

Original paper

New records of hoverflies (Diptera: Syrphidae) and the rediscovery of *Primocerioides regale* Violovitsh for the fauna of Serbia

Jeroen van STEENIS¹, Zorica NEDELJKOVIĆ², Tamara TOT³, Leendert-Jan van der ENT⁴, André van ECK⁵, Libor MAZÁNEK⁶, Anja ŠEBIĆ³, Snežana RADENKOVIĆ³, Ante VUJIĆ³

¹Research Associate Naturalis Biodiversity Center, c/o Hof der Toekomst 48, 3823HX Amersfoort, The Netherlands.

²University of Novi Sad, BioSense Institute - Research Institute for Information Technologies in Biosystems, Dr Zorana Đinđića 1, 21000 Novi Sad, Serbia

³University of Novi Sad, Faculty of Science, Department of Biology and Ecology, Trg Dositeja Obradovića 2, 21000 Novi Sad, Serbia

⁴Applied University of Arnhem and Nijmegen, Schonenbergsingel 50, 6881 NS, Velp, The Netherlands (LJvdE)

⁵Korte Hoefstraat 30, 5046 DB Tilburg, The Netherlands (AvE)

⁶Jívová 231, 783 16 Jívová, Czech Republic (LM)

Received: 7 August 2019 / Accepted: 5 October 2019 / Published online: 3 November 2019

Summary. In preparation for the IUCN workshop on the European Red List of Syrphidae from April 4th-16th 2019, a total of 59 hoverfly species were collected in Novi Sad and on Fruška Gora Mountain (Serbia). Among the identified species, one species is possibly new to science, *Brachypalpus* aff. *valgus*, and six other species are new to the fauna of Serbia: *Brachyopa grunewaldensis*, *B. silviae*, *Criorhina pachymera*, *Epistrophe cryptica*, *Psilota anthracina* and *Sphiximorpha petronillae*. During the preparation of this work, a photo taken in Belgrade confirmed the occurrence of *Primocerioides regale* in Serbia. Additionally, six rarely recorded species for the fauna of Serbia were collected: *Brachyopa maculipennis*, *B. plena*, *Criorhina floccosa*, *Epistrophella coronata*, *Mallota fuciformis* and *Sphiximorpha subsessilis*. The list of new and rare species and information on behaviour and habitats are provided. The value of Kamenički Park, Novi Sad, for saproxylic hoverflies is discussed and possible conservation measurements are proposed to retain this treasury of rare and possibly threatened species. The previously proposed co-occurrence of *Sphiximorpha petronillae* and the European velvety tree ant (*Liometopum microcephalum* (Panzer, 1798)) is also discussed.

Keywords: conservation management, endemic species, European velvety tree ant, Kamenički Park, *Primocerioides regale*, Saproxylic species, *Sphiximorpha petronillae*.

INTRODUCTION

During the first IUCN European Syrphidae Red List workshop conducted in Novi Sad, Serbia at the University campus in early April 2019, hoverflies were collected in the vicinity of the workshop location. The sampling took place along the Danube River, close by the University campus, and in Kamenički Park on the other side of the Danube River in Fruška Gora National Park. One additional record from Belgrade, based on a photograph is included as well.

With ~6000 described species, hoverflies (Diptera: Syrphidae) represent one of the most species-rich Diptera

families (Rotheray and Gilbert 2011). The hoverfly fauna of Serbia has been investigated rather extensively (e.g. Vujić and Glumac 1994; Vujić et al. 2002; Radenković et al. 2004; Nedeljković et al. 2009; van Steenis et al. 2015; Vujić et al. 2018) sometimes with a special focus on conservation issues (Radenković et al. 2013; Vujić et al. 2016). These publications have regularly added new species for the fauna of Serbia, resulting in a total of 412 species of Syrphidae known for Serbia (Vujić et al. 2018).

The aim of the present survey was to improve our knowledge of the syrphid fauna in Novi Sad and its surroundings.

MATERIAL AND METHODS

Between the 4th and 16th of April 2019, four localities (University campus of Novi Sad, Stražilovo, Popovica, and Kamenički Park) were visited. Adult hoverflies were collected by hand net, while they were visiting flowers such as *Salix triandra*, *Prunus avium*, *Taraxacum officinale* and *Chelidonium majus* or flying through the vegetation. However, many of the saproxylic species were collected at or close to sap runs on a variety of deciduous trees. Some specimens were preserved in alcohol for further DNA analysis. The specimens remain in the collections of the authors, respectively JvS, LJvdE, AvE, LM, and at the Faculty of Science, Department of Biology and Ecology, University of Novi Sad, Serbia (FSUNS).

Species were identified using well-known criteria established in the Syrphidae literature.

Photos of live specimens and habitats were recorded by the first author using a Nikon Coolpix P510, the photo of *Quercus pubescens* tree in Kamenički Park was taken by Tamara Tot using a Canon SX540 HS. Other illustrations were created with the aid of a Canon EOS D6 equipped with a Canon MP-E 1-5x macro zoom lens. Several photos for each figure were processed with Zerene Stacker and further edited with GIMP 2.8.22.

Collecting localities

1. Novi Sad, University campus along the Danube River (Figs 1A, B).

This is a small stretch of riverine forest dominated by *Salix triandra*, *S. alba*, *Tilia tomentosa* and *Populus* spp. The understory consists of low herbs with flowering white *Apia-*



Fig. 1. Collecting localities, Serbia. **A, B:** University Park, Novi Sad; **C:** Fruška Gora, Stražilovo; **D:** Kamenički Park (photo TT).

ceae, *Lamium* spp., *Taraxacum officinale* and *Chelidonium majus*. Some planted *Prunus avium* were in full blossom, attracting many wild bees and some hoverflies. Several of the *S. alba* trees were damaged due to storms or possibly floods so that dead branches (Fig. 2A) and logs were present. One tree (Fig. 2B) was found with two large sap runs. Smaller sap runs were also present in some other nearby *S. alba* trees. This stretch of riverine forest was separated from the adjacent land by a large dike, the inland part consisting mainly of meadows with scattered *Populus* trees of which several had sap runs. The latter were as high as five meters or more and it was not possible to observe any Syrphidae visiting them.

2. Novi Sad, Kamenički Park (Figs 1D, 2D).

For a further description of this park see the discussion at the end of this paper. Collecting was mainly conducted at four different habitats: the western part of the park with scattered broadleaved trees and an abundant understory of



Fig. 2. Habitats of Serbian hoverflies. **A:** *Salix alba*, University Park on which two males of *Brachypalpus valgus* were found; **B:** Sap run on *S. alba*, University Park, with three species of *Brachyopa*, *Brachypalpus valgus* and *Sphiximorpha subsessilis*; **C:** Sap run on *Populus alba*, Fruška Gora with *Brachyopa maculipennis* ♂; **D:** Old *Quercus pubescens* tree with broken off branches, Kamenički Park with several *Brachyopa* species, two *Brachypalpus* species, *Psilota anthracina* and *Sphiximorpha petronillae*.

Lamium spp., *Chelidonium majus*, *Aegopodium* spp., *Ajuga* spp. and the Serbia red listed species *Stellaria uliginosa* (Jakovljević et al. 2015); alongside the Danube river in a small forest clearing resulting from a fallen tree (most likely a *Tilia tomentosa*) with lush herb vegetation; at several sap runs on *Carpinus betulus* and *Acer* spp. in the same forested part along the river Danube; and finally, higher up the slopes at a single *Quercus pubescens* tree (Fig. 1D). The latter had large branches broken off which created two areas with hidden sap runs and rotting heartwood (Fig. 2D). Many ants were found on the entire tree.

3. Sremski Karlovci, Fruška Gora, Stražilovo (Fig. 1C).

This is an area on the eastern slopes of the forested part of Fruška Gora mountain with a small stream (Stražilovački potok) flowing west to east with several smaller and larger meadows along the stream. The meadows were rich in herbal plants, with some scattered larger shrubs. The forest consists of a mixture of open to dense broadleaved forest with scattered pine trees within the entire area. Several old trees were present with sap runs on two adjacent *Quercus petraea* and one *Populus alba* (Fig. 2C) standing at the bank of the stream. In one of the meadows, cut pine logs were present on which some saproxylic hoverflies were collected.

4. Sremska Kamenica, Fruška Gora, Popovica.

This is a forested area on the northern slopes of small peak on Fruška Gora mountain close to village of Popovica, containing a small lake, "Jezero na Popovici". The forest was a relatively dense broadleaved forest with flowering *Corydalis cava* on the ground, and locally with flowering *Cerasus* trees and pine tree areas. *Robinia pseudoacacia* growth was present around the ridge. The old quarry, named Orlovo Bojište, had open dry areas present on the southern slope. Most specimens were collected on open areas close to the lake with flowering *Prunus spinosa* bushes and along the tourist path through the relatively dense deciduous forest on the other side of the lake. Some other specimens were collected on open areas in the old quarry which had a flowering growth of *Euphorbia* spp. and *Cerasus* trees/bushes.

RESULTS

In this paper a list of rare and new species recorded for the Serbian fauna is provided. All specimens have been identified to the species level, except for two. These two exceptions belong to an unknown *Brachypalpus* species. It is clearly differentiated from the other three known European species of this genus and might represent a previously undescribed taxon. Further study, especially of all the type specimens within the genus *Brachypalpus* is being initiated in order to sort out the status of these specimens. The references given in

the introduction are mostly not repeated here, only special references dealing with individual species are provided. In total, 301 specimens were observed belonging to 59 different species. A full list of Syrphidae species recorded during the above fieldwork is given in Appendix 1. Please note, *Primocerioides regale* is not listed since it is included in this paper based on a photo (see under this species) recorded in Belgrade.

List of species

Brachyopa grunewaldensis Kassebeer, 2000 – New to Serbia

New data. Serbia, Novi Sad, Kamenički Park, 45°13'48"N, 19°50'58"E, 07-04-2019, 1♀ leg. LM [LM]; Kamenički Park, 45°13'42.7656"N, 19°50'59.7264"E, 10-04-2019, 3♂ leg. AV, SR [FSUNS].

Ecology. The female was found near sap runs on the trunk of a *Carpinus betulus* tree. Close to this tree was an *Acer* sp. tree with a freshly broken branch, where a flying female *Brachyopa* was also observed. The males were collected around the sap run on a large, approximately 200 years old, *Quercus pubescens*.

Remarks. This is a widespread but rare species collected in most central European and Mediterranean countries (e.g. Doczkal and Dziock 2004; Mazánek et al. 2005; Bot and Van de Meutter 2018). The species has been misidentified as *B. bicolor* or *B. insensilis* in the past (Ricarte et al. 2013) and is possibly more widespread than currently known. The site in Serbia connects the Greek and central European populations and, as such, it was not unexpected to find this species in Serbia. The species is listed as endangered in Germany, as it seems to be declining there and restricted to very old *Quercus* forests (Ssymank et al. 2011).

Brachyopa maculipennis Thompson, 1980

New data. Serbia, Novi Sad, University Park, along Danube river, 45°15'0"N, 19°33'0"E, 07-04-2019, 1♂ leg. JvS [JvS], 1♂ leg JvS [AvE], 1♂ leg JvS, DNA voucher [CNC], 1♀ leg. LJvdE [LJvdE]; same data as previous, except 09-04-2019, 2♂ leg. JvS [JvS]; Serbia, Sremski Karlovci, Fruška Gora, Stražilovo, 08-04-2019, 45°9'36"N, 19°54'0"E, 1♂ leg. JvS [JvS], 1♂ leg. ZN [FSUNS].

Ecology. Found near sap runs on *Salix alba* (Fig. 3A) in an alluvial forest, together with *B. bicolor* and *B. insensilis* and at a sap run on *Populus alba* along a stream in a humid broadleaved forest.

Remarks. This is an endemic species to Europe, that is threatened in the Balkans (Vujić 1991; Vujić et al. 2001) and is a protected species in Serbia (Janković et al. 2018). In Germany it is red listed as critically endangered and strongly declining (Ssymank et al. 2011).

Brachyopa plena Collin, 1939

New data. Serbia, Fruška Gora, Popovica, 04-04-2019, 1♂ leg. LM [LM].

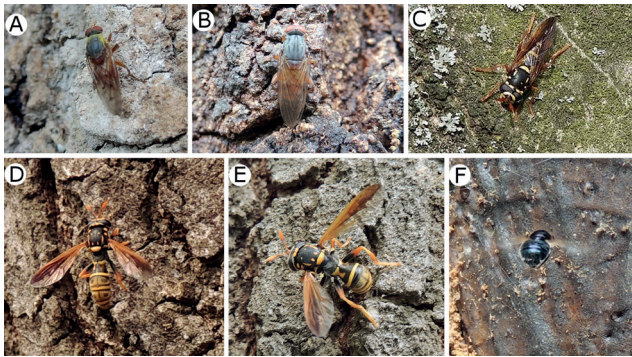


Fig. 3. Serbian hoverflies. **A:** *Brachyopa maculipennis* ♂, near sap run on *Salix alba*, University Park; **B:** *Brachyopa bicolor* ♂, near sap run on *Quercus* sp., Fruška Gora; **C:** *Primocerioides regale* ♂, on *Quercus* sp. trunk, Memorial Park of Jajinci, Belgrade, photo by M. Mareš; **D:** *Sphiximorpha petronillae* ♀ 1, egg laying behaviour near sap run on *Quercus pubescens*, Kamenički Park; **E:** *Sphiximorpha petronillae* ♀ 2, egg laying behaviour near sap run on *Q. pubescens*, Kamenički Park; **F:** *Psilota anthracina* ♀, egg laying behaviour near sap run on *Q. pubescens*, Kamenički Park.

Ecology. Found patrolling close to a sap run on the trunk of a slim, tall deciduous tree within a relatively dense deciduous forest adjacent to the lake, Jezero Popovica.

Remarks. This is a rare south-east European species that has many scattered and older records (e.g. Collin 1939; Bradescu 1991; Mazánek et al. 2005).

Brachyopa silviae Doczkal & Dziock, 2004 – **New to Serbia**

New data. Serbia, Novi Sad, Kamenički Park, 45°13'48"N, 19°50'58"E, 07-04-2019, 1♂ leg. LM [LM].

Ecology. Found near sap runs on the trunk of a *Carpinus betulus* tree, in the same place as *B. grunewaldensis*.

Remarks. This recently described species of the *B. insensilis* group was previously only known from Germany and one other locality in France (Doczkal and Dziock 2004; Speight et al. 2013). In Germany it is known from several localities and the species is connected to old growth *Quercus-Fagus* forests. The Serbian record suggests its larval habitat is sap runs on deciduous trees.

Brachypalpus* aff. *valgus (Figs 4A, B) – **New to Serbia**

New data. Serbia, Novi Sad, Kamenički Park, 45°13'12"N, 9°50'24"E, 09-04-2019, 1♂ leg JvS [JvS]; Kamenički Park, 45°13'42.7656"N, 19°50'59.7264"E, 10-04-2019, 1♀ leg AV, SR [FSUNS].

Ecology. Adults were found patrolling a single *Quercus pubescens* tree with sap runs and areas of decaying heartwood.

Remarks. This is a distinct species clearly different from any other currently known West-Palaearctic *Brachypalpus* species, and most likely represents an undescribed species. No other specimens were found in the collection in Novi Sad (FSUNS) nor in any of the private collections of the authors

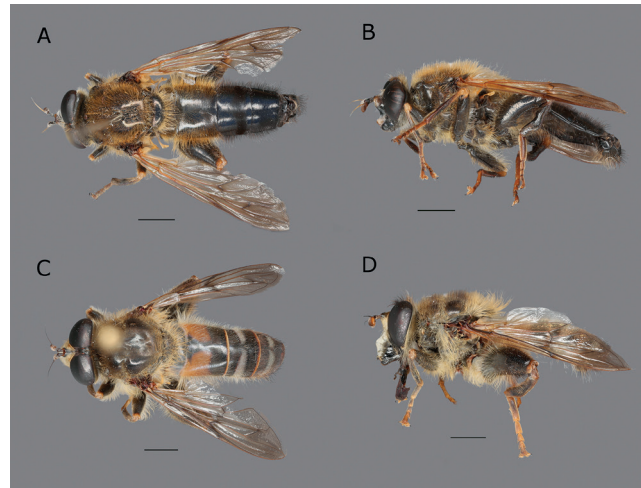


Fig. 4. Adult habitus – **A, C:** dorsal view; **B, D:** lateral view. **A, B:** *Brachypalpus* aff. *valgus*; **C, D:** *Criorhina pachymera*. (Scale bar 2.5 mm.)

so the species is believed to be very rare. The status of this taxon species will be resolved and its result will be published in a separate paper revising the European species of the genus.

Criorhina floccosa (Meigen, 1822)

New data. Serbia, Novi Sad, University Park, along Danube river, 45°15'0"N, 19°33'0"E, 04-04-2019, 1♂ leg. JvS [JvS]; Kamenički Park, 45°13'42.7656"N, 19°50'59.7264"E, 10-04-2019, 1♂ leg. AV, SR [FSUNS].

Ecology. The male at the University Park was collected in late afternoon while patrolling around a *Tilia tomentosa*.

Remarks. This is a rare species in Serbia (Vujić and Milankov 1999), but widespread throughout Europe (Speight 2018) and at least in the Netherlands increasing its range (Reemer et al. 2009) and as such hardly likely to be threatened at European level.

Criorhina pachymera Egger, 1858 (Figs 4C, D) – **New to Serbia**

New data. Serbia, Novi Sad, Kamenički Park, 45°13'12"N, 19°50'24"E, 09-04-2019, 2♂ leg. JvS [JvS]; Kamenički Park, 45°13'42.7656"N, 19°50'59.7264"E, 16-04-2019, 1♂ leg. TT & ŠA [FSUNS].

Ecology. The males were patrolling live trees with damaged bark on the lower part of the trunk at a maximum height of 1 meter above the ground.

Remarks. This species is listed as threatened in the Balkans (Vujić et al. 2001). It is a widespread species with an increasing population in the Netherlands (Reemer et al. 2009). Although it is listed as critically endangered and declining in Germany (Ssymank et al. 2011) it is not likely to be threatened at European level.

Epistrophe cryptica Doczkal & Schmid, 1994 (Figs 5A, B) – **New to Serbia**

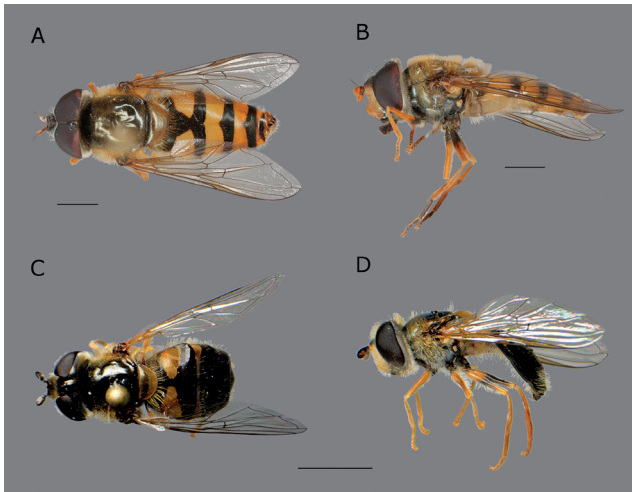


Fig. 5. Adult habitus – **A, C:** dorsal view; **B, D:** lateral view. **A, B:** *Epistrophe cryptica* male; **C, D:** *Epistrophebella coronata* female. (Scale bar 2.5 mm.)

New data. Serbia, Novi Sad, University Park, along Danube river, 45°15'0"N, 19°33'0"E, 07-04-2019, 1♂ leg. JvS [JvS].

Ecology. The male was collected visiting flowers of *Prunus avium* in alluvial *Salix-Tilia* forest close to the Danube River.

Remarks. This is a rare but widespread species in Europe (Speight 2018), possibly extending its range in Belgium and the Netherlands (Bot and Van de Meutter 2019). In the field, males of *Epistrophe cryptica* are similar to males of *E. nitidicollis* and *E. melanostoma* which makes it difficult to separate these species in the field.

Epistrophebella coronata (Rondani, 1857) (Figs 5C, D)

New data. Serbia, Sremska Kamenica, Kamenički Park, 45°13'44.3712"N, 19°50'58.1388"E, 16-04-2019, 1♀ leg. TT & ŠA [FSUNS].

Ecology. The female was collected on leaves of *Tilia tomentosa* along one of the footpaths bordering a narrow strip of wood at one side of open grassland.

Remarks. This species is (along with *Primocerioides regale* and *Sphiximorpha petronillae*), arguably, one of the rarest European hoverflies and previously known only from four localities (Doczkal and Vujić 1998; de Courcy Williams et al. 2011) and four specimens, all from mountainous areas. In Serbia it is red listed (Vujić et al. 2001) and it is a prime candidate for the European red-list as well. The species could have been overlooked as its real status was revised not too long ago. The species resembles the very common *Epistrophe eligans* and also, to a lesser extent, *Ischyrosyrphus* spp. and *Melangyna* spp. (Doczkal and Vujić 1998).

Mallota fuciformis (Fabricius, 1794)

New data. Serbia, Novi Sad, University Park, along

Danube river, 45°15'0"N, 19°33'0"E, 07-04-2019, 1♀ leg. AvE [AvE].

Ecology. The female was collected visiting flowers of *Prunus avium* along an alluvial *Salix-Tilia* forest close to the Danube River.

Remarks. A second female was observed on the same tree but could not be collected. Only two earlier reports for Serbia are known (Nedeljković et al. 2009; Radenković et al. 2013). This is a very rare but widespread West-Palaearctic species and its status throughout Europe varies as it is listed as vulnerable and declining in Germany (Ssymank et al. 2011) while it is recently extending its range in the Netherlands (Reemer et al. 2009; Bot and Van de Meutter 2019).

Primocerioides regale Virolovitsh, 1985 (Fig. 3C)

New data. Serbia, Belgrade, Memorial Park of Jajinci, 03-05-2019, 1♂ M. Mareš [photo].

Ecology. It was seen on a trunk of *Quercus* sp. in a young thermophilous *Fraxinus* forest park in Belgrade.

Remarks. This is another extremely rare European species with only three other localities known (van Steenis et al. 2016; Speight 2018). The species was supposed to have been described from Belgrade but no type material could be found (van Steenis et al. 2016). The occurrence in Serbia is here confirmed. The species is currently known from only three recent post 2010 localities in Europe, namely NE Greece, Lesvos (Ricarte et al. 2012; Steenis et al. 2016) and Belgrade, making it a candidate for the European Red List.

Psilota anthracina Meigen, 1822 – **New to Serbia**

New data. Serbia, Novi Sad, University Park, along Danube river, 45°15'0"N, 19°33'0"E, 07-04-2019, 1♂ leg. AvE [AvE], 1♂ leg. LjvdE [LjvdE]; Serbia, Novi Sad, Kamenički Park, 45°13'12"N, 19°50'24"E, 09-04-2019, 2♀ leg. JvS [JvS]; Kamenički Park, 45°13'42.7656"N, 19°50'59.7264"E, 10-04-2019, 9♀ leg. AV & SR [FSUNS]; Kamenički Park, 45°13'42.7656"N, 19°50'59.7264"E, 16-04-2019, 3♀ leg. TT & ŠA [FSUNS].

Ecology. The males were collected visiting flowers of *Prunus avium* along an alluvial *Salix-Tilia* forest close to the Danube river and the females were collected with egg laying behaviour near a sap run on *Quercus pubescens* (Fig. 3F).

Remarks. This is a widespread European species and extending its range in the Netherlands (Reemer et al. 2009).

Sphiximorpha petronillae (Rondani, 1850) (Figs 3D, E; 6A, B) – **New to Serbia**

New data. Serbia, Novi Sad, Kamenički Park, 45°13'12"N, 19°50'24"E, 09-04-2019, 1♂, 2♀ leg. JvS [JvS]; Kamenički Park, 45°13'42.7656"N, 19°50'59.7264"E, 10-04-2019, 1♀ leg. AV & SR [FSUNS].

Ecology. The male was sitting motionless on the trunk of a very large *Quercus pubescens* tree at a height of 1.5 m-

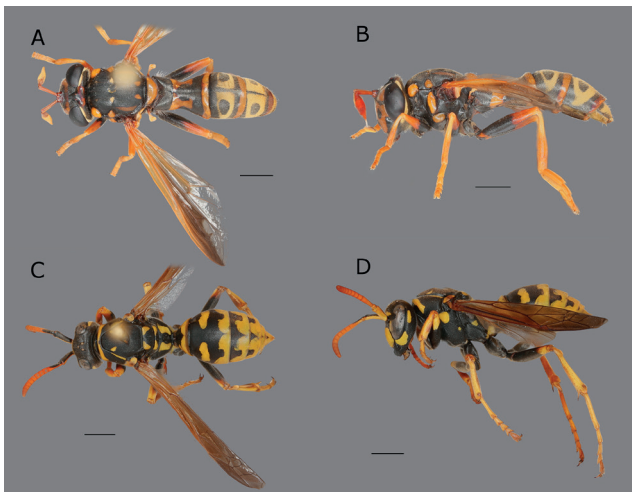


Fig. 6. Adult habitus – **A, C:** dorsal view; **B, D:** lateral view. **A, B:** *Sphiximorpha petronillae* female; **C, D:** *Polistes dominulus* female (the Netherlands). (Scale bar 2.5 mm.)

tres. The females (Figs 3D, E) were seen with egg laying behaviour on the same tree. One female stayed far from the sap run and walked slowly over the bark. Another female landed close to the sap run and was more active as if to avoid the ants present around the sap run. While flying the females showed remarkable similarity to the European paper wasp, *Polistes dominulus*, with the orange antennae and long yellow metalegs hanging down (Figs 6C, D). The two females were seen with the tip of the abdomen in crevices in the bark as if laying eggs. Eggs could not be found but it is very likely that they were present.

Remarks. This is an endemic species for Europe and extremely rare (van Steenis et al. 2016). It is recently known only from one other locality in NE Greece (Speight, 2018). Part of the habitat in Italy and Montenegro where this species was previously found is supposed to be destroyed (Ante Vujić and Pierfillippo Cerretti pers. comm.). This species should be considered as critically endangered.

Sphiximorpha subsessilis (Illiger in Rossi, 1807)

New data. Serbia, Novi Sad, University Park, along Danube river, 45°15'0"N, 19°33'0"E, 09-04-2019, 1♂ leg. JvS [JvS]; Kamenički Park, 45°13'42.7656"N, 19°50'59.7264"E, 10-04-2019, 1♀ leg. AV & SR [FSUNS].

Ecology. The male was patrolling around a *Salix alba* with two large sap runs in an alluvial forest along the Danube River. The female was collected on the bark of a large, old *Quercus pubescens*.

Remarks. There is only one previous published report for the occurrence of this species in Serbia (Radenković et al. 2013) although it was also recently collected from the Stražilovo area in the Fruška Gora National Park (Zorica Nedelković pers. comm.). It is a widespread but rare species in the West Palaearctic region (van Steenis et al. 2016) and

shows extreme fluctuations in population size in Belgium and some parts of the Netherlands (Bastiaan Wakkie pers. comm; JvS pers. obs.).

DISCUSSION

During this short investigation many saproxylic species were collected of which several were new to the Serbian fauna. Although the Serbian fauna is relatively well known the number of new species for its fauna is surprisingly high. In the light of the increasing numbers of saproxylic species in Belgium and the Netherlands (Reemer et al. 2009; Bot and Van de Meutter 2019) it could be that saproxylic species do relatively well in all of Europe. The possible explanation for this increase will be multidimensional and more research is needed to find out the true reasons. The investigation resulted in increasing the number of hoverfly species in Serbia to 419.

Value of the Kamenički Park for saproxylic hoverflies

Just a few days collecting in a small (33 ha) forested area (Kamenički Park) within an urban setting revealed six new saproxylic species for the Serbian fauna, including one possible new species for science. Among these was the extremely rare European endemic *Sphiximorpha petronillae*. This stresses the importance of this remnant of a former widespread alluvial forest along the Danube (Secerov and Nevenic 2004) which seems to harbour a wealth of saproxylic hoverfly species not equalled elsewhere in Serbia. Only by thorough further investigations can its real importance be revealed. Fortunately, the area is already under protection as a Nature Monument and classified as a saproxylic insect and bird park (Anonymous 2010; Sekulić 2011).

In the park there are several different allocated areas, for recreation, for leisure and for nature conservation. It is the highest ranked park in the Novi Sad area for aesthetic, social and ecological values (Lakićević and Srđević 2017; Lukić et al. 2018).

The western part of the park is relatively flat with a typical park-like structured forest of scattered trees and an understory of low growing herbs with some larger bushes of *Prunus* spp., *Sambucus* ssp and *Crataegus* spp. In this part, little dead wood is found, however, trees are sometimes old and contain small rot holes or sap runs. Here most of the *Brachypalpus valgus*, two specimens of *Criorhina pachymera* and also *Paragus pecchiolii* and both *Xanthogramma* species were collected. Along the meadows some *Crataegus*, *Prunus* and *Sambucus* shrubs are present. In the forested part of the park (with e.g. *Acer platanoides*, *Carpinus* spp., *Ulmus minor*, *Tilia tomentosa*, *Quercus cerris* and *Q. robur*) along the Danube river, *Brachyopa bicolor*, *B. grunewaldensis*, *B. silviae*,

Brachypalpus laphriformis, *Ferdinandea cuprea* and *Neocnemodon brevidens* were collected near a fallen tree which created a small forest clearing and/or close to trees with sap runs. The following rare saproxylic species *Brachyopa bicolor*, *B. grunewaldensis*, *B. insensilis*, *Brachypalpus aff valgus*, *B. valgus*, *Criorhina pachymera*, *Psilota anthracina* and *Sphiximorpha petronillae* were collected on one single *Quercus pubescens* tree with sap runs. This tree and one other, were both planted in 1805, and are standing on a mown meadow in a higher part of the park with a children's playground close by and a soccer field below. Close by there is a flowering *Prunus avium* and some damaged *Aesculus* trees. Towards the east there is a planted pine forest with very little undergrowth present and, to the north, a hillside forest with several broad-leaved trees. Here the two *Quercus pubescens* trees contained several rot holes which were covered by steel wire frames, and wounds were present where large branches had been cut from the tree trunk. Most of these wounds were plastered with a protective layer to prevent further damage. On one of the trees, two such wounds were cracked open and here the heartwood was visibly decaying with sap runs present along the outer edges of the wounds (Fig. 5D). On this tree the European velvety tree ant, *Liometopum microcephalum* (Panzer, 1798) was very abundant. This ant is an indicator species for high biodiversity and has only a restricted range in SE Europe (Petráková et al. 2017).

Protective measures

Kamenički Park has an important role for tourism and nature protection (Lukić et al. 2018), but the proposed measures to promote tourism in the park (Jegdić and Gradinar 2016) pose a possible threat to the free standing trees. In the context of these proposals, it is advised that Kamenički Park should be listed as a Prime Hoverfly Area (see Vujić et al. 2016) that requires strict protection. In the western part of the park, some selected old trees could be felled and their branches and logs left on the forest floor to enhance the habitat for deadwood living insects. The borders between the meadows and the forest could be transformed into a herb rich meadow with flowering food plants for insects like *Ranunculus* spp. and several different Apiaceae. This can be achieved by mowing these borders only once every year or even every two years. The management of the two *Quercus pubescens* trees should be aimed at preserving the old trees. A careful evaluation of the best protective measurements is required. The two areas where large branches have fallen off need to be left alone without any management. If, in the future, further branches are removed then the resulting stumps should be left untreated so that decaying heartwood and new sap runs can develop. The old rot holes, which are

currently fenced off by steel wire frames, need to be kept clear of the plants which grow within them. This will ensure longer survival of this important microhabitat for saproxylic species. Along with these protective measures, planting new *Quercus pubescens* trees along the forest borders and in the meadow is advised. The pine forest does not seem to have a high recreational value, nor does it have any significant ecological importance within the overall area. It is advised that this forest should be converted to an open broadleaved forest by planting trees like *Quercus cerris*, *Q. pubescens*, *Aesculus hippocastanum*, *Tilia tomentosa* with some flowering shrubs and trees like *Crataegus* spp. and *Prunus* spp.

Further research on *Sphiximorpha petronillae*

The enigmatic and European endemic hoverfly *Sphiximorpha petronillae* is known from only five localities (van Steenis et al. 2016; Speight 2018) and is, together with *Epi-strophella coronata*, one of the rarest European species. In Italy, there are only two records; one from before 1850 and the other from 1997. In Montenegro it was recorded once in 1994 and in NE Greece it was collected several times in recent years. The localities in Italy and Montenegro are suspected to be lost or degraded in such a way that the existence of the species is doubtful (van Steenis et al. 2015; Mei 2016). In Greece there seems to be a flourishing population which is connected to old *Quercus cerris* trees inhabited by the European velvety tree ant (Speight 2018). The distribution of this ant seems to coincide with the collecting localities of *Sphiximorpha petronillae* in Italy, Montenegro and especially in Greece (Del Toro et al. 2009; Petráková et al. 2017). The possibility of *Polistes dominulus* being the model for *Sphiximorpha petronillae* has already been mentioned in the Results section above. However, another plausible model could be the European ant hunter *Tracheliodes curvitarus* (Hymenoptera, Crabronidae). This wasp is known to predate on the European velvety tree ant and they are found at several European localities where this ant still remains (Zettel et al. 2004; Mei 2016). For the future protection of *Sphiximorpha petronillae* it is advised that more research is required in order to establish the true connection with the European velvety tree ant and to search for further populations at localities where the ant and its predatory wasp are known to occur.

ACKNOWLEDGMENTS

The IUCN is thanked for organizing the European Syrphidae Red List workshop in Novi Sad, which refunded travel expenses, making it possible to collect specimens here. Gerard Pennards (Amersfoort, the Netherlands) assisted JvS, AvE and LJvdE during sample collecting in the University park. Furthermore, Zlata Markov (Novi Sad, Serbia) is ac-

knowledge for driving JvS to the fabulous Kamenički Park laying the foundation for this paper. Mihailo Vujić (Belgrade, Serbia) is thanked for his post on the rediscovery of *Primocerioides regale* by Miroslav Mareš (Belgrade, Serbia) who is acknowledged for the nice photograph of the male specimen. Chris Palmer (Portsmouth, United Kingdom) and Nigel Wyatt (London, United Kingdom) kindly checked the English language in this manuscript. Jiri Schlaghamerský (Brno, Czech Republic) is acknowledged for sending the first author some important papers about the identification of the European velvety tree ant.

REFERENCES

- Anonymous. 2010. Regulation of the Government on the Ecological Network, Official Gazette of the Republic of Serbia No. 102/2010, 1–28.
- Bot S, Van de Meutter F. 2019. *Veldgids Zweefvliegen*. KNNV Uitgeverij, Zeist, 388 pp.
- Bradescu V. 1991. Les Syrphides de Roumanie (Diptera, Syrphidae). Clés de détermination et répartition. Travaux du Muséum d'Histoire naturelle Grigore Antipa. 31:1–83.
- Collin JE. 1939. Notes on Syrphidae (Diptera). III. The Entomologist's Monthly Magazine. 75:104–109.
- De Courcy Williams ME, Toussidou M, Speight MCD. 2011. Hoverflies (Diptera, Syrphidae) new to Greece from the Rhodope Mountains of Thrace and eastern Macedonia, including *Simosyrphus scutellaris* new to Europe. Dipterists Digest. 18:181–198.
- Del Toro I, Pacheco JA, Mackay WP. 2009. Revision of the Ant Genus *Liometopum* (Hymenoptera: Formicidae). Sociobiology. 53(2A):296–369.
- Doczkal D, Dziock F. 2004. Two new species of *Brachyopa* Meigen from Germany, with notes on *B. grunewaldensis* Kassebeer (Diptera, Syrphidae). Volucella. 7:35–59.
- Doczkal D, Vujić A. 1998. Redescription of *Epistrophella coronata* (Rondani, 1857), stat. rest., comb. nov., with first description of the male, and notes on the generic assignment (Diptera, Syrphidae). Volucella. 3:51–62.
- Janković MA, Miličić MS, Radišić DP, Milić DM, Vujić A. 2018. New findings on protected and strictly protected species confirm the value of the Prime Hoverfly Area network. Matica Srpska Journal for Natural Sciences. 135:63–71.
- Jakovljević K, Niketić M, Lakušić D, Vukolčić S. 2015. Conservation status of some rare Boreo-Montane species in Serbia. Bulletin of the Natural History Museum. 8:87–100.
- Jegdić V, Gradinač O. 2016. Cites as destination of Urban Ecotourism. A case study of Novi Sad. Acta Economica et Turistica. 2(2):101–236.
- Lakićević MD, Srđević BM. 2017. Multiplicative versions of promethee method in assessment of parks in Novi Sad. Matica Srpska Journal for Natural Sciences. 132:79–86.
- Lukić D, Berjan S, El Bilali H. 2018. Indicators of tourism development of the Serbian Danube region. R-Economy. 4(1):30–38.
- Mazánek L, Vujić A, Gregor T, Barták M, Kubík Š. 2005. Syrphidae, pp 197–229. In: Barták and Kubík (eds) Diptera of Podyjí National Park and its environs. Česká zemědělská univerzita v Praze Fakulta agrobiologie, potravinových a přírodních zdrojů. Děkanátem FAPPZ, PowerPrint, Praha 6 - Suchbátol.
- Mei M. 2016. Records of *Tracheliodes varus* (Panzer) and *T. curvitaris* (Herrich-Schaeffer) from Central Italy (Hymenoptera, Crabronidae). Ampulex. 8:16–19
- Nedeljković Z, Vujić A, Šimić S, Radenković S. 2009. The fauna of hoverflies (Diptera: Syrphidae) of Vojvodina province, Serbia. Archives of Biological Sciences. 61(1):147–154.
- Petráková L, Tóthová A, Schlaghamerský J. 2017. Phylogeography of the rare velvety tree ant *Liometopum microcephalum* (Formicidae: Dolichoderinae). Journal of Biogeography. 44(7):1652–1664.
- Radenković S, Vujić A, Šimić S. 2004. New data on hoverfly diversity (Insecta: Diptera: Syrphidae) of the special nature reserve the Obedska Bara marsh (Ramsar site in Serbia). Proceedings for Natural Sciences, Matica Srpska. 107: 21–31.
- Radenković S, Nedeljković Z, Ricarte A, Vujić A, Šimić S. 2013. The saproxylic hoverflies (Diptera: Syrphidae) of Serbia. Journal of Natural History. 47(1-2):87–127.
- Reemer M, Renema W, van Steenis W, Zeegers Th, Barendregt A, Smit JT, van Veen MP, van Steenis J, van der Leij LJJM. 2009. De Nederlandse zweefvliegen (Diptera: Syrphidae). Nederlandse Fauna 8, Leiden. Nationaal Natuurhistorisch Museum Naturalis, KNNV Uitgeverij, European Invertebrate Survey – Nederland.
- Ricarte A, Quinto J, Speight MCD, Marcos-García MA. 2013. A contribution to knowledge of the biodiversity of Syrphidae (Diptera) in Spain. Archives of Biological Science Belgrade. 65(4):1533–1537.
- Rotheray GE, Gilbert FS. 2011. The Natural History of Hoverflies. Forrest Text The Blissett group, London, 334 pp.
- Secerov V, Nevenic M. 2004. Serbian Danube Basin through the Ages: from Past to Present. Journal of Serbian Geographic Society. 84(2): 223–230.
- Sekulić G. 2011. Overview of the national system of protected areas in Serbia: Recommendations for the Implementation of IUCN Protected Area Management Categories. Master Thesis of the Management of Protected Areas Programme, University of Klagenfurt. 89 pp.
- Speight MCD, Sarthou V, Garrigue J. 2013. *Brachyopa silviae* Doczkal & Schmid, *Chrysotoxum gracile* Becker and *Eumerus pussilius* Loew (Diptera, Syrphidae) new to France. Dipterists Digest. 20:33–40.
- Speight MCD. 2018. Species accounts of European Syrphidae, 2018. Syrph the Net, the database of European Syrphidae (Diptera), vol.103, Syrph the Net publications, Dublin, 302 pp.
- Ssymank A, Doczkal D, Rennwald K, Dziock F. 2011. Rote Liste und Gesamtartenliste der Schwebfliegen (Diptera: Syrphidae) Deutschlands. In: Binot-Hafke et al. (Red.): Rote Liste gefährdeter Tiere, Pflanzen und Pilze Deutschlands. Band 3: Wirbellose Tiere (Teil 1). Münster (Landwirtschaftsverlag). Naturschutz und Biologische Vielfalt. 70(3):13–83.
- van Steenis J, van Steenis W, Ssymank A, van Zuijlen MP, Nedeljković Z, Vujić A, Radenković S. 2015. New data on the hoverflies (Diptera: Syrphidae) of Serbia and

- Montenegro. *Acta entomologica serbica*. 20:67–98.
- van Steenis J, Ricarte A, Vujić A, Birtelle D, Speight MCD. 2016. Revision of the West-Palaeartic species of the tribe Cerioidini (Diptera, Syrphidae). *Zootaxa*. 4196(2):151–209.
- van Veen M. 2004. Hoverflies of Northwest Europe: Identification keys to the Syrphidae. KNNV Publishing, Utrecht, 255 pp.
- Vujić A. 1991. Species of genus *Brachyopa* Meigen, 1822 (Diptera: Syrphidae). *Bulletin of Natural History, Belgrade, B*. 46:141–150.
- Vujić A, Glumac S. 1994. Fauna of hover flies (Diptera: Syrphidae) of Fruška gora. *Matica Srpska, Novi Sad*, 81 pp. [in Serbian].
- Vujić A, Milankov V. 1999. New data for the tribes Milesiini and Xylotini (Diptera, Syrphidae) on the Balkan Peninsula. *Dipteron*. 2(6):113–132.
- Vujić A, Šimić S, Radenković S. 2001. Endangered species of hoverflies (Diptera: Syrphidae) on the Balkan Peninsula. *Acta entomologica serbica*. 5:93–105.
- Vujić A, Šimić SD, Radenković S. 2002. New data on hoverflies diversity (Insecta: Diptera: Syrphidae) on the Fruška Gora mountain (Serbia). *Proceedings for Natural Sciences, Matica Srpska*. 103:91–106.
- Vujić A, Radenković S, Nikolić T, Radisić D, Trifunov S, Andrić A, Markov Z, Jovicić S, Mudri Stojnić S, Janković M, et al. 2016. Prime Hoverfly (Insecta: Diptera: Syrphidae) Areas (PHA) as a conservation tool in Serbia. *Biological Conservation*. 198:22–32.
- Vujić A, Radenković S, Nedeljković Z, Šimić SD. 2018. A new checklist of hoverflies (Diptera: Syrphidae) of the Republic of Serbia. *Matica Srpska Journal for Natural Sciences*. 135:7–51.
- Zettel H, Ljubomirov T, Steiner FM, Schlick-Steiner BC, Grabenweger G, Wiesbauer H. 2004. The European ant hunters *Tracheliodes curvitarisus* and *T. varus* (Hymenoptera: Crabronidae): taxonomy, species discrimination, distribution, and biology. *Myrmecologische Nachrichten*. 6:39–47.

Appendix 1. Species list of recorded species, the total number of males and females is given for each of the four collecting sites in the surroundings of Novi Sad. The species marked with an asterisk are new to the Serbian fauna and are discussed in more detail in the paper. Only *Primoceroideus regale* is not listed here, see under that species for further information.

Species	Collecting sites				Σ
	University Park	Kamenički Park	Stražilovo	Fruška Gora Popovica	
<i>Baccha elongata</i>	–	4♂, 1♀	1♀	1♂	7
<i>Brachyopa bicolor</i>	3♂	6♂, 3♀	1♂	–	13
<i>B. grunewaldensis</i> *	–	3♂, 1♀	–	–	4
<i>B. insensilis</i>	11♂, 5♀	8♂, 1♀	5♂	–	30
<i>B. maculipennis</i>	6♂, 1♀	–	2♂	–	9
<i>B. plena</i>	–	–	–	1♂	1
<i>B. silviae</i> *	–	1♂	–	–	1
<i>Brachypalpus aff valgus</i> *	–	1♂, 1♀	–	–	2
<i>B. laphriformis</i>	–	1♀	–	–	1
<i>B. valgus</i>	4♂, 1♀	11♂, 1♀	1♂	–	18
<i>Chalcosyrphus nemorum</i>	–	–	1♂	–	1
<i>Cheilosia nebulosa</i>	–	–	1♂	–	1
<i>C. proxima</i>	–	–	1♂	–	1
<i>C. psilophthalma</i>	–	1♀	–	–	1
<i>C. semifasciata</i>	–	–	1♂	–	1
<i>C. vernalis</i>	–	1♂, 2♀	–	–	3
<i>Criorhina floccosa</i>	1♂	1♂	–	–	2
<i>C. pachymera</i> *	–	3♂	–	–	3
<i>Dasysyrphus albostrigatus</i>	–	1♂	1♂	–	2
<i>D. laskai</i>	–	–	1♀	–	1
<i>Epistrophe cryptica</i> *	1♂	–	–	–	1
<i>E. eligans</i>	10♂, 5♀	3♀	6♂, 3♀	1♂	28
<i>E. melanostoma</i>	2♀	2♂, 4♀	1♂	2♂, 2♀	13
<i>E. nitidicollis</i>	3♂, 1♀	3♂, 2♀	2♂	1♂	12

Species	Collecting sites				
	Fruška Gora				
	University Park	Kamenički Park	Stražilovo	Popovica	Σ
<i>Epistrophella coronata</i>	–	1♀	–	–	1
<i>E. euchroma</i>	–	10♂, 1♀	–	2♂, 1♀	14
<i>Episyrphus balteatus</i>	1♀	1♀	–	–	2
<i>Eristalis arbustorum</i>	1♂	–	–	–	1
<i>E. pertinax</i>	1♂	–	–	1♂	2
<i>E. tenax</i>	1♀	–	–	–	1
<i>Eupeodes latifasciatus</i>	–	–	1♂, 1♀	–	2
<i>E. luniger</i>	1♂	–	3♂, 1♀	–	5
<i>E. bucculatus</i>	–	1♀	–	–	1
<i>Ferdinandea cuprea</i>	1♂	1♂	–	–	2
<i>Helophilus pendulus</i>	2♂, 3♀	1♂	–	–	6
<i>Mallota fuciformis</i>	1♀	–	–	–	1
<i>Melangyna lasiophthalma</i>	1♀	–	–	6♂, 1♀	8
<i>Melanostoma mellinum</i>	–	–	4♂, 1♀	–	5
<i>M. scalare</i>	1♀	1♀	3♂, 1♀	–	6
<i>Myathropa florea</i>	1♂	3♂	–	–	4
<i>Neocnemodon brevidens</i>	–	1♂, 1♀	–	–	2
<i>N. latitarsis</i>	–	3♂	–	–	3
<i>Paragus bicolor</i>	–	–	–	1♂	1
<i>P. pecchiolii</i>	–	3♂, 2♀	–	–	5
<i>Parasyrphus punctulatus</i>	–	–	1♂, 1♀	–	2
<i>Pipiza luteitarsis</i>	–	1♀	–	–	1
<i>P. notata</i>	–	–	1♀	–	1
<i>Pipizella viduata</i>	–	3♂	–	–	3
<i>Platycheirus albimanus</i>	–	1♂	1♂, 2♀	–	4
<i>P. fulviventris</i>	1♂	–	–	–	1
<i>P. scutatus</i>	1♂, 2♀	3♂	1♂, 1♀	–	8
<i>Psilota anthracina*</i>	2♂	14♀	–	–	16
<i>Sphaerophoria scripta</i>	–	1♂	4♂	1♂	6
<i>Sphiximorpha petronillae*</i>	–	1♂, 3♀	–	–	4
<i>S. subsessilis</i>	1♂	1♀	–	–	2
<i>Syrphus ribesii</i>	4♂, 1♀	2♀	6♂, 1♀	2♂	16
<i>S. vitripennis</i>	2♂	4♂	–	–	6
<i>Xanthogramma dives</i>	–	1♂	–	–	1
<i>X. stackelbergi</i>	–	1♂	1♂	–	2
Σ = 59					Σ = 301