

# Contribution to the knowledge of the Odonata fauna of Bosnia and Herzegovina – Results of the ECOO 2012

Dejan KULIJER<sup>1</sup>, Damjan VINKO<sup>2</sup>, Magnus BILLOVIST<sup>3</sup>, Jan Joost MEKKES<sup>4</sup>

<sup>1</sup> National Museum of Bosnia and Herzegovina, Zmaja od Bosne 3, 71000 Sarajevo, Bosnia and Herzegovina; E-mail: dejan.kulijer@gmail.com

<sup>2</sup> Slovenska 14, SI-1234 Mengeš, Slovenia; E-mail: damjan.vinko@gmail.com

<sup>3</sup> The Swedish Society for Conservation of Nature in Scania, Box 1013, 221 04 Lund; E-mail: magnus.billqvist@naturskyddsforeningen.se

<sup>4</sup> Vliers 2, 7751 ZS, Dalen, the Netherlands; E-mail: jayjaymekkes@hotmail.com

**Abstract.** As a part of the 2<sup>nd</sup> European Congress on Odonatology (ECOO 2012), which was held in the beginning of July 2012 in Belgrade (Serbia), a post congress excursion to Bosnia and Herzegovina was organized. Between 6 and 12 August 2012, altogether 36 localities in three biogeographical regions throughout Bosnia and Herzegovina were surveyed, and 52 dragonfly species were found. This represents 83% of the hitherto recorded dragonfly species for the country. The most significant results are the second record and a new locality of *Somatochlora metallica*, second record of *Coenagrion hastulatum*, and first observation of the strong population of *Lindenia tetraphylla* for the country. New records of rare and/or threatened species, i.e. *Coenagrion ornatum*, *Ceriatrion tenellum*, *Caliaeschna microstigma*, *Cordulegaster heros* and *Selysiotthemis nigra*, are also reported. The records of the most interesting species are briefly discussed from the aspects of biogeography and nature conservation.

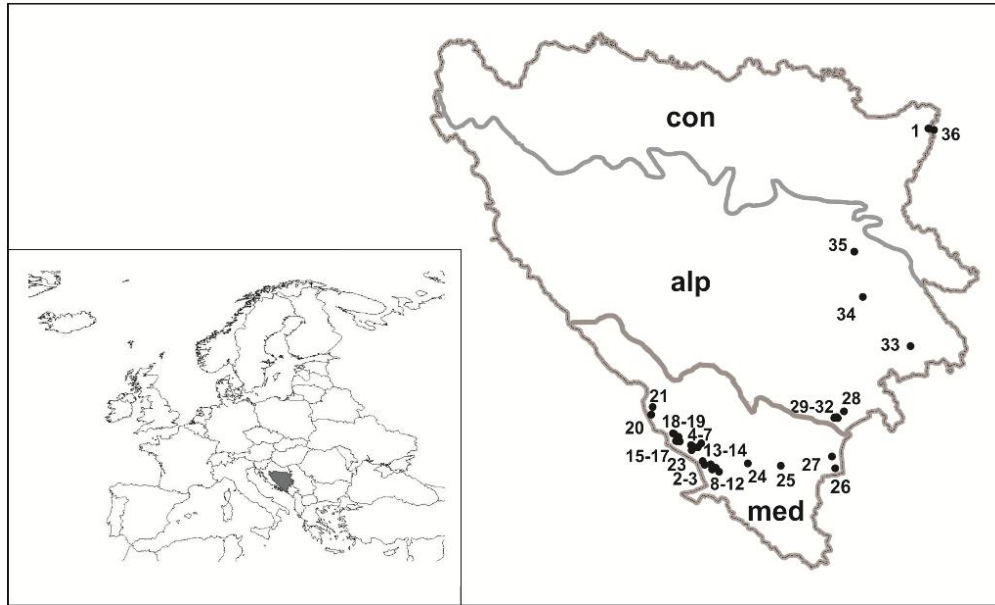
Key words: Odonata, dragonflies, distribution, Bosnia and Herzegovina, the Balkans

**Izveček. PRISPEVEK K POZNAVANJU ODONATNE FAVNE BOSNE IN HERCEGOVINE – REZULTATI ECOO 2012** – Kot del drugega evropskega odonatološkega kongresa (ECOO 2012), ki je v začetku julija 2012 potekal v Beogradu (Srbija), je bila organizirana pokongresna ekskurzija v Bosno in Hercegovino. V času med 6. in 12. julijem 2012 je bilo v treh biogeografskih regijah pregledanih 36 lokalitet in popisanih 52 vrst kačjih pastirjev, kar je 83 % vseh znanih vrst kačjih pastirjev za Bosno in Hercegovino. Med pomembnejšimi je bilo zabeleženo drugo pojavljanje in novo nahajališče kovinskega lesketnika (*Somatochlora metallica*), drugo pojavljanje barjanskega škratca (*Coenagrion hastulatum*) in prvo opažanje populacije velike peščenke (*Lindenia tetraphylla*) za državo. Poročamo tudi o novih nahajališčih redkih in/ali ogroženih vrst: koščičnega škratca (*Coenagrion ornatum*), rdečega voščenca (*Ceriatrion tenellum*), bledega vetrnjaka (*Caliaeschna microstigma*), velikega studenčarja (*Cordulegaster heros*) in temnega slaniščarja (*Selysiotthemis nigra*). Najzanimivejše najdbe so na kratko opisane z biogeografskega in naravovarstvenega vidika.

Ključne besede: Odonata, kačji pastirji, razširjenost, Bosna in Hercegovina, Balkan

## Introduction

Bosnia and Herzegovina is a small country located in the western part of the Balkan Peninsula (Fig. 1). Karst mountains cover the largest, central part of the country separating the southern and the Mediterranean area of Herzegovina from the lowland area of North Bosnia. As a consequence, three biogeographical regions can be distinguished: the Mediterranean, Alpine and Continental (Kulijer et al. 2013, Redžić et al. 2008).



**Figure 1.** Geographical position of Bosnia and Herzegovina with the borders of biogeographical regions (med – Mediterranean, alp – alpine, con - continental) and the position of localities investigated during the post congress excursion of the 2<sup>nd</sup> European Congress on Odonatology (ECO 2012).

**Slika 1.** Geografski položaj Bosne in Hercegovine s prikazom mej biogeografskih regij (med – sredozemska, alp – alpska, con - celinska) in lego lokalitet, preučevanih v okviru pokongresne ekskurzije 2. evropskega odonatološkega kongresa (ECO 2012).

Due to the poor research activities in the past, and as a consequence of the recent war, the country remained one of the least explored in Europe in terms of dragonfly fauna. Although numerous papers with dragonfly records from the country have been published over the past 120 years, most of them include only small number of records or cover only a small portion of the investigated area. The earliest dragonfly records from the country originate from 1888, and can be found in the entomological collection of the National Museum of Bosnia and Herzegovina, where some of the first specimens from the Balkan Peninsula are kept (Kulijer & Marinov 2010). This collection is the most significant source of information on dragonflies of Bosnia and Herzegovina from the past. More than 60 years ago, the old Odonata collection of the National Museum of Bosnia and Herzegovina was reviewed by Adamović (1948), who reported 45 species for the country. In a brief overview of the dragonfly fauna of the former Yugoslav republics, Bedjanič & Bogdanović (2006) mention a

total of 53 species for Bosnia and Herzegovina, while Boudot et al. (2009) listed 50 species for the country. Recently, Jović et al. (2010) compiled a list of 57 dragonfly species, based upon reviewing the literature and new faunistic data. Several papers, which contribute to the knowledge of the dragonfly fauna in the country, have also been published recently, including Bedjanić (2011) and Kulijer (2012).

The dragonfly studies in Bosnia and Herzegovina have recently been significantly intensified, and a great number of new records have become available. In 2009, a national survey and mapping of dragonfly distribution in the country was launched, and the dragonfly database of Bosnia and Herzegovina was created (Kulijer et al. 2013). The first comprehensive revision of Odonata in Bosnia and Herzegovina that includes all available data from literature, revision of museum collections, and a significant number of new, previously unpublished records is given by Kulijer et al. (2013). It includes records of 63 species for the country.

As the 2<sup>nd</sup> European Congress on Odonatology (ECOO 2012) was held in Belgrade (Serbia) in the beginning of July 2012, it was an opportunity to investigate the dragonfly fauna of the Balkan Peninsula as well as to present richness of species and habitats of one of the most preserved and odonatologically least known regions of Europe. Two post congress excursions to Bosnia and Herzegovina and Macedonia were organized. In this article, we present and discuss results of the post congress excursion to Bosnia and Herzegovina made between 6 and 12 August 2012.

## Study area

Our survey included all three biogeographical regions of the country. Northern Bosnia, bordering on the Sava River in the north, is a lowland region under the continental influence from Central Europe and Pannonian planes that stretch further to the north. In this area we visited two localities: one on the first (L 1) and one on the last day of the survey (L 36). At both locations, numerous gravel pits were found; some of them were largely overgrown by vegetation and hardly accessible, while others that are still in use were more or less without vegetation. At the last location we also inspected a small section of the Drina River in the border area to Serbia.

South Herzegovina region, influenced by the Mediterranean climate from the Adriatic Sea, with 55 known species, is the dragonfly richest region of the country (Kulijer et al. 2013). The most interesting habitats in this area are found in the lower part of the Neretva River basin. Our research focused on Hutovo Blato Nature Park and the Trebižat River Valley. Hutovo Blato (L 8-12) is one of the most important marshland areas of the country, and one of the most significant dragonfly areas. While traveling from the Neretva River Valley towards the mountain areas of East Bosnia, we also inspected several habitats at the Bregava River (L 24), Dabarsko polje (L 25) and Gatačko polje (L 26-27).

Some of the most interesting habitats in central part of the country are glacial lakes, ponds and bogs in the high mountain zone above 1,400 m. These lakes host populations of several species, mainly of the northern European distribution which, in this area, are at the southern border of their distributions (Kulijer et al. 2013). On one of the last survey days we inspected some of these habitats in Zelengora Mts. in Sutjeska National Park, where most of these lakes are located. In Zelengora Mts., we inspected the Donje Bare and Gornje Bare Lakes, and forest habitats along the road and ponds near Gornje Bare Lake (L 28-32). While traveling through Central Bosnia, we also made few quick stops in order to investigate several habitats, mainly running water (L 33-35).

## Material and methods

The Odonata were surveyed between 6 and 12 August 2012. The weather during the survey period was sunny, sometimes with high noon temperatures of over 35 °C, or 40 °C in the Mediterranean area. In general, the weather was very favourable for dragonflies, and mostly without rain or wind.

Mainly dragonfly adults were observed, while exuviae and larvae were searched for only sporadically. In total, we visited 36 localities (Fig. 1, Tab. 1): 26 in the Mediterranean region, 8 in the Alpine region, and 2 in the Continental region of the country. The division into three biogeographical regions is based on the map of the distribution of biogeographical regions in Europe (EEA 2005).

Our intention was to investigate as many different habitats as possible, but the short time of the excursion limited the research. The selection of localities was based on the possibility to find the most interesting species, and to present the diversity of species and habitats of the West Balkans and – with it – Bosnia and Herzegovina. Although we visited all three biogeographical regions of the country, the restricted time enabled detailed study only in the Mediterranean region. This region hosts some of the most interesting and most endangered taxa in the country. The region is characterized by rich and diverse freshwater habitats that are insufficiently researched.

All the records collected during this research have been entered into the national dragonfly database, and voucher specimens deposited in the collections of the National Museum of Bosnia and Herzegovina in Sarajevo.

**Table 1.** List of the localities investigated during the post congress excursion of the 2<sup>nd</sup> European Congress on Odonatology (ECCO 2012) to Bosnia and Herzegovina. For each locality geographical coordinates, altitudes and the survey dates are given.

**Tabela 1.** Seznam preučevanih lokalitet v okviru pokongresne ekskurzije 2. evropskega odonatološkega kongresa (ECCO 2012) v Bosno in Hercegovino. Za vsako lokaliteto je dodan zapis geografskega položaja, nadmorske višine in datum preučevanja.

	Locality name	X	Y	Alt. [m]	Date
1.	Gravel pits at Pavlović Bridge, Bijeljina	44° 47' 21"	19° 17' 54"	88	6-VII-2012
2.	Neretva River near Struge	43° 04' 54"	17° 41' 55"	2	7-VII-2012
3.	Trebižat River near Gorica	43° 06' 03"	17° 41' 08"	14	7-VII-2012
4.	Spring near Donji Studenci	43° 10' 10"	17° 37' 41"	49	7-VII-2012
5.	Vakuf spring at Studenci	43° 10' 47"	17° 36' 26"	41	7-VII-2012
6.	Spring and small stream at Gornji Studenci	43° 10' 51"	17° 36' 10"	60	7-VII-2012
7.	Road near Studenci	43° 10' 49"	17° 36' 24"	66	7-VII-2012
8.	Škrka Lake, Hutovo blato	43° 05' 02"	17° 44' 31"	4	8-VII-2012
9.	Canal and Krupa River at Karaotok (by boat), Hutovo blato	43° 03' 59"	17° 46' 35"	2	8-VII-2012
10.	Deransko Lake (by boat), Hutovo blato	43° 02' 48"	17° 47' 59"	2	8-VII-2012
11.	Krupa River from Karaotok to Svitavsko Lake, Hutovo blato	43° 03' 27"	17° 45' 03"	3	8-VII-2012
12.	Small canal and ponds near Karaotok, Hutovo blato	43° 04' 15"	17° 45' 06"	4	8-VII-2012
13.	Međugorje, village centre	43° 11' 27"	17° 40' 33"	160	9-VII-2012
14.	Road south of Međugorje	43° 10' 14"	17° 39' 06"	142	9-VII-2012
15.	Small canal at Humac village, Ljubuški	43° 11' 58"	17° 31' 28"	74	9-VII-2012
16.	Vrioštica River at Kutac, Ljubuški	43° 12' 06"	17° 30' 27"	72	9-VII-2012
17.	Mlade River at Lošče, Ljubuški	43° 12' 09"	17° 29' 53"	72	9-VII-2012
18.	Spring at Proboj, Ljubuški	43° 13' 26"	17° 30' 53"	99	9-VII-2012
19.	Spring of Vrioštica River, Vitina	43° 14' 15"	17° 29' 10"	94	9-VII-2012
20.	Spring and River Tihaljina at Peč Mlini	43° 20' 10"	17° 19' 26"	266	9-VII-2012
21.	Krenica Lake, Drinovci	43° 22' 29"	17° 19' 57"	257	9-VII-2012
22.	Road at Utvica, Vitina	43° 14' 28"	17° 28' 36"	86	9-VII-2012
23.	Kravice Waterfall and Trebižat River	43° 09' 21"	17° 36' 30"	48	10-VII-2012
24.	Bregava River NE of Stolac	43° 05' 20"	18° 00' 01"	109	10-VII-2012
25.	Small spring, stream and canal at Pribitu, Dabarsko karst polje	43° 04' 38"	18° 13' 49"	482	10-VII-2012
26.	Small pond at Kazanci, Gatačko karst polje	43° 03' 45"	18° 36' 38"	951	10-VII-2012
27.	Pond near Gareva village, Gatačko karst polje	43° 07' 23"	18° 35' 21"	919	10-VII-2012
28.	Road to Bare, Zelengora mountain	43° 21' 10"	18° 40' 29"	917	11-VII-2012
29.	Wet meadow and small ponds near Gornje Bare Lake	43° 19' 21"	18° 36' 29"	1521	11-VII-2012
30.	Gornje Bare Lake	43° 19' 12"	18° 36' 27"	1519	11-VII-2012
31.	Road to Donje Bare Lake	43° 19' 25"	18° 37' 26"	1453	11-VII-2012
32.	Donje Bare Lake	43° 19' 05"	18° 37' 50"	1485	11-VII-2012
33.	Drina river N of Goražde	43° 40' 53"	19° 08' 57"	369	12-VII-2012
34.	Pond near Sokolac, formed by small dam on the stream	43° 56' 08"	18° 48' 57"	881	12-VII-2012
35.	Drinjača River near Vlasenica	44° 12' 51"	18° 40' 10"	469	12-VII-2012
36.	Gravel pits and Drina River near Pavlović Bridge	44° 46' 56"	19° 20' 01"	86	13-VII-2012

## Results

Altogether, we collected 357 records of 52 species from 36 localities. The list of recorded species with the locality data is presented in Table 2. Remarks on some interesting species are provided in the discussion section.

**Table 2.** Checklist of the Odonata species recorded during the post congress excursion of the 2<sup>nd</sup> European Congress on Odonatology (ECCO 2012) to Bosnia and Herzegovina. The references for the locality where each species was observed are given. Species listed in Annexes II and/or IV of the Habitats Directive are printed in bold.

**Tabela 2.** Seznam vrst kačjih pastirjev, najdenih v okviru pokongresne ekskurzije 2. evropskega odonatološkega kongresa (ECCO 2012) v Bosno in Hercegovino. Zapisu vrste je dodan seznam lokalitet, na katerih je bila vrsta najdena. Vrste, uvrščene v Prilogo II in/ali IV Habitatne direktive, so v krepkem tisku.

Species	Number of locality
CALOPTERYGIDAE	
1. <i>Calopteryx splendens</i> (Harris, 1782)	2, 3, 4, 9, 12, 15-17, 19-21, 23, 24, 36
2. <i>Calopteryx virgo</i> (Linnaeus, 1758)	3-5, 15, 16, 18-20, 22-25, 35
LESTIDAE	
3. <i>Lestes sponsa</i> (Hansemann, 1823)	1, 27, 29, 30, 34
4. <i>Lestes dryas</i> Kirby, 1890	26, 27, 29, 30
5. <i>Lestes barbarus</i> (Fabricius, 1798)	12, 25, 26, 29
6. <i>Lestes virens</i> (Charpentier, 1825)	29
7. <i>Chalcolestes parvidens</i> (Artobolevskii, 1929)	12, 23
8. <i>Sympetma fusca</i> (Vander Linden, 1820)	1, 11, 12, 25, 27
COENAGRIONIDAE	
9. <i>Ischnura elegans</i> (Vander Linden, 1820)	1-4, 8-12, 15-17, 19, 21, 23, 25, 27, 36
10. <i>Ischnura pumilio</i> (Charpentier, 1825)	19, 25, 27, 34
11. <i>Enallagma cyathigerum</i> Charpentier, 1840	1, 9, 29-32, 34
12. <i>Coenagrion puella</i> (Linnaeus, 1758)	1-3, 8, 15, 16, 19, 25-27, 29, 34
13. <b><i>Coenagrion ornatum</i> (Selys, 1850)</b>	<b>16</b>
14. <i>Coenagrion scitulum</i> (Rambur, 1842)	27
15. <i>Coenagrion hastulatum</i> (Charpentier, 1825)	29, 32
16. <i>Erythromma viridulum</i> (Charpentier, 1840)	1, 8-11, 36
17. <i>Erythromma lindenii</i> (Selys, 1840)	2, 3, 8-10, 23
18. <i>Pyrrhosoma nymphula</i> (Sulzer, 1776)	32, 34
19. <i>Ceragrion tenellum</i> (de Villers, 1789)	3, 8, 16
PLATYCNEMIDIDAE	
20. <i>Platycnemis pennipes</i> (Pallas, 1771)	1-6, 9, 11, 12, 16, 17, 19-21, 23, 27, 33-36
AESHNIDAE	
21. <i>Aeshna mixta</i> Latreille, 1805	36
22. <i>Aeshna affinis</i> Vander Linden, 1820	2, 4, 8, 11, 19, 22, 25
23. <i>Aeshna isoceles</i> (Müller, 1767)	3, 9, 10-12, 19, 23, 25
24. <i>Aeshna grandis</i> (Linnaeus, 1758)	28-30, 32
25. <i>Aeshna cyanea</i> (Müller, 1764)	7, 13, 19, 25, 29, 30, 32
26. <i>Aeshna juncea</i> (Linnaeus, 1758)	29, 30, 32
27. <i>Anax imperator</i> Leach, 1815	1-4, 8-10, 15-17, 19, 21, 23-25, 29-32, 34
28. <i>Anax parthenope</i> (Selys, 1839)	1, 2, 8, 10, 11
29. <i>Brachytron pratense</i> (Müller, 1764)	9
30. <i>Caliaeschna microstigma</i> (Schneider, 1845)	4, 5, 6, 20, 23

	<b>Species</b>	<b>Number of locality</b>
	<b>GOMPHIDAE</b>	
31.	<i>Onychogomphus forcipatus</i> (Linnaeus, 1758)	1, 3, 4, 6, 15-17, 20, 23, 24, 35, 36
32.	<b><i>Lindenia tetraphylla</i> (Vander Linden, 1825)</b>	<b>2, 8, 10-12</b>
	<b>CORDULEGASTERIDAE</b>	
33.	<b><i>Cordulegaster heros</i> Theischinger, 1979</b>	<b>4-7, 14, 20, 23</b>
34.	<i>Cordulegaster bidentata</i> Selys, 1843	19, 20, 31
	<b>CORDULIIDAE</b>	
35.	<i>Cordulia aenea</i> (Linnaeus, 1758)	29-32
36.	<i>Somatochlora metallica</i> (Vander Linden, 1825)	29, 30, 32
37.	<i>Somatochlora meridionalis</i> Nielsen, 1935	4
38.	<i>Somatochlora flavomaculata</i> (Vander Linden, 1825)	9-11, 25
	<b>LIBELLULIDAE</b>	
39.	<i>Libellula quadrimaculata</i> Linnaeus, 1758	10, 11, 25, 29-32
40.	<i>Libellula depressa</i> Linnaeus, 1758	18, 20, 25, 27, 30
41.	<i>Libellula fulva</i> (Müller, 1764)	2-4, 6, 9-12, 17, 19, 21, 23, 25, 34
42.	<i>Orthetrum cancellatum</i> (Linnaeus, 1758)	2-5, 8, 10, 11, 21, 23, 30, 32, 33, 36
43.	<i>Orthetrum albistylum</i> (Selys, 1848)	1-3, 8-11, 15, 36
44.	<i>Orthetrum coerulescens</i> (Fabricius, 1798)	2-6, 8-12, 15-17, 19, 20, 22-25
45.	<i>Orthetrum brunneum</i> (Fonscolombe, 1837)	2, 4, 6, 8, 9, 11, 15, 17-19, 24, 25
46.	<i>Sympetrum sanguineum</i> (Müller, 1764)	1, 3, 8, 24, 25, 27, 30, 34
47.	<i>Sympetrum flaveolum</i> (Linnaeus, 1758)	25-27, 29, 30, 32
48.	<i>Sympetrum fonscolombii</i> (Selys, 1840)	10, 21, 34, 36
49.	<i>Sympetrum striolatum</i> (Charpentier, 1840)	8, 12, 15, 23
50.	<i>Sympetrum meridionale</i> (Selys, 1841)	1
51.	<i>Crocothemis erythraea</i> (Brullé, 1832)	1, 2, 4, 8-12, 17, 32, 36
52.	<i>Selysiotthemis nigra</i> (Vander Linden, 1825)	2-4, 6, 8-13, 15, 21, 24, 36

## Discussion

During the six days of our survey, 52 species were found. Compared to 63 Odonata species reported for Bosnia and Herzegovina by Kulijer et al. (2013), our findings comprise 83% of all known dragonfly species in the country.

The commonest species were *Platycnemis pennipes* and *Anax imperator*, both found at 20 localities (56%). *Orthetrum coerulescens* was found at 19 localities (53%) and *Ischnura elegans* at 18 (50%). Seven species, i.e. *Lestes virens*, *Coenagrion ornatum*, *Coenagrion scitulum*, *Aeshna mixta*, *Brachytron pratense*, *Somatochlora meridionalis*, and *Sympetrum meridionale*, were observed at only one locality. We found 12 species in all three regions of the country. Although significant numbers of species were found during time-restricted research, the numbers of the recorded species and their abundance do not reflect the actual richness of the visited areas – especially in the Alpine and Continental parts of the country. As a consequence of short or early flight period, some of the species were either probably missed or under-recorded. *Gomphus vulgatissimus* is a common and abundant spring species in all regions of the country, and – although we visited several localities, where the species has been recorded in past years (Kulijer, unpublished data) – we failed to find a single specimen.

Some other common spring species were also quite rare: *P. nymphula* was recorded at only two localities at higher altitudes, and *B. pratense*, common species in the Mediterranean area of the country, only at Deransko Lake, where a single female was observed.

For several nationally important species, i.e. *Ceriagrion tenellum*, *Caliaeschna microstigma*, *Somatochlora metallica*, *Selysiothemis nigra*, our observations add new localities and extend their known range in the country.

## Notes on selected species

At the beginning of the 20<sup>th</sup> century, Viktor Apfelbeck discovered a new form of *Calopteryx* in Herzegovina and named it *Calopteryx balcanica*. After inspecting the specimens collected by Apfelbeck, Fudakowski (1930) described this form as *Calopteryx splendens balcanica*. This taxon is known only from the Balkans, where it is present in coastal areas. In Bosnia and Herzegovina, rich populations are known from karst rivers of southern Herzegovina (Kulijer et al. 2013). We were lucky to observe *C. s. ancilla* and *C. s. balcanica* together and in great abundance in their typical habitat on the Neretva and Trebižat Rivers.

The distribution of closely related *Chalcolestes parvidens* and *C. viridis* in Bosnia and Herzegovina is still insufficiently known. Recent field surveys and the revision of museum collections suggests that *C. parvidens* is much more common in the country (Kulijer et al. 2013). Our survey also supports this, as we found *C. parvidens* at two localities but none with *C. viridis*.

Until recently, *Coenagrion ornatum* was known only from the specimens stored in the collections of the National Museum in Sarajevo. Recent field surveys revealed that the species is much more common in the country, especially at richly vegetated streams and ditches in the poljes (Kulijer 2012, Kulijer et al. 2013, Kulijer unpublished data). During our survey, we found the species only at a single locality, which is most likely due to the type of visited habitats and the early flight period of the species.

*Coenagrion hastulatum* is one of the most interesting species found in Zelengora Mts. Bedjanič (2011) recorded the species for the first time in the country, at these lakes, a year before, in the end of June. Although the main flight period of the species usually finishes at the beginning of July, we managed to find several individuals – male and female – on Gornje Bare Lake, and a male specimen on Donje Bare Lake together with thousands of *Enallagma cyathigerum*, which made our spotting of *C. hastulatum* much more difficult. This makes the second report of the species on these lakes and in the country, confirming the presence of the local population.

The distribution of *Ceriagrion tenellum* in the western part of the Balkan Peninsula is mainly restricted to a narrow belt along the Adriatic coast (Boudot et al. 2009, Dijkstra & Lewington 2006, Kalkman 2005). In Bosnia and Herzegovina, this species is mainly known only from a small number of localities in the south (Kulijer et al. 2013). Recently, the species was also found at a small lake in central Bosnia (Kulijer, unpublished data). In Croatia, just near the border with Bosnia and Herzegovina, there are also some known populations (Bogdanović et al. 2008, Vinko 2011). During our survey, we observed the species at three



localities – of which two are new for the species and first in the Trebižat River Valley. At L 3, several adults and two tandems were found at a small shallow pond fully overgrown by bushes and trees. The species was not observed at nearby stretches of the Trebižat River with richly developed vegetation along its banks. At L 16, adults and copula were found in the dense *Carex* vegetation along the Mlade River, and also on branches and leaves of bushes and trees that fully cover a small pond in the vicinity of the river. The pond is very similar to the one at L 3.

The European distribution of *Caliaeschna microstigma* is restricted to the Balkans (Boudot et al. 2009). In Bosnia and Herzegovina, the species occurs at the western border of its range. The species inhabits springs, fast flowing streams, and small rivers of the Herzegovina region (Kulijer et al. 2013). Our observations add new data to the knowledge of the species distribution in this area. In the Trebižat River Valley, the species was quite abundant, and often found together with *Cordulegaster* sp., especially the locally dominant *C. heros*.

One of the most interesting findings was the discovery of the population of *Lindenia tetraphylla* during the boat trip on Deransko Lake (Fig. 2) and along the Krupa River – both in Hutovo Blato Nature Park. *L. tetraphylla* was mentioned for the first time for the country by Bedjanić & Bogdanović (2006). All the previous records and the species status in the country were summarized and discussed by Kulijer et al. (2013). Our observations represent the first record of a strong population of this species in the country. Although only males were seen, the large number (at least 40 males at L 10, and 30 at L 11) and the territorial behaviour suggest that the species breeds in the area. The main number of individuals was observed patrolling over Deransko jezero, which is a shallow (about 0.5 m deep) muddy-bottom lake. Some club-rush and water lilies are growing in the central part, while the lake is surrounded by a vast area of dense reed beds, and fed by small cold streams and rivers from the nearby springs. The similar habitat of *L. tetraphylla* was reported in Turkey (Kalkman et al. 2004). Many of the observed individuals were of dark – dominantly black – form (Fig. 3), which is one of the characteristics of the population of *L. tetraphylla* in the Neretva area, regarded as separate, officially still undescribed species by Bogdanović (2006). Strong permanent populations of *L. tetraphylla* are rare in Europe (Boudot et al. 2009, Dijkstra & Lewington 2006, Schorr 1998). In Croatia, several populations have been reported by Belančić et al. (2008), with the closest population inhabiting the Neretva River delta. Further investigations are needed to determine whether permanent local population exists at Hutovo Blato.



**Figure 2.** At Deransko Lake (L 10), numerous males of *Lindenia tetraphylla* were observed while patrolling over the lake surface (photo: D. Vinko).

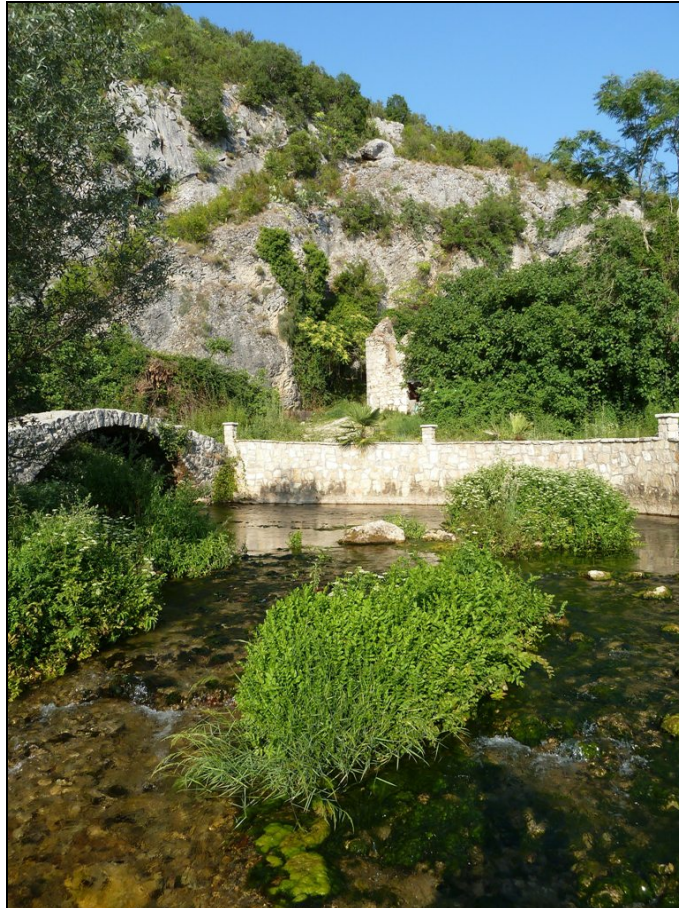
**Slika 2.** Na površju Deranskega jezera (L 10) je bilo opaženih več teritorialnih samcev velike peščenke (*Lindenia tetraphylla*) (foto: D. Vinko).



**Figure 3.** Dark form of *Lindenia tetraphylla*, caught at the Krupa River (L 11) in Hutovo Blato Nature Park (photo: D. Vinko).

**Slika 3.** Temni samec velike peščenke (*Lindenia tetraphylla*), ujet na Krupi (L 11) v Naravnem parku Hutovo blato (foto: D. Vinko).

Two species of the genus *Cordulegaster* are present in Bosnia and Herzegovina. Although both can be found in most areas of the country, *C. bidentata* dominates in central, mountainous region, while *C. heros* prevails in the north and south (Kulijer et al. 2013). We mostly investigated *Cordulegaster* habitats in the Trebižat River Valley. *C. heros* was recorded at seven localities – all being karst springs (Fig. 4), while *C. bidentata* was found at two places. Both species, including exuviae, were found at Peč Mlini (L 20) (Fig. 5). At this locality, adults and exuviae of *C. microstigma* were also observed. Ovipositing of *C. heros* was observed downstream, while *C. bidentata* and *C. microstigma* were observed upstream.



**Figure 4.** Karst springs and streams are typical habitat of *Cordulegaster heros* and *Caliaeschna microstigma* in South Herzegovina (photo: M. Billqvist).

**Slika 4.** V južni Hercegovini so kraški izviri in potoki tipični habitat za velikega studenčarja (*Cordulegaster heros*) in bledega vetrnjaka (*Caliaeschna microstigma*) (foto: M. Billqvist).



**Figure 5.** Karst spring of the Tihajina River at Peč Mlini (L 20), where adults and larvae of *Callaeschna microstigma*, *Cordulegaster heros* and *Cordulegaster bidentata* were found (photo: M. Billqvist).

**Slika 5.** Ob kraškem izviru na reki Tihajini pri Peč Mlinih (L 20) so bili zabeleženi tako odrasli kot tudi ličinke bledega vetrnjaka (*Callaeschna microstigma*), velikega (*Cordulegaster heros*) in povirnega studenčarja (*C. bidentata*) (foto: M. Billqvist).

The distribution and status of the closely related *Somatochlora metallica* and *S. meridionalis* in the country is discussed by Kulijer et al. (2013). Up until our field trip, only one record of a single male *S. metallica* had been known from Donje Bare Lake, found in 2009 (Kulijer et al. 2013). During our investigation, numerous individuals, tandems and ovipositing females were observed at Donje Bare and Gornje Bare Lakes in Zelengora Mts. This was the second record and a new locality (Fig. 6) of the species for the country, and the first time that a population of the species was observed. On the other hand, although we found it at only one locality (L 4), *S. meridionalis* is much more common – during recent surveys it has been found at more than 15 new localities (Kulijer 2012, Kulijer et al. 2013, Kulijer unpublished data).



**Figure 6.** Gornje Bare Lake (L 30) in Sutjeska National Park, the second discovered locality of *Somatochlora metallica* in Bosnia and Herzegovina (photo: D. Vinko).

**Slika 6.** Jezero Gornje bare v Nacionalnem parku Sutjeska je za Bosno in Hercegovino druga znana lokaliteta kovinskega lesketnika (*Somatochlora metallica*) (foto: D. Vinko).

The range of *Selysiothemis nigra* in Europe is restricted to the Mediterranean, where the scattered populations are mainly present in coastal areas (Boudot et al. 2009, Dijkstra & Lewington 2006). Our observations from Hutovo Blato confirm that the species is widely present in this area – as already reported by Kulijer et al. (2013). The record of *S. nigra* at Krenica Lake (L 21) in northwest Herzegovina is the westernmost for the country. Quite unexpectedly, the species was also observed at our last locality, near Pavlović Bridge in North Bosnia (L 36). From a parked car, a male imago sitting on burned vegetation was observed by D. Vinko and M. Billqvist. Even though no picture was taken and no sampling was made, it was close enough to the car to be determined with certainty. While this species is typical of the Mediterranean coast (Boudot et al. 2009), it is not suspected to be found inland. A vagrant was found 245 kilometres from the coast, in the area that is separated from the coast by high mountains and without any river flowing to the south, which is a very strange site. The record from gravel pits near Pavlović Bridge (L 36) is so not only by far the northernmost for the country, but also an interesting and rare occurrence of this species this far inland. As the species is known as a strong migrant (Boudot et al. 2009), the records from a wider area of south Herzegovina are to be expected, while the occurrence of the species at Pavlović Bridge is most likely to be just a very rare observation of a vagrant individual.

## Biogeographical and conservation perspective

From a biogeographical point of view, the Dinaric Alps are one of the most important refugia in southeastern Europe that harbour interesting disjunct relict populations of several boreal dragonfly species. These habitats are insufficiently explored and potentially threatened due to effects of climate change and increasing human activity. To date, the Zelengora Mts. are the only known locality in Bosnia and Herzegovina where *Coenagrion hastulatum* and *Somatochlora metallica* have been found. Additionally, numerous lakes and ponds in this area also host what are probably the most significant populations of *Aeshna juncea* and *A. grandis* in the country (Kulijer et al. 2013). We had luck with perfect weather at both locations, where rich dragonfly communities were observed; although the lack of time and the remoteness of the mountain lakes prevented us to visit more of these interesting localities.

Records of *C. ornatum*, *L. tetraphylla*, and *C. heros* are especially interesting from the conservation point of view. These species are listed in the Annexes II and/or IV of the Habitats Directive. *L. tetraphylla* is also listed as Vulnerable (VU) in the European Red List of Odonata and *C. ornatum*, *C. heros*, *C. bidentata*, and *C. microstigma* as Near Threatened (NT) (Kalkman et al. 2010). In the Mediterranean region, *C. heros* is Vulnerable, and *C. ornatum*, *B. pratense*, *C. microstigma*, *C. bidentata*, *L. tetraphylla*, *C. aenea*, *S. metallica* are Near Threatened (Riservato et al. 2009). Additionally, several recorded species, i.e. *C. hastulatum*, *C. tenellum*, *A. grandis*, *C. microstigma*, *S. metallica* and *S. nigra*, are rare, or have restricted distribution in Bosnia and Herzegovina (Kulijer et al. 2013).

## Acknowledgements

Big thanks to Ana Tratnik, Nina Erbida (Slovenia), Dolf Ramaker (Netherlands), and Robin Pranter (Sweden), who also participated in this field trip and helped us with their observations. Thanks to Slovenians for the transport during this excursion. We would also like to thank the management of Hutovo Blato Nature Park and Sutjeska National Park for research permissions and assistance.

The authors would also like to express their thanks to both revisers.

The participation by Slovene and Bosnian odonatologists was partly funded by the Student Organization of University of Ljubljana and Student Council of the Biotechnical Faculty University of Ljubljana.

## References

- Adamović Ž.R. (1948): La liste de la collection des Odonates du Musée d'Etat à Sarajevo. Godišnjak Biološkog instituta u Sarajevu 1: 79-84. [Serbian, French s.]
- Bedjanič M. (2011): *Coenagrion hastulatum* (Charpentier, 1825), new for the dragonfly fauna of Bosnia and Herzegovina (Odonata: Coenagrionidae). *Natura Sloveniae* 1(2): 31-36.
- Bedjanič M., Bogdanović T. (2006): Regional guide to dragonflies: other states of former Yugoslavia. In: Dijkstra K.-D.B., Lewington R. (Eds.), *Field guide to the dragonflies of Britain and Europe*. British Wildlife Publishing, Dorset, pp. 57.
- Belančić A., Bogdanović T., Franković M., Ljuština M., Mihoković N., Vitas B. (2008): Red data book of dragonflies of Croatia. Ministry of Culture, State Institute for Nature Protection, Croatia, 132 pp. [Croatian, Engl. s.]
- Bogdanović T. (2006): Ecology, morphology and cytogenetics of genus *Lindenia* (Insecta, Odonata, Gomphidae) in Croatia. PhD thesis, Univ. Zagreb. viii+193 pp.
- Bogdanović T., Merdić E., Mikuska J. (2008): Data to the dragonfly fauna of Lower Neretva river. *Entomologica Croatica* 12(2): 51-65.
- Boudot J.-P., Kalkman V.J., Azpilicueta Amorín M., Bogdanović T., Cordero Rivera A., Degabriele G., Dommanget J.-L., Ferreira S., Garrigós B., Jović M., Kotarac M., Lopau W., Marinov M., Mihoković N., Riservato E., Samraoui B., Schneider W. (2009): Atlas of the Odonata of the Mediterranean and North Africa. *Libellula* (Suppl.) 9, 256 pp.
- Dijkstra K.-D.B., Lewington R. (2006) (Eds.): *Field guide to the Dragonflies of Britain and Europe*. British Wildlife Publishing, Gillingham, 320 pp.
- European Environmental Agency (EEA) (2005): Biogeographical regions of Europe. <http://www.eea.europa.eu/data-and-maps/data/biogeographical-regions-europe-2005> (last accessed 25.10.2012).
- Fudakowski J. (1930): Über die formen von *Calopteryx splendens* Harr. aus Dalmatien und Herzegovina (Odonata). *Annls. Mus. Zool. Pol.* 9(6): 57-63.
- Jović M., Gligorović B., Stanković M. (2010): Review of faunistical data on Odonata in Bosnia and Herzegovina. *Acta entomologica serbica* 15(1): 7-27.
- Kalkman V.J. (2005): On the distribution of the genus *Ceriagrion* in the Balkans, including *C. georgifreyi*, a species new for the European fauna (Odonata: Coenagrionidae). *Libellula* (Suppl.) 6: 25-32
- Kalkman V.J., Kop A., Pelt G.J.V., Wasscher M. (2004): The dragonflies of the surroundings of Lake Köyceğiz and the River Eşen, Muğla province, SW Turkey (Odonata). *Libellula* (Suppl.) 5: 39-63.
- Kalkman V.J., Boudot J.-P., Bernard R., Conze K.-J., de Knijf G., Dyatlova E., Ferreira S., Jović M., Ott J., Riservato E., Sahlen G. (2010): European Red List of Dragonflies. Publications Office of the European Union, Luxembourg, 29 pp.
- Kulijer D. (2012): Odonata species and habitats at Livanjsko polje karst wetland area. IDF-Report 48: 1-38.

- Kulijer D., Marinov M. (2010): Odonata from Bulgaria in the collection of National Museum of Bosnia and Herzegovina. *Acta entomologica serbica* 15(2): 161-169.
- Kulijer D., De Knijf G., Franković M. (2013): Review of the Odonata of Bosnia and Herzegovina. *Odonatologica* 42(2), in press.
- Redžić S., Barudanović S., Radević M. (2008): Bosnia and Herzegovina – Land of Diversity, First national Report of Bosnia and Herzegovina for the Convention on Biodiversity. Federal Ministry of Environment and Tourism, Sarajevo, 162 pp.
- Riservato E., Boudot J.-P., Ferreira S., Jović M., Kalkman V.J., Schneider W., Samraoui B., Cuttelod A. (2009): The Status and Distribution of Dragonflies of the Mediterranean Basin. Gland, Switzerland and Malaga, Spain: IUCN. vii + 33 pp.
- Schorr M., Schneider W., Dumont H.J. (1998): Ecology and distribution of *Lindenia tetraphylla* (Insecta, Odonata, Gomphidae): a review. *Int. J. Odonatol.* 1(1): 65-88.
- Vinko D. (2011): Poročilo odonatološke skupine na Ekosistemih Jadrana – delta Neretve 2011. *Erjavecija* (26): 42-44.