJ software were used to visualize differences in mean wing shape among species pairs. All statistical analyses were performed in Statistica for Windows (Dell Statistica, 2015).

Table 1. The list of *Merodon* specimens used for molecular and geometric morphometrics analyses.

Taxon	Collecting locality	Sex	DNA ID	GenBank accession number COI	GenBank accession number 28S	GenBank accession number ITS2	Wing ID
M. ambiguus Bradescu, 1986	RS, Đerdap	♂	AU56	MH133974			
M. aureus Fabricius, 1805	IT, Ballino	♂	AU163	MH133978			
M. chalybeus Wiedemann, 1822	ES, Algeciras	♀	AU752	MH133976			
M. cinereus (Fabricius, 1794)	AT, Alpes	♂	AU360	MH133993			
M. dobrogensis Bradescu, 1982	ROU, Mangalia	♂	AU415	MH133977			
M. sapphous Vujić, Pérez--Bañon et Radenković, 2007	TU, Isparta	♂	AU427	MH133975			
M. unicolor Strobl, 1909	ES, Sierra Nevada	♀	AU320	MH133979			
M. atricapillatus sp. n.	GR, Crete	♀	AU175	MH133987	MH137246		WM2232
		♀	AU176	MH133988	MH137247	MH137238	WM2233
		♀	AU178	MH133990	MH137249		WM2235
		♀					WM2237
		♀	AU181	MH133992	MH137251		WM2238
		♀					WM2228
		♀					WM2229
		♀					WM2230
		♂	AU177		MH137248		WM2234
		♂	AU179	MH133991	MH137250		WM2236
		♂					WM2231
M. caerulescens Loew, 1869	GR, Rhodes	♂	AU106	MH133984	MH137243		
		♀					WM2218
		♀					WM2224
		♂	AU102	MH133980	MH137239		WM2219
		♂					WM2217
		♀	AU107	MH133985	MH137244	MH137237	WM2226
		♀	AU108	MH133986	MH137245		WM2223
		♀					WM2220
		♀					WM2221
		♀					WM2222
		♀	AU103	MH133981	MH137240		WM2210
		♀	AU104	MH133982	MH137241		WM2211
		♀					WM2203
		♀					WM2205
		♀					WM2206
		♀					WM2207
		♂	AU105	MH133983	MH137242		WM2202
		♂					WM2204
		♂					WM2208
		♂					WM2209
		♀					WM2225
		♀					WM2214
		♀					WM2215
		♀					WM2216
		♂					WM2212
		♂					WM2213

RESULTS AND DISCUSSION

Molecular evidence

The COI sequence analyses indicate that *Merodon caerulescens* is not a single species, but the complex of two cryptic and genetically divergent species. A set of 13 combined sequences of the 3' and 5' end of the COI gene was analyzed. The length of the aligned sequences is 1400bp. In phylogenetic tree construction, we additionally included representatives from different subgroups of *Merodon aureus* group, one sequence per species (see Table1). The species divergence is shown by MP and ML trees construction where the two populations (Rhodes and Crete) of *M. caerulescens* form two reciprocally monophyletic clades with medium to high bootstrap nodal support values (88/84 and 94/97) (Figure 1). Thus, we consider the Rhodes population as true *M. caerulescens* and population from Crete as a new species *M. atricapillatus* sp. n.

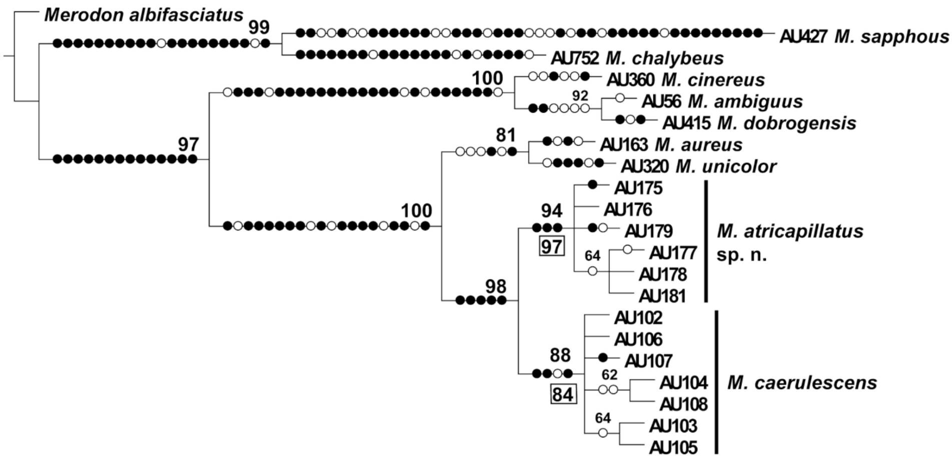

Figure 1. COI Maximum parsimony tree (333 steps, consistency index: 81, retention index: 84). The bootstrap values ≥50 are indicated near nodes, values from Maximum Likelihood tree are indicated in squares. Filled circles represent non-homoplasious characters, open circles are homoplasious characters.

Out of 1400 positions of the analyzed COI sequences, 16 are variable, while 11 positions are parsimony informative. The total number of haplotypes is 9 (Figure 2). The haplotype diversity (Hd) of the complex is 0.949, the average number of differences (K) is 5.769, and the nucleotide diversity (Pi) is 0.00412. The haplotypes of the two species form two haplotype groups on MJ network which are separated by seven mutational steps (Figure 2). The average uncorrected p distance value between the species (0.7%) is in the range of values recorded for cryptic, closely related hoverfly species (e. g. Marcos-García et al., 2011; Vujić et al., 2013; Popović et al., 2015; Nedeljković et al., 2015; Šašić et al., 2016; Radenković et al., 2018).

	COI haplotypes (DNA ID)	28S genotypes (DNA ID)
M. caerulescens	Hap1 (AU102, AU106), Hap2 (AU103, AU105), Hap 3 (AU104, AU108), Hap 4 (AU107)	I (AU102, AU103, AU105, AU106, AU108) II (AU104, AU107)
M. atricapillatus sp. n.	Hap5 (AU175), Hap6 (AU176), Hap7 (AU177), Hap8 (AU178, AU181), Hap9 (AU179)	II (AU175, AU176, AU177, AU178, AU179, AU181)

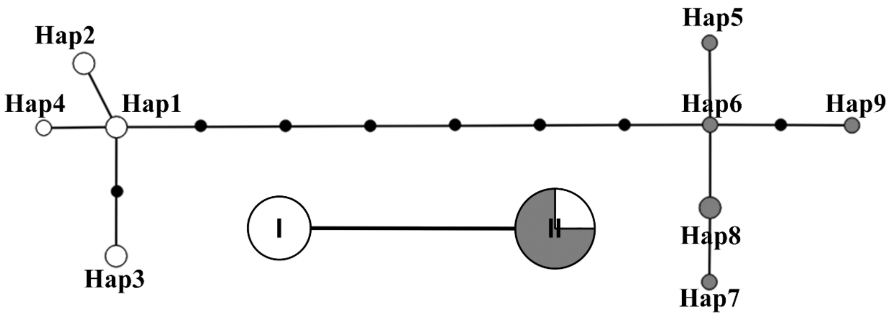

Figure 2. Median-joining network of COI haplotypes and 28S rRNA genotypes of *Merodon caerulescens* complex.

In order to define barcoding gap between the two species, we applied ABGD analysis of COI sequences which resulted in sequences partitioning into two groups which correspond to two *M. caerulescens* complex species (barcoding gap detected at 0.001 distance value). The same results were obtained by analyzing all three distance types (uncorrected p, T92, and K80).

The genetic divergence which is shown by COI sequence analyses is supported based on the ITS2 sequences. Assuming technical constraints in ITS2 amplification for *Merodon* specimens, ITS2 sequences where produced for only one specimen per species (AU107 and AU176). The sequences differ in gap region of 6 bp in *M. atricapillatus* sp. n. AU176 sequence comparing to *M. caerulescens* AU107 sequence (Figure 3). Namely, the AU107 sequence contains "AAAACG" motif in two copies, while AU176 contains only one copy. However, considering that only one specimen per species was tested we take this result with caution. We suspect that this difference might be important for species delimitation, although it is also possible that length variation in ITS2 sequences is an intraspecific phenomenon. For example, Mengual et al. (2006) found variability in a dinucleotide repeat region, $AT_{(1-5)}$ between Spanish *M. albifrons* specimens and interpreted it as intraspecific.

Figure 3. The comparisons of ITS2 sequences of *Merodon caerulescens* and *M. atricapillatus*.

In contrast to the variability of COI and ITS2 sequences, the 28S rRNA gene sequences are typically more conservative and most often do not show a significant divergence between closely related species (Mengual et al., 2006; Patwardhan et al., 2014) which has also been shown in the *M. caerulescens* complex. A total of 13 sequences of the 28S rRNA gene of *M. caerulescens* complex were analyzed. The length of the aligned sequences is 585bp. Only 2 genotypes with a difference in one base position are defined (Gd = 0.5128). The genotype I is unique for *M. caerulescens*, while the genotype II is shared between the two species from *M. caerulescens* complex (Figure 2).

Geometric morphometric evidence

Molecular results were supported by high significant wing shape differentiation within *Merodon caerulescens* species complex. Principal component analysis (PCA) carried out on the Procrustes shape variables produced 18 PCs from which 16 describe the highest overall classification percentage of investigated taxa, and are used in further analyses. DA showed that *M. caerulescens* and *M. atricapillatus* sp. n differ highly significantly in wing shape (males: $F_{16,29} = 4.099$; $p < 0.01$; females $F_{16,29} = 5.7527$; $p < 0.01$). All specimens were correctly classified to *a priori* defined groups, which additionally strengthens the interspecific discrimination. Canonical variates analysis produced three highly significant axes (CV1: Wilks' Lambda = 0.00805; $\chi 2 = 173.5858$; $p < 0.01$; CV2: Wilks' Lambda = 0.0987; $\chi 2 = 83.3734$; $p < 0.01$; CV3: Wilks' Lambda = 0.3987; $\chi 2 = 33.1061$; $p < 0.01$). The first canonical axis depicts the sexual dimorphism, while CV2 clearly separated *M. caerulescens* from *M. atricapillatus* sp. n. (Figure 4A). The attractiveness of the insect's wings in integrative taxonomic studies is primarily connected to the fact that wing shape is controlled by genes (Moraes et al., 2004; Mezey & Houle, 2005; Dworkin & Gibson, 2006; Yeaman et al., 2010), which makes them important character for separating species. Over the past few years the geometric morphometric analysis of wing shape has proved to be significant in the field of new hoverfly species discovery (Nedeljković et al., 2013, 2015; Vujić et al., 2013; Ačanski et al., 2016; Šašić et al., 2016; Radenković et al., 2018). Moreover, in all of the above-mentioned studies, geometric morphometrics results were well supported by molecular results.

The superimposed outline drawings depict the differences in mean wing shape among each species which are the most obvious among males, with longer wings of *M. caerulescens* (Figure 4B). We can assume that clearer disparities of male wing shapes compared to female can be related to flight ability and, moreover, male species specific courtship song (Cowling and Burnet, 1981; Stubbs and Falk, 1983; Sacchi and Hardersen, 2013; Menezes et al., 2013; Outomuro et al., 2013). Generally speaking, the flies use their wings for producing courtship songs which have an important role in sexual selection and species recognition (Saarikettu et al., 2005; Routtu et al., 2007).

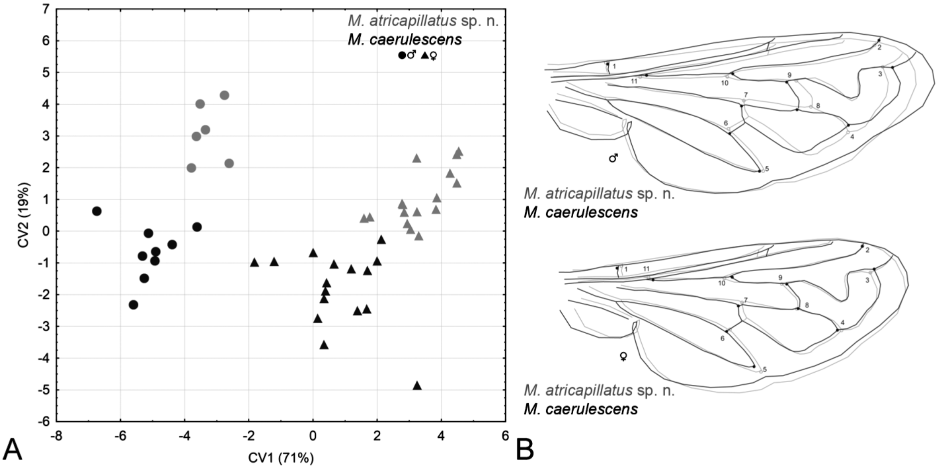

Figure 4. Shape variability among species of the *M. caerulescens* complex. A) Scatter plot of individual scores of CV1 and CV2. B) Superimposed outline drawings showing differences in average wing shape for each species pair. Differences between the species were exaggerated five-fold to make them more visible.

Morphological description

The species of the *Merodon aureus* group are small-sized (8–13 mm) with a short, rounded abdomen, a distinct spike on the hind trochanter in males, and a characteristic structure of the male genitalia: posterior surstyle lobe with parallel margins and rounded apex and a narrow, elongated, sickle-shaped hypandrium without lateral sclerite of aedeagus (see in Šašić et al., 2016: Figure 1). The *Merodon caerulescens* (sensu Šašić et al., 2016) is taxon with strong blue body lustre, mesonotum at least near wing base with the black pile, tibiae and tarsi predominantly black, tergites uniformly dark, tergites III and IV predominantly covered with the black pile.

Merodon caerulescens Loew, 1869

Type material. LECTOTYPE. Greece: 1♂, Rhodes, leg. Erber, (ZHMB). PARALECTOTYPES. Greece: 2♂♂, Rhodes, leg. Erber, (ZHMB).

Additional material. Greece, Rhodes: 2♂♂, 2♀♀, (NHMW). 1♂, 1♀, leg. Bgst. (NHMW). 1♂, leg. Erber, (det. P.H.v Doesburg, 1964: *Lampetia caerulescens*) (RMNH). Kattavia: 05.iv.1971, 3♀♀, (RMNH), 6♂♂, 1♀, leg. V.S.vd Goot (RMNH), 1♀, leg. V.S.vd Goot, J.W.A. Lucas (RMNH); 09.iv.1971, 5♀♀, (RMNH), 1♂, leg. V.S.vd Goot (RMNH). 1♀, Laerma, 08.v.1987, leg. V.S.vd Goot (RMNH). 1♂, Lahania, 08.iv.1971, leg. V.S.vd Goot (RMNH). Lindos, 04.iv.1971: 16♀♀, (RMNH), 1♀, leg. C. Claussen, (RMNH), 2♂♂, 1♀, leg. J.A.W. Lucas, V.S.vd Goot (♀ZMC, ♂RMNH), 25♂♂, 43♀♀, leg. V.S.vd Goot, (RMNH), 1♂, leg. V.S.vd Goot (NHMW); 06.iv.1971: 1♂, 1♀, (RMNH), 14♂♂, 64♀♀, leg. V.S.vd Goot (RMNH), 1♀, leg. V.S.vd Goot (NHMW); 08.iv.1971:

15♂♂, 20♀♀, leg. V.S.vd Goot (RMNH), 1♂, leg. J.A.W. Lucas, V.S.vd Goot (ZMC); 5♂♂, 7♀♀, 09.iv.1971, leg. V.S.vd Goot (RMNH); 2♂♂, 11.iv.1971, leg. V.S.vd Goot (RMNH); 2♀♀, 13.iv.1968, (ZMC); 1♀, 15.iv.1970, leg. V.S.vd Goot (RMNH); 2♀♀, 27.iii.1970, leg. V.S.vd Goot (RMNH); 1♀, 30.iii.1970, leg. V.S.vd Goot (RMNH).Loutanis river, Afantou – Archangelos: 1♀, 01.iv.2012, leg. A. Vujić, L. Likov (FSUNS); 2♂♂, 1♀, 15.iv.2012, leg. A. Vujić, L. Likov (FSUNS). 4♂♂, 6♀♀, Near Butterfly Valley, 17.iv.2012, leg. A. Vujić, L. Likov (FSUNS). 5♀♀, nr. Archipoli, 10.iv.2012, leg. A. Vujić, L. Likov (FSUNS). 1♀, nr. Kolympia, 08.iv.2012, leg. A. Vujić, L. Likov (FSUNS). 1♂, 2♀♀, Petaloudes, 12.iv.1971, leg. V.S.vd Goot (RMNH). Profitis, Ilias: 1♂, 23.iv.1970, leg. v. Ooststroom, (RMNH); 2♂♂, 3♀♀, 16.iv.2012, leg. A. Vujić, L. Likov (FSUNS). 1♂, Agios Nicholas Fountoukli, 11.iv.2004, leg. C. Lange, J. Ziegler (ZHMB). 1♂, Emponas, 15.iv.2004, leg. C. Lange, J. Ziegler (ZHMB). 1♂, Mesanagros, 08.iv.2004, leg. C. Lange, J. Ziegler (ZHMB).

Range and preferred habitat. Rhodes island (Greece); open, grassy areas in pine forest or Mediterranean scrub.

Merodon atricapillatus Šašić, Ačanski et Vujić sp. n.

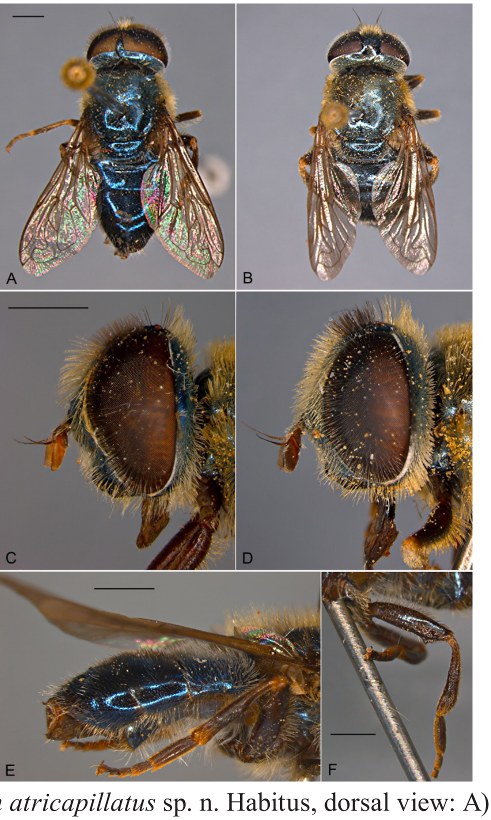

Figure 5. *Merodon atricapillatus* sp. n. Habitus, dorsal view: A) male, B) female. Head, lateral view: C) male, D) female. E) Abdomen, male, lateral view. F) Hind leg, lateral view. Scale=1 mm.

Type material. HOLOTYPE: Greece: 1♂, Crete, Lasithi, Sissi, 23.iv.2014, leg. A. Vujić (FSUNS). PARATYPE: (FSUNS). Greece, Crete: Heraklion, 2 km S Chersonisos: 1♂, 19.iv.1984 (FSUNS), 1♀, 16.x.1987, 3♂♂, 05.iv.1985. 2♂♂, 8♀♀, Lasithi, Sissi, 23.iv.2014, leg. A. Vujić (FSUNS). Sisi near Malia: 2♀♀, 03.iv.1983, leg. C. Claussen (RMNH), 2♂♂, 08.iv.1983, leg. C. Claussen (RMNH); 1♀, Stalis, 21.iv.1988, leg. J. Mahler, E. Torp (ZMC).

Additional material. Greece, Crete: Heraclion: 2 km S Chersonisos: 29♂♂, 7♀♀, 03.iv.1986, 4♂♂, 14♀♀, 16-19.iv.1984, 10♂♂, 5♀♀, 18.iv.1987, 9♂♂, 2♀♀, 27.iii.1986: 2♀♀, 2 km W Limenas Chersonisos, 27.iv.1984; Chersonisos: 20♂♂, 05.iv.1985, (1♂ leg. C. Claussen, MZH), 1♂, 9♀♀, 11.iv.1985, (2♀♀ leg. C. Claussen, MZH); Limenas Chersonisos: 2♀, 30.iii.1986, 2♀♀, 20.iv.1987; 2♂♂, Potamies, 24-26.iv.1984; 3♂♂, 1♀, 3 km NW Potamies, 07.iv.1985. Lasithi: 18♂♂, 7♀♀, Sissi, 3-8.iv.1983; Sisi near Malia, 1♀, 03.iv.1983, leg. J.A.W. Lucas (RMNH), 1♀, 08.iv.1983, leg. J.A.W. Lucas (RMNH), 2♂♂, 08.iv.1983, leg. J.A.W. Lucas (RMNH).

Diagnosis. Species with bluish body reflection; mesoscutum with black pile on posterior half, at least near wing basis; hind femur with whitish pile, except apical fourth with black ones (in *M. caerulescens* more black pilosity), tergite II covered with pale pile in male (in *M. caerulescens* posterior margin with black pilosity). Similar to *M. caerulescens*, from which it differs by molecular data, wing morphometry and distribution.

Body size. Length: body = 9 mm; wing = 8 mm (n = 15).

Description. MALE (Figure 5ACEF). Head (Figure 5C). Antenna orange-brown; basoflagellomere reddish, 1.3–1.5 times longer than pedicel, dorsal margin concave between the arista and the apex, apex acute; arista yellow basally, as long as pedicel and basoflagellomere together. Face and frons shiny black with bluish lustre, covered with long whitish pile. Oral margin bare, with blue lustre. Vertical triangle isosceles, shiny black, covered with long black pile. Eye contiguity about 12 ommatidia long. Ocellar triangle isosceles. Eye pile long, dark in the upper third. Occiput shiny, bluish, except for along eye margin with a narrow stripe of white microtrichia; covered with whitish pile. Thorax. Mesonotum bluish with strong metallic reflections, predominantly covered with long, dense, erect pale pile, except black pile present on the posterior half of mesoscutum, at least near wing basis; mesoscutum with three very weak longitudinal stripes of dark brown microtrichia in anterior half. Posterior anepisternum, anepimeron and dorsal part of katepisternum with long whitish-yellow pile. Wing light brownish, with yellow veins. Dorsal and ventral calypters brownish. Haltere with light brown pedicel and dark brown capitulum. Femora black with pale apex; pilosity of fore femur predominately pale, mid femora with mixed black and pale pile; hind femur predominantly covered with yellow pile except few black ones in the apical 1/4 (Figure 5F). Tibiae predominantly dark except yellowish basal third and top; tarsi dark brown dorsally and yellow brown ventrally; covered in yellow pile with some intermixed black ones (hind tarsi dorsally can have more black pile). Hind trochanter with inner spike ending in two angular points (one corner more protruded). Abdomen (Figure 5E). Oval, slightly longer than mesonotum; black with blue metallic reflections. Tergites without microtrichose bands. Tergite II completely covered with yellow pile; tergites III and IV predominately covered with black pile except lateral sides. Sternites shiny black, covered with long light yellow pile, except for a few black pile on sternite IV. Genitalia. Similar to all other species of the *aureus* group.

FEMALE (Figure 5BD). Similar to the male except for normal sexual dimorphism and in the following characteristics: ocellar triangle equilateral. Vertex with black pile. Mesoscutum with less black pilosity, in some specimens completely pale. Hind trochanter without a spike. Pilosity on abdomen shorter than in male; tergites II – IV with more black pile in female than in male.

Etymology. The word *atricapillatus* refers to the important diagnostic character of the species. The Latin adjective ater means black, and refers to the colour of long pile (Latin noun capillatus means long hairs) on mesonotum of this species.

Range and preferred habitat. Crete island (Greece); Mediterranean scrub along coastal zone.

CONCLUSION

Based on the presented evidence it is possible to distinguish two species within *Merodon caerulescens* species complex: *M. caerulescens* and *M. atricapillatus* sp. n. The two species are endemic to the Aegean islands Rhodes and Crete. The speciation in *M. caerulescens* complex is probably a consequence of allopatric processes which conditioned the reduction of gene flow between the two island populations. Molecular evidence based on COI sequences and geometric morphometric evidence both support the two-species concept. COI divergence (0.7%) indicate recent speciation. 28S rRNA gene sequences are not of much importance, considering a low level of variability, while the ITS2 sequences variability remains to be additionally tested.

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ИНТЕГРАТИВНА ТАКСОНОМИЈА *Merodon caerulescens* КОМПЛЕКСА (Diptera: Syrphidae) – ДОКАЗИ О КРИПТИЧНОЈ СПЕЦИЈАЦИЈИ

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РЕЗИМЕ: У овом истраживању примењен је приступ интегративне таксономије у циљу раздвајања врста *Merodon caerulescens* комплекса. Молекуларне анализе потврђују дивергенцију COI секвенци између популација са грчких острва Родос и Крит. Показане су и разлике у ITS2 секвенцама које је потребно додатно тестирати. Секвенце 28S рРНК гена су се још једном показале као сувише конзервационе за раздвајање блиско сродних врста. Резултати геометријске морфометрије указали су на разлике у облику крила између мужјака и женки две анализиране острвске популације. Додатно, суптилне разлике између поменутих популација видљиве су у покривености тела длакама и њиховој обојености. На основу свих изнетих резултата могуће је закључити да је *Merodon caerulescens* комплекс две врсте: *M. caerulescens* (Родос) и *M. atricapillatus* sp. n. (Крит).

КЉУЧНЕ РЕЧИ: 28S, COI, ITS2, геометријска морфометрија, острвска специјација, *Merodon caerulescens* комплекс

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TAXONOMIC STUDY OF THE GENUS *Paragus* Latreille, 1804 (Diptera: Syrphidae) IN THE COLLECTIONS OF THE DEPARTMENT OF BIOLOGY AND ECOLOGY AT THE UNIVERSITY OF NOVI SAD (FSUNS), SERBIA

ABSTRACT: In this study, we investigated 3,086 adult specimens (974 females and 2,112 males) of the genus *Paragus* collected in the period 1950–2017 and deposited in the collections of the Department of Biology and Ecology, University of Novi Sad (FSUNS). All four subgenera of *Paragus* are present in the FSUNS collection. We provide data on 59 species, most of which belong to the subgenus *Paragus* (37), followed by *Pandasyopthalmus* (16), *Serratoparagus* (5) and *Afroparagus* (1). We conclude that some taxa of this genus require revision because of unresolved taxonomic problems.

KEYWORDS: collection, hoverflies, Paragini, review, taxonomy

INTRODUCTION

Paragus Latreille, 1804 is the sole genus of the tribe Paragini Goffe, 1952 (Ssymank and Mengual, 2014), and comprises more than 100 described species. It is widely distributed on all continents except for South America and Antarctica (Vujić et al., 2008). All species of the genus are small flies (2.5–6.5 mm length), but exhibit different patterns of coloration and pilosity on the abdomen (Gilasian and Sorokina, 2011). Adults mainly prefer arid biotopes and usually occur near the ground in short grass (Sorokina, 2009). The larvae are aphid predators (Van de Weyer, 2000). Their distinctive facial profile, well-developed

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tergite I and non-segmented aedeagus distinguish this genus from other syrphinids (Vujić et al., 2008).

Species within the genus are frequently misidentified because their taxonomy is almost entirely based on colour differences (Marcos-García and Rojo, 1994). Stuckenberg (1954*a*) was the first authority to utilize the male terminalia in combination with more traditional characters of adult morphology to divide the genus *Paragus* into two subgenera: *Paragus* Latreille, 1804 and *Pandasyopthalmus* Stuckenberg, 1954 (Rojo et al., 2006). Current knowledge of Afrotropical *Paragus* is based mainly on Stuckenberg's revisions (1954*a*,*b*).

Oriental species of the genus were revised by Thompson and Ghorpade (1992), who provided a key for 14 species. Identification of European *Paragus* species was virtually impossible until Goeldlin's (1976) revision (Speight, 2017), with detailed analyses of the statuses and Western Palearctic distributions of species found in his papers. However, Eastern Palearctic species of the genus *Paragus* have not been revised (but see studies by Mutin and Barkalov, 1999; Sorokina and Cheng, 2007; Sorokina 2002, 2009) and taxonomic assignments of many records from that region remain questionable (Claußen and Weipert, 2004). The first revision of New World *Paragus* species was carried out by Vockeroth (1986), who described six new species and provided illustrations of the male terminalia and distribution maps for each species.

Šimić (1986) conducted a detailed investigation of the genus *Paragus* within the territory of the former Yugoslavia, and described *Paragus constrictus* Šimić, 1986 from Bosnia and Herzegovina.

Vujić et al. (2008) presented the first combined morphological and molecular phylogeny of the tribe Paragini. That study effectively reversed the conclusions of an earlier, solely genetic study by Rojo et al. (2006), dividing this genus into four subgenera, including the two previously established subgenera and adding two new subgenera: *Afroparagus* Vujić et Radenković, 2008 and *Serratoparagus* Vujić et Radenković, 2008.

Species of these subgenera clearly differ from each other by the eye pilosity being evenly distributed (in *Pandasyopthalmus*), eye pilosity forming two pale vertical stripes (in *Paragus*) (Sorokina, 2009), partial fusion of the terga (in *Afroparagus*) (Ssymank and Mengual, 2014), the serrated scutellum (in *Serratoparagus*) (Van de Weyer, 2000), as well as the varied structures of the male terminalia in all subgenera.

To date, 54 species of the genus *Paragus* have been recorded from the Palaearctic (Khaghaninia and Hosseini, 2013), 24 from the Orient (Sorokina, 2009), 28 from the Afrotropics (Ssymank and Mengual, 2014), and 8 from the Nearctic (Vockeroth, 1986).

The aim of the present study was to review and update the taxonomy of the genus *Paragus* within the insect collection of the Department of Biology and Ecology in Novi Sad, Serbia (FSUNS).

MATERIAL AND METHODS

This study is based on examination of 3086 adult *Paragus* specimens. Some of the material is available at Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad (FSUNS). Additional material was a loan from the following institutions and private collections and temporarily is a part of FSUNS collection:

M. B. coll. – private collection of Miroslav Barták, Prague, Czech Republic

M. H. coll. – private collection of Martin Hauser, Sacramento, United States of America

G. S. coll. – private collection of Gunilla Ståhls, Helsinki, Finland

D. D. coll. – private collection of Dieter Doczkal, München, Germany

R. H. coll. – private collection of Rustem Hayat, Erzurum, Turkey

T. R. N. coll. – private collection of Tore R. Nielsen, Sandnes, Norway

BME – Bohart Museum of Entomology, University of California, Davis, United States of America

J. A.W. L. coll. – private collection of J.A.W. Lucas, Rotterdam, The Netherlands

NML – National Museums Liverpool, Liverpool, England

J. A. coll. – private collection of Jabbari Azadeh, Teheran, Iran

H. S. coll. – private collection of Hussein Sadeghi, Mashhad, Iran

S. R. coll. – private collection of Santos Rojo, Alicante, Spain

C. C. coll. – private collection of Clauß Claußen, Flensburg, Germany

C. S. coll. – private collection of Carmen Stanescu, Sibiu, Romania

J.H. S. coll. – private collection of Jens- Hermann Stuke, Bremen, Germany,

CEUA – La Colección Entomológica de la Universidad Alicante, Alicante, Spain

Van de Weyer coll. – private collection of Guy van de Weyer, Belgium

AEU – University of the Aegean, Mytilene, Greece

SMNS – Staatliches Museum für Naturkunde, Stuttgart, Germany

The specimens were collected as adults using different methods including: Malaise traps, yellow and white pan water trap and swept from vegetation. The studied material was collected over a 67 year period (1950–2107), by different authors from 52 countries: Austria (3), Azerbaijan (4), Bosnia and Herzegovina (9), Bulgaria (2), Canada (1), China (2), Croatia (261), Czech Republic (107), Egypt (2), Ethiopia (3), France (61), Germany (46), Ghana (1), Greece (272), India (7), Indonesia (8), Iran (72), Israel (2), Italy (50), Japan (2), Kazakhstan (14), Kenya (6), Kyrgyzstan (1), Laos (3), Macedonia (79), Madagascar (3), Malaysia (6), Mali (2), Malta (1), Morocco (15), Mexico (9), Mongolia (33), Montenegro (411), Mozambique (3), Namibia (17), Norway (7), Pakistan (1), Portugal (1), Republic of South Africa (105), Romania (14), Serbia (531), Slovenia (10), Spain (146), Sri Lanka (8), Switzerland (2), Thailand (1), Tunis (16), Turkey (365), United States of America (317), Uzbekistan (1), Yemen (15), Zambia (24) and 4 specimens with unknown locality.

Identification of adults was based on external morphological features and structure of male terminalia by using Nikon SMZ 745T stereomicroscope. For identification, some relevant literature was used such as Goeldlin de Tiefenau (1976); Vockeroth (1986), Stuckenberg (1954 *a*, *b*); Vujić et al. (1999); Stanescu (1991); Gilasian and Sorokina (2011). Identifications were carried out by Glumac, Šimić, Vujić, Radenković, Nedeljković, Ricarte, Tot, Claußen, Doczkal, Kassebeer, Vockeroth, Daccordi, Isidro, Mengual, Hauser, Rojo, Sommaggio, Nielsen, Marcos-García, Sedman, and Kimura.

To study the male terminalia, we softened pinned, dry specimens in a humidity chamber and extracted the male terminalia with an entomological pin. Terminalia were cleared in boiling KOH for 5 minutes. This was followed by brief immersion in acetic acid to neutralize KOH, and then immersion in 95% ethanol to neutralize the acid. The terminalia have been stored in plastic microvials containing glycerol, pinned under the source specimen.

RESULTS

In total, we examined 3086 specimens belonging to four subgenera (*Paragus*, *Pandasyopthalmus*, *Afroparagus*, *Serratoparagus*). List below summarizes the *Paragus* species in the FSUNS collection.

Family Syrphidae
Subfamily Syrphinae
Tribe Paragini
Genus *Paragus*
Subgenus *Afroparagus*
Paragus borbonicus Macquart, 1842
Subgenus *Serratoparagus*
Paragus auritus Stuckenberg, 1954
Paragus azureus Hull, 1949
Paragus capricorni Stuckenberg, 1954
Paragus crenulatus Thompson, 1869
Paragus pusillus Stuckenberg, 1954
Subgenus *Pandasyopthalmus*
Paragus abrogans Goeldlin, 1971
Paragus ascoensis Goeldlin et Lucas, 1981
Paragus atratus Meijere, 1906
Paragus brachycerus Thompson, 1992
Paragus coadunatus (Rondani, 1847)

Paragus constrictus Šimić, 1986
Paragus haemorrhous Meigen, 1822
Paragus aff. *haemorrhous*
Paragus jozanus Matsumura, 1916
Paragus longiventris Loew, 1858
Paragus marshalli Bezzi, 1915
Paragus minutus Hull, 1938
Paragus sp. 1
Paragus sp. 2
Paragus tibialis (Fallen, 1817)
Paragus villipennis Thompson, 1992
Subgenus *Paragus*
Paragus absidatus Goeldlin, 1971
Paragus albifrons (Fallen, 1817)
Paragus angustifrons Loew, 1863
Paragus angustistylus Vockeroth, 1986
Paragus asiaticus Peck, 1979
Paragus bicolor (Fabricius, 1794) (revised status in prep. new name *testaceus*)
Paragus aff. *bicolor*
Paragus bispinosus Vockeroth, 1986
Paragus bradescui Stanescu, 1981
Paragus cinctus Schiner et Egger, 1853
Paragus compeditus Wiedemann, 1830
Paragus cooverti Vockeroth, 1986
Paragus finitimus Goeldlin, 1971
Paragus flammeus Goeldlin, 1971
Paragus glumaci Vujić, Šimić et Radenković, 1999
Paragus gulangensis Li et Li, 1990
Paragus hermonensis Kaplan, 1981
Paragus hylopteri Marcos-García et Rojo, 1994
Paragus kopdagensis Hayat et Claussen, 1997
Paragus leleji Mutin, 1986
Paragus longistylus Vockeroth, 1986
Paragus mariae Sorokina, 2003
Paragus majoranae Rondani, 1857
Paragus medeae Stanescu, 1991
Paragus oltenicus Stanescu, 1977
Paragus pecchiolii Rondani, 1857
Paragus punctatus Hull, 1949
Paragus punctulatus Zetterstedt, 1838
Paragus quadrifasciatus Meigen, 1822
Paragus radjabii Gilasian et Sorokina, 2011
Paragus romanicus Stanescu, 1992 (revised status in prep. new name *bicolor*)
Paragus sexarcuatus Bigot, 1862
Paragus stackelbergi Bankowska, 1968
Paragus strigatus Meigen, 1822

Paragus sp. 3
Paragus vandergooti Marcos-García, 1986
Paragus variabilis Vockeroth, 1986

DISCUSSION AND CONCLUSION

The genus *Paragus* was first described in the early 19th century and most species definitions were largely based on colour differences. Stuckenberg (1954*a*) described intraspecific variability in the structures of the male terminalia of some species within the subgenus *Pandasyopthalmus*, but problems in species identification remain. Some species are still of uncertain status, particularly in the *bicolor* and *majoranae/hermonensis* complexes, and in the subgenus *Pandasyopthalmus* (Speight, 2017). Determinations of *Pandasyothalmus* species are extremely difficult because of the limited morphological differences between some species. Colour characters of adults from the *majoranae/hermonensis* complexes and the *bicolor* group are unreliable, so identifications can only be reliably achieved through examinations of the male terminalia.

The most consistent and significant distinguishing character of hoverfly species is the structure of the male terminalia (Sorokina, 2009). However, it is obvious that females cannot be identified based on this character (Speight, 2017). Although the females of some species can be identified by linking their localities to the distributions of identified male lineages, many remain undescribed because they are non-distinguishable (Rojo et al., 2006).

Our detailed investigation of the genus *Paragus* in the collection of FSUNS has identified 59 species. Most of the species belong to the subgenus *Paragus* (37), followed by *Pandasyopthalmus* (16), *Serratoparagu*s (5) and *Afroparagus* (1). The majority of the specimens were collected from the territory of the former Yugoslavia (n=1203) (i.e., Serbia, Montenegro, and Croatia). A significant number of *Paragus* specimens (n=105) were collected during a field trip to the Republic of South Africa. The Afrotropical region is a centre of Paragini diversity, hosting the largest diversity of *Pandasyopthalmus* species (Vujić et al., 2008). Accordingly, we expect that more *Paragus* species occur in this part of the world than currently described.

The large FSUNS collection holds three *Paragus* species new to science (*Paragus* sp. 1, *Paragus* sp. 2, *Paragus* sp. 3) and one potential new species (*Paragus* aff. *haemorrhous*).

Both *Paragus* sp. 1 and *Paragus* sp. 2 have very unique taxonomic characters. Since their eye pilosity is evenly distributed and black and their mesonotums are shiny without sub-median vittae, these two new species belong to the subgenus *Pandasyopthalmus*. Molecular analyses would help establish their systematic position within that subgenus.

Based on external morphological characters *Paragus* sp. 3 resembles species *Paragus glumaci*. These species can be separated reliably by the structure of male terminalia.

Paragus aff. *haemorrhous* is similar to the species *Paragus haemorrhous* but differs from it by having a much smaller ejaculatory apodeme, a differently shaped surstylus and a darker pterostigma.

Paragus aff. *bicolor* (*Paragus rarus*, in prep.) shares very similar morphological characters with *Paragus bicolor* (*Paragus testaceus* revised status, in prep.) and *Paragus romanicus* (*Paragus bicolor* revised status, in prep.). It can be distinguished from these latter two species by the structures of the male terminalia: the surstyli of *Paragus* aff. *bicolor* (*Paragus rarus*, in prep.) are stubby with a depression, whereas in *Paragus romanicus* (*Paragus bicolor* revised status, in prep.) they are elongated and in *Paragus bicolor* (*Paragus testaceus* revised status, in prep.) they are stubby but without a depression. Additional molecular analyses will be necessary to reveal their respective systematic positions.

Following detailed analysis of the available *Paragus* material in the FSUNS collection, we conclude that some species of this genus require taxonomic revision because of the unresolved problems. Although identifications are now largely dependent on features of the male terminalia, more precise means of identification remains necessary to firmly establish specimen identity (Speight, 2017). Our results demonstrate a clear need for a revision of some of the type material of the genus *Paragus*. Molecular study would certainly help clarify unresolved taxonomic problems in this genus.

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ТАКСОНОМИЈА РОДА *Paragus* Latreille, 1804 (Diptera: Syrphidae) ИЗ ЗБИРКЕ ДЕПАРТМАНА ЗА БИОЛОГИЈУ И ЕКОЛОГИЈУ УНИВЕРЗИТЕТА У НОВОМ САДУ, СРБИЈА (FSUNS)

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РЕЗИМЕ: У овом раду је анализиран род *Paragus* Latreille, 1804 из Збирке Департмана за биологију и екологију у Новом Саду (ФСУНС). Прегледано је укупно 3.086 адултних јединки (974 женке и 2.112 мужјака), сакупљених у периоду 1950–2017. Анализом примерака регистровано је 59 врста из рода *Paragus*, од којих 37 припада подроду *Paragus*, 16 подроду *Pandasyopthalmus*, пет подроду *Serratoparagus* и један подроду *Afroparagus*. Детаљна анализа рода *Paragus* у Збирци Департмана за биологију и екологију као и додатног материјала из приватних колекција, који су тренутно део Збирке ФСУНС показује да овај род захтева ревизију због бројних нерешених таксономских проблема. Таксономски статус неких врста рода *Paragus* још није разјашњен и захтева наставак истраживања.

КЉУЧНЕ РЕЧИ: колекција, Diptera, *Paragus*, Syrphidae, таксономија

UDC 57:929 Glumac S.

SLOBODAN GLUMAC
(1930–1996)

Slobodan Glumac was born on September 29, 1930 in Senj (ex Yugoslavia). For a while, the Glumac family lived in Mrkonjić Grad and Senta; in 1936, they came to Novi Sad where Slobodan Glumac finished elementary school. In 1946, the family moved to Belgrade and Slobodan attended The Third Boys Grammar School. He graduated with excellent grades in 1950, and was released from taking the final examination. He entered the Faculty of Sciences, Department of Biology, in the same year. His high school teacher Mr. Brana Gojković, according to the words of the Professor himself, aroused his love for nature and his wishes to learn about it as much as possible. Along with his studies, he started to volunteer at the Natural Science Museum of Serbian Land and in 1952 he was engaged for a full-time job of a taxidermist. The job in the Museum had multiple benefits; it financially helped the survival of the family during the post-war period and initiated the beginning of Professor Glumac's research work.

Hydrae, his "first love" in the amazing world of nature, were the subject of his first five-year investigation. Professor Glumac published six articles based on his studies but *Hydrae* remained one of his unfulfilled dreams. Later, during his life he tried to interest any of his associates to investigate symbiosis of hydra. Unfortunately, he failed in his attempts. Along with his work in the Museum, numerous fieldworks and other duties, he graduated in June 1954, with average grade of 8.94 and won the University of Belgrade award for his student research work. After the graduation, he continued to work in the Museum as a custodian. After he had served his military term, he moved to Novi Sad in 1955 and got a job as the Assistant for Agricultural zoology at the newly founded Faculty of Agriculture. He has always proudly mentioned that he came to Novi Sad on the invitation of Professor Pavle Vukasović. He started to collect hoverflies as a student and they became his major investigation during the next twenty years and the subject he would occasionally follow until the end of his life. He explored many regions of our country riding a bicycle with an auxiliary motor and being equipped with entomology net. His favorite memories were always about the fieldwork in Macedonia and collecting of hoverflies on Kožuf Mountain, Mavrovo Lake, and the village of Oteševo.

In July 1957, he defended his PhD dissertation *Syrphidae (Diptera) in our country, their systematics and phylogeny based on the structure of the male phallus* at the Faculty of Sciences, University of Belgrade and became one of the youngest doctors of sciences. In 1958, he was elected Assistant Professor for Agricultural zoology at the Faculty of Agriculture, University of Novi Sad. In the same year, he spent several months in London on a study visit, thoroughly exploring the rich collections of hoverflies collection in the British Natural History Museum. During these years he began teaching biology at the Faculty of Technology in Novi Sad and the authorized texts of his lectures were printed.

In 1960, Professor Slobodan Glumac attended the XI World Congress of Entomology in Vienna. His paper on phylogenetic systematics of hoverflies based on the male genitalia structure and the way of larval development aroused the interest of the congress participants. Since then and until 1988, he had been a regular participant of world entomology congresses that were held every four years all around the world (Great Britain, USSR, Australia, the USA, Japan, Germany, and Canada).

The idea of introducing the study of biology in Novi Sad, which brought Professor Glumac to our city, began its realization in 1961 when the Council of the Faculty of Philosophy elected him the acting chief of the department for newly founded study group of biology. The enrolment of the first generation of 18 students was the beginning of the studies of biology in Novi Sad. In 1963, Professor Glumac was elected as an Associate Professor of morphology and systematics of invertebrates; in the same year he was appointed director of the University Institute of Biology, the duty he performed until 1971. Besides his engagement as a lecturer for the systematics of invertebrates, he held various courses in evolution, ecology of animals, zoology practicum, and biogeography. In 1967, he was appointed vice-dean of the Faculty of Philosophy. During the students riots in 1968 he stayed days and nights with his students in the Faculty premises giving them his support, advice, and the protection of a vice-dean authority.

After the separation of the Faculty of Natural Sciences from the Faculty of Philosophy in 1969, professor Glumac was elected acting dean of the new faculty. In the same year he was chosen to the position of full professor based on the report and evaluation given by academician Pavle Vukasović, academician Siniša Stanković, and Professor Simeun Grozdanić. In the conclusion of their report they wrote: “He carried out all his duties scrupulously and with utmost discipline. It is important to point out to his work and communication with the students, his readiness to help, and willingness to find and apply the best possible solution for various situations that are habitual in teaching profession. Such demeanour has got him the respect and the greatest esteem among his students and colleagues.” In the same year, the postgraduate studies in taxonomy were founded, the first and still the unique ones in our country. Professor Glumac was the founder and the planner of the taxonomy studies from the very beginning and until the time of his retirement and almost a hundred of students won their master degree under his management. He guided 32 students through the elaboration of their theses, mentored eleven MSc and seven PhD dissertations. He used his expert skillfulness and an abundance of ideas to provoke freedom and creativity of his co-workers and delicately direct them to correct solutions. Therefore, these theses are of special quality and many students carry the recognizable seal of his influence.

In 1971, professor Glumac was elected vice-rector of the University of Novi Sad. During his two-year term he engaged his energy and organization capacities to support the construction of new building of the Institute of Biology, which was finished in 1973. A four-storied building with its amphitheatres, classrooms for practical teaching, greenhouses and air and light chambers was a cause of envy at that time. It is one of greatest achievements of Professor Glumac and still our pride today. At that time, the first monograph titled *The Catalog of Syrphidae Fauna* was published in the edition of the Slovenian Academy of Sciences and Arts; it consolidated the results gathered over a twenty-year period of collecting and investigation of this group of Diptera.

According to the subject of research, the scientific work of Professor Glumac can be divided into several parts. At the beginning he was focused to the ecophysiological investigations of hydrae. Papers on hydrae were the first published articles of Professor Glumac dating from 1953 to 1957; they present original ideas and new results of general biological importance.

The most significant results of Professor Glumac's work were achieved through fundamental and applied research of entomofauna of hoverflies. Articles on hoverflies are most significant among his scientific opus not only by their number and scope but also by their contribution to science development.

From present point of view it is hard to say what has induced Professor Glumac to initiate the research of an insect family that has certainly not been in the focus of interest among the entomologists of that time. His first fieldwork dated from springtime of 1952, immediately after being engaged as a taxidermist in the Natural Science Museum, Belgrade. At that time, there were not many hoverflies specialties either in Europe or worldwide. The majority of the scientists interested in hoverflies research were mainly focused on the investigation of dipterous insects in general. Only today one can clearly envisage the significance of Professor Glumac's choice of the subject of his research. The evidence is seen not only in the Professor's results that have made him recognized in the world entomology but also in increased interest in hoverflies research all over the world. Today, three European journals publish only the papers on hoverflies and the number of amateur entomologists that collect hoverflies is constantly expanding.

Professor Glumac spent the first fieldwork years collecting and studying hoverflies around Serbia. The results he obtained were published in his first paper on hoverflies titled *Hoverflies in Serbia from the collection of the Natural Science Museum of the Serbian Land* in 1955. He collected hoverflies in various areas of Serbia – from the surroundings of Belgrade, mountain ranges of Homolje and Kopaonik, to Kosovo and regions around Trepča. After serving his military term, he collected hoverflies in Istra for two years (1955 and 1956); on the second year he expanded his research to the south coast of the Adriatic Sea. The results of these investigations were presented in two manuscripts published in the *Bulletin of the Natural Science Museum of Serbian Land* in 1956. Due to his energy and efficiency during those years he managed to examine the collection of the National Museum of Bosnia and Herzegovina in Sarajevo. The results he gathered were published in the *Almanac of the Institute of Biology* immediately upon the end of the visit; his subsequent publication presented some species of hoverflies found in Yugoslavia for the first time. His synthetic paper on the distribution and density of *Syrphidae* in Yugoslavia dated from that period too.

His transfer from the Natural Science Museum, Belgrade to the Faculty of Agriculture, Novi Sad, conditioned the fieldwork in the following period. In 1956 and 1957 he thoroughly investigated the terrains on Fruška Gora Mountain and the results were published in two papers, one of them being of monographic character.

The intensive research work was partially slowed down by the elaboration of his doctoral thesis, which he successfully defended in 1957. From 1958 to 1961 and additionally in 1966, Professor Glumac focused his fieldwork research to Macedonia. The results he acquired during the study excursions were published in the monograph of hoverflies in Macedonia (1986). The crown of his studies on the diversity of hoverflies in Yugoslavia was the publication of the *Catalog of hoverflies fauna in Yugoslavia* in 1972. The Catalog presents the results of his fifteen-year investigations, which have been consolidated with the findings of other researchers of hoverflies in Yugoslavia as early as the work of Schiner in 1857. Professor Glumac himself discovered more than half 326 species and 57 subspecies of hoverflies described in the Catalog on the territory of Yugoslavia for the first time. The greatest contribution of Professor Glumac in taxonomy was his pointing to the species that it would be necessary to revise. Based on this, his students today can boast with published descriptions of 15 new species in science, many of them being endemic in our regions. Professor himself was the initiator of those studies and always supported his co-workers to cope with challenging taxa.

He contributed the most through his work on defining of phylogenetic relationships within the family *Syrphidae.* This part of his scientific contribution to entomology has never been recognized enough, particularly not on the West. Unfortunately, his most significant texts were published in Serbian, a handicap for the comprehension of the brilliance and perception of his mind so vividly expressed in the papers. Phylogenetic relationships within hoverflies family, which he raised to the level of superfamily, were the topic of his doctoral thesis. Later, he published several individual contributions dealing with certain aspects of evolutionary mechanisms in the family of hoverflies that gave not only the problem solutions but also the ideas and directions for future work.

The papers in which Professor Glumac presented the ecology, ethology, and chorology of hoverflies using a completely new approach are of great significance. At that time, it was not typical to supplement the lists of species with relevant comments on adults' appearance and behavior observed during the fieldwork. Today, such method is a common one. The published records of professor Glumac are even more valuable because they can be compared to the results of current investigations. The content of his paper titled the *First results of the application of pollen analysis in ecological study of insects* has been a stimulus to investigations carried out by a number of scientists today. The results obtained by using this method have gained in their significance only today because they allow full identification of numerous relationships within the studied ecosystems. In recent years, it has extensively been used due to the development of ecological monitoring in autochthonous and biocenoses with human influence.

Professor Glumac gave a significant contribution to the understanding of zoogeographical regularities in the Balkan territories and widely. His sharp conclusions based on the results of his own investigations of fauna, pointed to numerous regularities in the distribution of hoverflies species and possible reasons for such distribution. Worth mentioning is his contribution to the theory on "pulsating" areas of distribution of species that continually appear in smaller number outside the borders of known distribution. Even today, his results are inspiration and a good starting point for researchers in their attempts to fully understand zoogeographic and biogenetic regularities of hoverflies distribution.

Parallel to investigating hoverflies, Professor Glumac began the study of two groups of harmful insects: bean weevil (*Acanthoscelides obtectus*) and corn borer (*Ostrinia nubilalis*) at the beginning of 1960s. These investigations were conducted in cooperation with a number of his colleagues of different expertise (physicists, chemists, biochemists, physiologists, histologists, etc.). In addition, in his scope of investigations he included the study on mosquitoes in cooperation with Branka Božičić (marital surname Lothrop) a professor of evolution until she moved to the USA.

The activities of the Yugoslav Entomology Society were restored in 1971. Scientific meetings were held every year and Professor Glumac, as one of the most esteemed members of the Society, attended the meetings not only with presentation of his papers but also with active participation in the discussion on other papers, mostly those presented by young authors. His constructive remarks and observations were helpful to many and his negative reviews were often said in his own unique and witty way.

In August of the same year, he attended XV World Congress of Entomology held in Washington. On this occasion, Professor Glumac was elected *ad personam* for the member of the Standing Committee of World Congresses of entomology, which was the highest international recognition for his work and contribution to the world entomology.

His work in Matica srpska was of special importance. Since the publication of his first paper in the *Matica Srpska Journal for Natural Sciences* in 1956 till the very end he was attached to this institution and closely cooperated in its work. He was a member of the editorial board of the *Matica Srpska Journal for Natural Sciences* from 1963 and its editor in chief for twenty years (1977–1996). He was a member of Matica srpska management board and Matica srpska executive board and a general secretary of the department of natural sciences. He dedicated his efforts to the realization of a number of projects among which the *Monographs of Fruška Gora* is of special importance because it yielded in a number of valuable monographs on flora, fauna, inhabitants, and water sources of the region. His long-term cooperation and engagement in the activities of Matica Srpska was acknowledged with his election for vice-president of Matica Srpska in 1991.

Professor Glumac retired in 1995. He continued coming to the Institute, to read something, talk to his colleagues, give his advice to younger associates, examine interesting samples of hoverflies and discuss them with those who continued his investigations.

Thirty-five generations of biology students will always remember his stimulating lectures on invertebrates and evolution, especially the first 15 generations he accompanied during the fieldwork research of Fruska Gora and the Adriatic. Fieldwork investigations were the days for relaxation and break from many duties waiting for him in Novi Sad.

It should be mentioned once more that his major research on hoverflies is undoubtedly his greatest contribution to world science. Whenever it was necessary, he was able to see more and further than others. The paths he took and directions he indicated more then 60 years ago are followed by his closest co-workers, many of young researchers in our laboratory, and by the scientists form different parts of the world.

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• Informing the author's (or reviewer's) head of department or employer of any misconduct by means of a formal letter.

• The formal, announced retraction of publications from the journal in accordance with the Retraction Policy (see below).

• A ban on submissions from an individual for a defined period.

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1.2. The manuscripts should be written in correct English language regard¬ing the grammar and style. The manuscripts should be submitted electronically as a separate file to vnikolic@maticasrpska.org.rs and enclosed with the author's written consent for the publishing of the manuscript.

1.3. Upon the reception of the manuscript, the author shall be assigned with a manuscript code, which has to be referred to in any further correspondence. The authors will be notified about the manuscript reception within seven days and about the reviewers' opinion within two months from submission. All submitted manuscripts are reviewed and proofread.

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2.1. Type the manuscripts electronically on A4 (21 x 29.5 cm) format with 2.5 cm margins, first line indent, and 1.5 line spacing. When writing the text, the authors should use Times New Roman size 12 font and when writing the abstract, key words, summary, and footnotes use font size 10.

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