

REVIEW OF THE ODONATA OF BOSNIA AND HERZEGOVINA

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The current knowledge on the Odonata fauna of Bosnia and Herzegovina is summarized based on museum and private collections, literature and new unpublished data of the authors. In all, 63 spp. are known, including first reports of *Platycnemis pennipes nitidula*, *Anax parthenope*, *Gomphus flavipes*, *G. schneiderii*, *Cordulegaster heros* and *Selysiotthemis nigra* for the country. *Caliaeschna microstigma* is rediscovered after more than 100 yr. The first reliable data on the occurrence of *Somatochlora metallica* is reported. More than 1,400 new records were collected and a national odonatol. database has been created. Annotations to the new spp. and to some other faunistically interesting species are given. Possible future additions to the fauna of Bosnia and Herzegovina are discussed.

INTRODUCTION

Bosnia and Herzegovina is located in the western part of the Balkan Peninsula (Fig. 1), between 42°26' and 45°15' N, and 15°45' and 19°41' E. The northern and central part is called Bosnia, while Herzegovina is situated in the south. The climate is moderate-continental in the northern part, sub-mountainous and mountainous in the central part and Mediterranean in the south, resulting in three distinct biogeographical regions and in a high diversity of habitats and species (REDŽIĆ et al., 2008). The most important habitats can be found in the karstic Dinaric Alps, which cover more than half of the country. The major part of them remains largely unexplored. To the north of the karst region lies the lowland region of Posavina, with the lower reaches of several large rivers and the Sava river that forms the natural border with Croatia. Locally, especially in the poljes or flat

fields, these ecosystems are threatened by increasing human exploitation, especially for agriculture practices and energy production (KULIJER, 2012).

Most historical data is based on voucher specimens found in the collections of the National Museum in Sarajevo. This collection comprises more than 660 specimens from Bosnia and Herzegovina and was collected between 1888 and 1932. First reports on the dragonfly fauna date from the end of 19th century. After Bosnia and Herzegovina became part of the Austrian-Hungarian Empire in 1878, the country became more accessible to foreign researchers and several papers were published on the dragonfly fauna (PETROVIĆ et al., 1891; PUSCHING, 1896; KLAPALEK, 1898; McLACHLAN, 1898). Various field surveys carried out mostly during the 20th century resulted in new data on dragonflies. As a result, many papers were published but most of them only give anecdotal information on dragonflies or concentrate on small region (i.e. MORTON, 1908; ADAMOVIĆ, 1949, 1967; MIKŠIĆ, 1953; GEORGIJEVIĆ & LUTERŠEK, 1966; GEORGIJEVIĆ, 1976; DUMONT, 1977; DELIRY & LOOSE, 1987; LOHMANN, 1992; KIAUTA & KOTARAC, 1995; BEDJANIČ, 2011). Based on material from the collection of the National Museum, the first comprehensive list of Odonata was published by ADAMOVIĆ (1948) and includes data on 45 species. Recently a review of all literature data was summarized by JOVIĆ et al. (2010a) and it also included some new records.

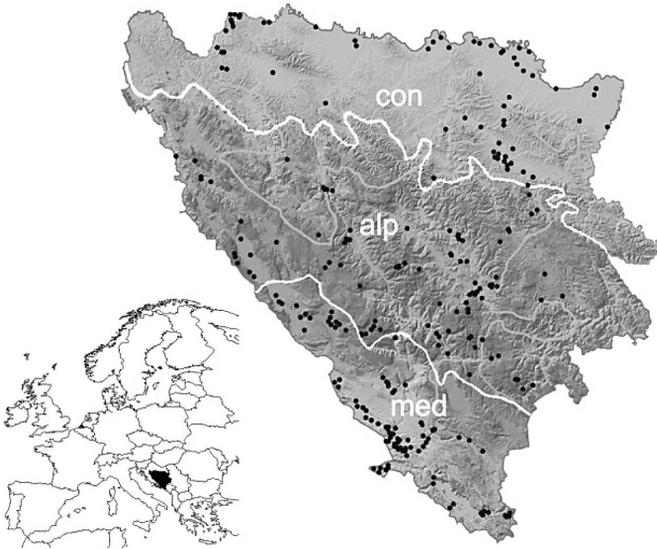


Fig. 1. Geographical position of Bosnia and Herzegovina in Europe, showing the localities from which new records were gathered (black dots). White lines indicate the border between the biogeographical regions, based on the European Environmental Agency (EEA), 2005.

In this paper we critically review existing data on the Odonata of Bosnia and Herzegovina and include many new, unpublished records, including five newly recorded species and one subspecies for Bosnia and Herzegovina. This contribution will serve as a baseline for future research and conservation.

MATERIAL AND METHODS

The checklist we present here is based on specimens found in the collections of the National Museum of Bosnia and Herzegovina in Sarajevo and the Croatian Natural History Museum in Zagreb and all published records known to the authors. Additionally more than 1,400 new records have been collected by the authors from 251 localities (Fig. 1). Most of these observations were made in the period 2009-2011. Specimens from the collection of the National Museum in Sarajevo, previously published by ADAMOVIĆ (1948), were re-examined and several corrections were made. Furthermore, many previously unknown specimens were found in this collection. Voucher specimens of all species are deposited at the National Museum in Sarajevo. Some of the collected specimens are deposited at the Croatian Natural History Museum and in the personal collections of the second and third authors.

All former and recent observations were georeferenced and included into one database. This database is stored at the National Museum in Sarajevo and managed by the first author. It is the intention that this database becomes the national database of dragonflies for Bosnia and Herzegovina and that it will serve as a valuable source of information for nature conservation and the protection of dragonflies and their habitats.

RESULTS

Alltogether 63 species have been found in Bosnia and Herzegovina (Tab. I). In recent years, more than 1,400 new records belonging to 59 species were collected. Five species, *Anax parthenope*, *Gomphus flavipes*, *G. schneiderii*, *Cordulegaster heros* and *Selysiotthemis nigra* and one subspecies, *Platycnemis pennipes nitidula*, are reported here for the first time for Bosnia and Herzegovina. Our investigations resulted in the rediscovery of *Caliaeschna microstigma* after more than 100 years. *Somatochlora metallica* was previously reported by ADAMOVIĆ (1948) but re-examination of the collected specimens showed them to be all *Somatochlora meridionalis*. Our new record from Zelengora mountain is presently the only reliable record of the occurrence of *S. metallica* in Bosnia and Herzegovina. Of particular importance was the discovery of populations of several threatened European species such as *Coenagrion ornatum*, *Gomphus flavipes*, *Lindenia tetraphylla* and *Cordulegaster heros*.

Although most of the dragonfly specimens from the collection of the National Museum of Bosnia and Herzegovina are very old, they remain still an important source of information for the Balkan Peninsula (KULIJER & MARINOV, 2010). The knowledge of the dragonfly fauna of the country was mostly based on this collection, which was previously reviewed and resulted in the publication of ADAMOVIĆ (1948). Our revision of the collection in 2010 revealed the presence of additional specimens of some species previously not mentioned by

Table I

Checklist of the Odonata of Bosnia and Herzegovina and the total number of records for the country. – [med = Mediterranean; – alp = Alpine; – con = Continental; – nd = new data; – new species for the country are given in bold]. – Taxonomy follows DIJKSTRA & LEWINGTON (2006) and GYULAVARI et al. (2011) for *Chalcolestes*. For key to the bibliographic references, see footnote

Species	Biogeographical region			Total No. of records
	med	alp	con	
CALOPTERYGIDAE				
<i>Calopteryx splendens</i> (Harris, 1782)	1, 4, 6, 7, 11, 13, 15, 20, 27, nd	1, 11, 12, 13, 30, 35, nd	1, 13, 15, 23, nd	117
<i>Calopteryx virgo</i> (Linnaeus, 1758)	1, 6, 7, 13, 15, 22, 35, nd	1, 12, 13, 14, 19, 25, 35, nd	1, 13, 15, 17, nd	108
LESTIDAE				
<i>Lestes sponsa</i> (Hansemann, 1823)	15	1, 15, nd	15, 26, nd	26
<i>Lestes dryas</i> Kirby, 1890	nd	1, 15, nd	-	43
<i>Lestes barbarus</i> (Fabricius, 1798)	6, 7, 15, 19, nd	1, 19, nd	1, 15	53
<i>Lestes virens</i> (Charpentier, 1825)	nd	nd	1, 15, nd	22
<i>Lestes macrostigma</i> (Eversmann, 1836)	15	-	-	1
<i>Chalcolestes viridis</i> (Vander Linden, 1825)	1*, 6, 7, 15	nd	nd	4
<i>Chalcolestes parvidens</i> (Artobolevskii, 1929)	15, nd	15	nd	11
<i>Sympyca fusca</i> (Vander Linden, 1820)	1, 6, 7, 15, 19, nd	1, 15, nd	1, nd	40
COENAGRIONIDAE				
<i>Ischnura elegans</i> (Vander Linden, 1820)	1, 2, 3, 5, 6, 7, 9, 15, nd	1, 5, 15, 34, nd	15, nd	159
<i>Ischnura pumilio</i> (Charpentier, 1825)	1, 5, 15, nd	1, 5, nd	1, 15, nd	49
<i>Enallagma cyathigerum</i> Charpentier, 1840	15, nd	1, 5, 15, nd	nd	50
<i>Coenagrion pulchellum</i> (Vander Linden, 1825)	1, 15, nd	1, 15, nd	1, nd	19
<i>Coenagrion puella</i> (Linnaeus, 1758)	5, 15, nd	1, 15, 23, 25, nd	1, nd	90
<i>Coenagrion ornatum</i> (Selys, 1850)	nd	1	1	5
<i>Coenagrion scitulum</i> (Rambur, 1842)	nd	1, nd	-	8
<i>Coenagrion hastulatum</i> (Charpentier, 1825)	-	5	-	2
<i>Erythromma najas</i> (Hansemann, 1823)	15, 19	-	nd	7
<i>Erythromma viridulum</i> (Charpentier, 1840)	15, nd	15, nd	15, nd	26
<i>Erythromma lindenii</i> (Selys, 1840)	2, 6, 7, 15, 19, nd	-	-	33
<i>Pyrrhosoma nymphula</i> (Sulzer, 1776)	5, 15, nd	1, 5, 35, nd	-	29
<i>Ceragrion tenellum</i> (de Villers, 1789)	15, nd	1, nd	-	8
PLATYCENEMIDIDAE				
<i>Platycnemis pennipes</i> (Pallas, 1771)	1, 5, 6, 7, 9, 15, 19, nd	1, 14, 30, nd	1, 15, nd	138
AESHNIDAE				
<i>Aeshna mixta</i> Latreille, 1805	1, 13, 15, 19, nd	1, nd	26, nd	33
<i>Aeshna affinis</i> Vander Linden, 1820	1, 15, nd	15, 25, nd	15, nd	28
<i>Aeshna isoceles</i> (Müller, 1767)	1, 5, nd	1, nd	1, nd	35
<i>Aeshna grandis</i> (Linnaeus, 1758)	-	5, 13, 15, 24, 28, 29, nd	-	11
<i>Aeshna cyanea</i> (Müller, 1764)	13, 15, nd	1, 5, 13, 15, 25, 26, nd	1, nd	58
<i>Aeshna juncea</i> (Linnaeus, 1758)	-	1, 5, 15, nd	-	21
<i>Anax imperator</i> Leach, 1815	5, 9, 13, 15, 18, 23, nd	1, 24, nd	1, nd	72
<i>Anax parthenope</i> (Selys, 1839)	nd	nd	nd	17
<i>Anax ephippiger</i> (Burmeister, 1839)	1, nd	nd	-	4
<i>Brachytron pratense</i> (Müller, 1764)	1, nd	nd	1, 26, nd	16
<i>Caliaeschna microstigma</i> (Schneider, 1845)	1, nd	-	-	5

Table I, continued

Species	Biogeographical region			Total No. of records
	med	alp	con	
GOMPHIDAE				
<i>Gomphus vulgatissimus</i> (Linnaeus, 1758)	1, 13, 15, 21, 22, 25, nd	nd	1, 13, nd	34
<i>Gomphus flavipes</i> (Charpentier, 1825)	-	-	nd	3
<i>Gomphus schneiderii</i> Selys, 1850	nd	-	-	1
<i>Onychogomphus forcipatus</i> (Linnaeus, 1758)	1, 9, 15, 25, nd	25, nd	1, 16, 17, nd	54
<i>Lindenia tetraphylla</i> (Vander Linden, 1825)	15, nd	-	-	3
CORDULEGASTERIDAE				
<i>Cordulegaster heros</i> Theischinger, 1979	nd	nd	nd	13
<i>Cordulegaster bidentata</i> Selys, 1843	1, 25, nd	1, 5, 19, nd	nd	33
CORDULIIDAE				
<i>Cordulia aenea</i> (Linnaeus, 1758)	nd	5, 15, nd	1, nd	16
<i>Somatochlora metallica</i> (Vander Linden, 1825)	-	nd	1**	1
<i>Somatochlora meridionalis</i> Nielsen, 1935	9, 15, nd	nd	nd	16
<i>Somatochlora flavomaculata</i> (Vander Linden, 1825)	15, nd	nd	-	7
<i>Epitheca bimaculata</i> (Charpentier, 1825)	-	-	1	1
LIBELLULIDAE				
<i>Libellula quadrimaculata</i> Linnaeus, 1758	5, nd	1, 5, 15, nd	nd	31
<i>Libellula depressa</i> Linnaeus, 1758	5, 9, 13, 15, nd	1, 12, 13, 15, 19, nd	1, nd	67
<i>Libellula fulva</i> (Müller, 1764)	1, 5, 6, 7, 15, nd	nd	nd	35
<i>Orthetrum cancellatum</i> (Linnaeus, 1758)	2, 5, 6, 7, 9, 15, 23, nd	15, nd	nd	61
<i>Orthetrum albistylum</i> (Selys, 1848)	nd	1, nd	1, 15, nd	32
<i>Orthetrum coerulescens</i> (Fabricius, 1798)	15, 35, nd	1, 15, 23, 25, 32, nd	1, nd	42
<i>Orthetrum brunneum</i> (Fonscolombe, 1837)	5, 9, 15, 19, nd	1, 23, 32	nd	29
<i>Leucorrhinia pectoralis</i> (Charpentier, 1825)	-	-	1, 10	1
<i>Sympetrum sanguineum</i> (Müller, 1764)	1, 2, 8, 9, 15, 23, 33, nd	1, 15, 30, nd	1, 15, nd	113
<i>Sympetrum flaveolum</i> (Linnaeus, 1758)	5, 15, 19, nd	1, 15, 23, 24, 25, 33, 35, nd	-	54
<i>Sympetrum fonscolombii</i> (Selys, 1840)	1, 2, 9, 15, nd	15, nd	nd	36
<i>Sympetrum striolatum</i> (Charpentier, 1840)	1, 6, 7, 15, nd	1, 19, 25, nd	nd	49
<i>Sympetrum vulgatum</i> (Linnaeus, 1758)	-	nd	31, nd	3
<i>Sympetrum meridionale</i> (Selys, 1841)	9, 15, 19, 25, nd	15, 19, nd	nd	37
<i>Crocothemis erythraea</i> (Brullé, 1832)	1, 2, 5, 9, 13, 15, nd	15, nd	nd	71
<i>Selysiothemis nigra</i> (Vander Linden, 1825)	nd	-	-	27
Total number of species	55	53	46	2216

* reported species is *Lestes parvidens*; – ** reported species is *Somatochlora meridionalis*; – key to bibliographic references: 1: ADAMOVIĆ (1948; includes most material from the Victor Apfelbeck collection, 1888-193, in Natn. Mus. Sarajevo); – 2: ADAMOVIĆ (1949); – 3: ADAMOVIĆ (1967); – 4: ADAMOVIĆ & VIJATOV (1996); – 5: BEDJANIĆ (2011); – 6: BOGDANOVIĆ ET AL. (2008; records from Bukvić, 1998); – 7: BUCKVIĆ (1998); – 8: DELIRY & LOOSE (1987); – 9: DUMONT (1977); – 10: FRANKOVIĆ (1991; records from Adamović, 1948); – 11: FUDAKOWSKI (1930); – 12: GEORGIJEVIĆ & LUTERŠEK (1966); – 13: GEORGIJEVIĆ (1976); – 14: JOVIĆ & MIHAJLOVA (2009); – 15: JOVIĆ et al. (2010a); – 16: KEROVEC (2005a); – 17: KEROVEC (2005b); – 18: KIAUTA & KOTARAC (1995); – 19: KLAPALEK (1898); – 20: LOHMANN (1992); – 21: MATONOČKIN & PAVLETIĆ (1960); – 22: MATONIČKIN & PAVLETIĆ (1963); – 23: McLACHLAN

(1898); – 24: MIKŠIĆ (1953); – 25: MORTON (1908); – 26: PETROV (1891); – 27: PONGRAC (2000); – 28: PROTIĆ (1925); – 29: PROTIĆ (1927); – 30: PUSCHNIG (1896); – 31: RADEVIC et al. (2002); – 32: RIS (1909-1910; record published previously by McLachlan, 1898); – 33: RIS (1911-1912; record published previously by McLachlan, 1898); – 34: ŠENK (1956); – 35: VUKIĆ (1992)

Adamović and in the examination of the specimens collected after his review. Additional corrections were made for several species as a result of new taxonomic viewpoints. More details are given in the annotations to species.

ANNOTATIONS TO SOME SPECIES

The taxonomic status and distribution of the different subspecies of *Calopteryx splendens* in the Balkans has been discussed by many researchers, e.g. FUDAKOWSKI (1930), DUMONT (1977), ADAMOVIĆ & VIJATOV (1996), OLIAS & SERBEDIJA (1998) and PONGRAC (2000), but the status of the populations in Bosnia and Herzegovina is still insufficiently known. Three taxa of this variable species have been reported from Bosnia and Herzegovina. *Calopteryx splendens ancilla* was reported by ADAMOVIĆ & VIJATOV (1996) and PONGRAC (2000), while FUDAKOWSKI (1930) described *Calopteryx splendens balcanica* based on specimens from southern Herzegovina and Dalmatia (Croatia). The latter subspecies was later reported from southern Herzegovina and Dalmatia by several other researchers, e.g. ADAMOVIĆ (1967), DUMONT (1977), ADAMOVIĆ & VIJATOV (1996), BELANČIĆ et al. (2008) and JOVIĆ et al. (2010a). Based on our data *Calopteryx splendens balcanica* is confined to the Mediterranean part of the country (Trebinje, Stolac, Hutovo Blato, Ljubuški). The type subspecies *Calopteryx splendens splendens* was reported by FUDAKOWSKI (1930) from a single locality in central Bosnia. In regard to the wing spot size and pigmentation of the wings, specimens found in most parts of Bosnia and Herzegovina resemble ssp. *ancilla*.

In Europe, *Lestes macrostigma* is largely confined to brackish waters, both coastal and inland, and is mainly found in the Mediterranean region (BOUDOT et al., 2009). Recently, the species was observed at some ponds at Seline, near the Bilečko lake, close to the border with Montenegro (JOVIĆ et al., 2010a). An unconfirmed record exists from some ponds northeast and southeast of Trebinje (B. Gligorović, pers. comm.). It is unclear if local populations are present or if these refer to vagrant individuals.

The distribution ranges of the closely related species *Chalcolestes viridis* and *C. parvidens* overlap widely in the Balkans (OLIAS et al., 2007; BOUDOT et al., 2009). Historical records from Stolac and Domanovići were reported by ADAMOVIĆ (1948) as *C. viridis* but, after re-examination of the specimens, it turned out to be *C. parvidens*. Our data demonstrate that both species are present in all three regions of Bosnia and Herzegovina. At the moment, more records of

C. parvidens are known. Both species co-exist at Modrac lake in north-western Bosnia. The precise sympatric zone of both species and if hybridization occurs and at what level is insufficient known.

Coenagrion ornatum is Near Threatened species in Europe (KALKMAN et al., 2010) which was previously only known from two localities (ADAMOVIĆ, 1948). A specific field survey conducted in 2011 revealed that the species inhabits several karst poljes in Herzegovina (KULIJER, 2012; unpublished data). Karst poljes (or karst fields) are one of the specific habitats present in the Dinaric Alps and are flooded during winter months. The majority of karst fields of southeastern Europe are found in Bosnia and Herzegovina. They occur in the Mediterranean and in the Alpine region from 80 up to 1200 m a.s.l. As most of them are still poorly investigated, we expect that more local populations of *C. ornatum* will be found here in the future.

Erythromma najas was first mentioned by KLAPALEK (1898) from three localities in the region of Mostar. More than a century later new records were collected from several localities near the artificial Bilečko lake in eastern Herzegovina (JOVIĆ et al., 2010a) and by DK in 2011 at one pond close to Modrac lake in northern Bosnia. Compared to its congener *E. viridulum* (26 records), *E. najas* (7 records) is much scarcer. Although it is more common in central and northern Europe than in the Mediterranean part (BOUDOT et al., 2009), most records from Bosnia and Herzegovina come from the south. This is probably due to a better knowledge of this area.

Ceriagrion tenellum is a mainly western Mediterranean species that in the Balkans is confined to a narrow belt along the Adriatic coast and to some Greek islands (KALKMAN, 2005; BOUDOT et al., 2009). Our research in 2010 confirmed an old record from Boračko lake previously reported by ADAMOVIĆ (1948). The species was also found at several localities at Hutovo Blato Nature Park. Boračko lake is located in the northern part of Herzegovina, away from the coastal belt but still influenced by the warm Mediterranean climate through the Neretva river valley. Furthermore JOVIĆ et al. (2010a) reported the species from one locality near Trebinje. It is likely that more populations could be found in the southern part of the country.

Two subspecies of *Platynemis pennipes* are present in Bosnia and Herzegovina. The nominal subspecies *pennipes* occurs in the major part of the country. The subspecies *nitidula* is restricted to the extreme southern part and was only discovered in 2009 at Hutovo Blato Nature Park and in 2011 at Jazina (Trebinje), both by GDK. The morphology and distribution of *P. p. nitidula* in the Balkans is discussed by ADAMOVIĆ & VIJATOV (1997). They considered Skadar lake in Montenegro as the most western location. This range has been extended by the findings of JOVIĆ et al. (2008) and DE KNIJF et al. (2013) in the Mediterranean part of Montenegro, where the species is common. Our findings in the southern part of Bosnia and Herzegovina extend the range of this subspecies

further to the west.

A field campaign carried out in 2009 at Zelengora mountain in the eastern part of Herzegovina resulted in the discovery of populations of *Aeshna grandis* at three mountain lakes (JOVIĆ et al., 2010a; this paper). Although JOVIĆ et al. (2010a) considered the records as the first for Bosnia and Herzegovina, the species was already known for the country. PROTIĆ (1925, 1927) found larvae while collecting zooplankton at several lakes. As the identification was only based on larvae that were not preserved, his records should be taken with reservation. Later *A. grandis* was found at Treskavica mountain by MIKŠIĆ (1953) and by GEORGIJEVIĆ (1976) from several localities. It is currently only known from mountain lakes in the central part of the country. The record from Drina river in Serbia (JOVIĆ et al., 2010b) at the border with Bosnia and Herzegovina suggests that the species might also be present in the northern lowland area.

Although known from all neighbouring countries, *Anax parthenope* had never been observed in Bosnia and Herzegovina. Field surveys in 2009, 2010 and 2011 resulted in the discovery of the species at several localities. At some localities, such as Hutovo Blato, Boračko and Modrac lake, the species was very abundant. Most observations of *Anax ephippiger* from Bosnia and Herzegovina date from early spring and originate from the Mediterranean part. In July 2009 one teneral specimen was collected at Haljinići ponds in the central part of the country. This was the first proof of reproduction of this migrant species in the country.

Before our study, *Caliaeschna microstigma* was only known from a male collected in Mostar and found in the collection of the National Museum. A specific search for this species in 2011 resulted in the discovery of several new localities in the river valleys of Trebižat and Tihaljina, in the southern part of the country. At those localities exuviae, tenerals and adults were observed. These new localities in the southern part of Bosnia and Herzegovina are, together with the localities along the Dalmatian coast in Croatia, the most western populations of this species in Europe.

Another new species for Bosnia and Herzegovina is *Gomphus flavipes*, which was found in June and July of 2011. Exuviae were collected at three localities along the river Sava in northern Bosnia, on the border with Croatia. Its presence was expected as *G. flavipes* is a common species along the Sava and Danube river in Croatia and Serbia (ADAMOVIĆ, 1948, 1949; FRANKOVIĆ & VILENICA, 2009; VILENICA et al., 2011). The species has also been recorded from the region of Skadar lake in Montenegro (GLIGOROVIĆ & PEŠIĆ, 2007).

The distinction between *Gomphus schneiderii* and *G. vulgatissimus* was, until very recently, mainly based on the coloration of the eyes and on the geographical separation, whereby the blue-eyed *G. schneiderii* is restricted to Turkey and southern Greece (DIJKSTRA & LEWINGTON, 2006; BOUDOT et al., 2009). A small zone of co-occurrence is known from northern Greece (LOPAU, 2010). Recently, several populations of *G. schneiderii*, which lack the clear blue eyes, were

discovered in Montenegro (DE KNIJF et al., 2013). They differ of *G. vulgatis-simus* in that the superior appendages are curved upwards and have a widening tip, and the vulvar scale is short, blunt and has a clear rounded tip. The underside of the thorax, behind the third pair of the legs is clearly yellow (DE KNIJF et al., 2013). Our finding in the most southeastern part of the country extends the presence of *G. schneiderii* a little further west. We expect the species to be found at some other localities but limited to the warmest part of the country.

Many records of *Lindenia tetraphylla* in the Mediterranean probably refer to temporary populations or wandering specimens (SCHORR et al., 1998; BOUDOT et al., 2009). Several strong populations are known from countries along the eastern Adriatic coast. Probably the most important population is found at Skadar lake in Montenegro (DE KNIJF et al., 2013). More close by, a population occurs in the delta of the Neretva river, a wetland area shared between Croatia and Bosnia and Herzegovina. *L. tetraphylla* was first mentioned for Bosnia and Herzegovina at Hutovo Blato Nature Park by BEDJANIĆ & BOGDANOVIĆ (2006) but without any further details. While visiting this site, we observed single individuals. Additionally, JOVIĆ et al. (2010a) reported two males from Trebinje in the southeast of Herzegovina. We have no indication if a local population occurs in Bosnia and Herzegovina. It is possible that all observed individuals are just wandering from nearby populations such as from the Neretva river delta in Croatia (BELANČIĆ et al., 2008; BOGDANOVIĆ et al., 2008) or from Skadar lake in Montenegro (DE KNIJF et al., 2013). We presume that at least temporary populations exist in Bosnia and Herzegovina, which probably act as sink populations from wandering individuals from Croatia and Montenegro.

Cordulegaster heros is another new species for Bosnia and Herzegovina. It was found for the first time in 2007 at the spring of the river Tihaljina, soon followed by more observations at several other streams and small rivers in the southern part of the country. In 2011 it was also found in the northern part of Bosnia at several small tributaries of the river Una. It was expected there, as several populations occur in nearby Croatia (FRANKOVIĆ & VILENICA, 2009). *C. bidentata* is the common species in the central part of the country, which is dominated by high mountains and numerous small streams. Nevertheless, many streams and small rivers in the lower part of the valleys look to be very promising habitats for *C. heros*. ADAMOVIĆ (1967) mentions also the presence of *C. boltonii* (cited as *Cordulegaster annulatus*) from Bosnia but without giving further details. He refers to an older paper by himself on the collection of Sarajevo Museum (ADAMOVIĆ, 1948), where this species is mentioned from a single locality in eastern Serbia. Later ADAMOVIĆ et al. (1992) refers to the two specimens from eastern Serbia as *C. heros*. KULIJER & BOUDOT (2013) reviewed these specimens from Serbia and concluded that they belong to *C. insignis*. Other specimens of *C. boltonii*, *C. heros* or *C. insignis* were not found in the collection of the National Museum in Sarajevo.

Somatochlora metallica is a rather rare species in southeast Europe (BOUDOT et al., 2009) where it is mostly restricted to high altitudes (DE KNIJF et al., 2013). ADAMOVIĆ (1948) mentions the species as being found in the area of Derвента in the northern lowland area. His findings were based on several specimens present in the collection of the National Museum in Sarajevo. These specimens were checked and turned out to be all *S. meridionalis*. It was only in 2009 that *S. metallica* was for the first time discovered in Bosnia and Herzegovina. A male was collected by DK at Donje Bare lake, Zelengora mountain, in eastern Herzegovina and remains the only observation for the country. More research in the Dinaric Alps may yield more observations, as suitable habitats are present at more localities. When *S. metallica* and *S. meridionalis* co-occur in the same region, the former tends to be found at lakes and bogs at high altitudes, the latter at lowland streams (MARINOV, 2001; DIJKSTRA & KALKMAN, 2012; MILL, 2012).

Orthetrum coerulescens is a widespread species in Bosnia and Herzegovina. Both subspecies, *O. c. coerulescens* and *O. c. anceps* have been previously reported for the country. The status and the distribution of these taxa in Europe were discussed in details by MAUERSBERGER (1994). Both ssp. overlap in a large part of the Balkan, where often intermediate forms can be found. ADAMOVIĆ (1948) reported both ssp. from Bosnia based on specimens present in the collection in the Museum of Sarajevo. We reviewed these specimens and concluded that they belong to the ssp. *anceps* or to an intermediate phenotypes. McLACHLAN (1898) presented one record of *O. c. anceps* from Sarajevo (reported as *O. ramburii*). MAUERSBERGER (1994) mentioned pure *O. anceps* and hybrids of both taxa from Croatia, Montenegro and Serbia. Our observations confirm the presence of *O. c. anceps* and hybrids in Bosnia and Herzegovina. Most of the observed individuals belong to intermediate phenotypes that are closer to the ssp. *anceps*. Individuals with fully pruinose abdomen and thorax are also found, especially in the southern part.

Sympetrum vulgatum is the rarest of the six *Sympetrum* species occurring in Bosnia and Herzegovina and is only known from three localities. It was for the first time mentioned for Bosnia and Herzegovina by RADEVIĆ et al. (2002) from Bardača fishponds in the north of Bosnia. This observation could unfortunately not be checked. In 2009, DK found the species at Haljinići ponds and at Plivska lakes in the central part. The species is probably more common, especially in the north.

Selysiothemis nigra has a very scattered distribution in the Mediterranean (BOUDOT et al., 2009). Our records are the first for Bosnia and Herzegovina. Its presence was expected in the southern part of the country considering the number of observations in neighbouring coastal areas of Croatia and Montenegro (BELANČIĆ et al., 2008; DE KNIJF et al., 2013). *S. nigra* has been found to be locally very common in the south of Herzegovina, even very abundant such as in Hutovo Blato in 2009 and 2010.

DISCUSSION

For the compilation of the list of dragonfly species from Bosnia and Herzegovina, we used all specimens contained in the collection of the Museums of Sarajevo and Zagreb, records published by several authors and many new data collected by the authors. The collections of the National Museum of Sarajevo were critically checked and, if necessary, corrected. All this resulted in more than 2200 records of 63 species of Odonata being found in Bosnia and Herzegovina. All these data are now stored in an odonatological database which is managed by the first author. Although many records were collected within the last few years, the total number of records remains quite low. This can be explained by the nearly complete lack of old data, especially from the last 50 years. Many areas are still under investigated, partly due to recent war activities and numerous minefields that are still present.

More than 100 records are available of five species (Tab. I). The species which has been observed most is *Ischnura elegans* (159 records), followed by *Platycnemis pennipes* (138), *Calopteryx splendens* (117), *Sympetrum sanguineum* (113) and *Calopteryx virgo* (108). At the other end of the list are five species which are only known from a single record. These are *Lestes macrostigma*, *Gomphus schneiderii*, *Epitheca bimaculata*, *Somatochlora metallica* and *Leucorrhinia pectoralis*. No recent records of *E. bimaculata* and of *L. pectoralis* are available. As could be expected, the Mediterranean region of Bosnia and Herzegovina with 55 species present (Tab. I) has the highest diversity. The Alpine region hosts 53 species despite its less favourable climate for dragonflies. Only 46 species were observed in the Continental region. The regional diversity probably reflects more research intensity in the different regions rather than real differences in species richness.

The topography and the climate are the main factors that influence the diversity and distribution of dragonflies in Bosnia and Herzegovina. The Dinaric Alpine mountain system extends in a northwest-southeast direction and forms a barrier for many species. South of it, lays the Mediterranean part of the country, which holds populations of *Caliaeschna microstigma*, *Gomphus schneiderii*, *Lindenia tetraphylla* and *Selysiotthemis nigra*. Several mountain lakes, ponds and bogs are found in the Alpine region. They are home to species with a more central and northern distribution in Europe. Populations of *Coenagrion hastulatum*, *Aeshna grandis*, *A. juncea*, and *Somatochlora metallica* are confined to those specific habitats in Bosnia and Herzegovina and are here at their edge of their ranges (DIJKSTRA & LEWINGTON, 2006; BOUDOT et al., 2009; BEDJANIĆ, 2011; DE KNIJF et al., 2013). The northern part of Bosnia belongs to the Continental region and is characterised by several large rivers and numerous oxbows along the Sava river. This is the region where *Gomphus flavipes*, *Epitheca bimaculata* and *Leucorrhinia pectoralis* have been seen. The presence of *E. bimaculata* and

L. pectoralis requires confirmation, as only single observations from more than 100 years ago exist.

Dragonflies are not protected at all in Bosnia and Herzegovina and no Red List is available. Six species of European concern are found in Bosnia and Herzegovina. *Coenagrion ornatum*, *Lindenia tetraphylla*, *Cordulegaster heros*, *Gomphus flavipes* and *Leucorrhinia pectoralis* are all listed in the Annexes II and/or IV of the Habitats Directive. *L. tetraphylla*, *G. flavipes* and *L. pectoralis* are also mentioned in Annex II of the Bern convention. Two species, *Lestes macrostigma* and *Lindenia tetraphylla* were assessed as Vulnerable, and *Coenagrion ornatum* and *Cordulegaster heros* were classified as Near threatened in the European Red List (KALKMAN et al., 2010). Based on the present data and on our expert judgement we consider 13 species as rare and potentially threatened. *Lestes macrostigma* *Ceriagrion tenellum*, *Caliaeschna microstigma*, *Gomphus schneiderii*, *Lindenia tetraphylla* and *Selysiothemis nigra* are all confined to the Mediterranean region whereas *Coenagrion hastulatum*, *Aeshna grandis* and *Somatochlora metallica* are restricted to lakes and ponds at higher altitudes in the mountain region. Four species, *Erythromma najas*, *Epitheca bimaculata*, *Leucorrhinia pectoralis* and *Sympetrum vulgatum* are very rare in the country.

Although several new species have been discovered during the last few years, we expect that the list of species will be augmented in the near future. Several species are present in neighbouring parts of Croatia, Serbia or Montenegro and suitable habitats seems to be present in Bosnia and Herzegovina. *Ophiogomphus cecilia* is a common species along large rivers in the adjacent lowland area in Croatia (BELANČIĆ et al., 2008) and the presence of populations along Sava river and its larger tributaries seems very likely. Another species which can be expected to occur in this part of Bosnia and Herzegovina is *Leucorrhinia caudalis*. A population exists in Lonjsko polje area in Croatia (BELANČIĆ et al., 2008) close to the border. Numerous mountain lakes and small fragmented *Sphagnum* bogs occurs at an altitude from 1,400 to 1,800 m a.s.l. in Bosnia and Herzegovina. This is the area where it would be useful to search for *Somatochlora arctica* or *Leucorrhinia dubia*. Populations of *L. dubia* can be found in nearby mountain ranges in Serbia and Montenegro (JOVIĆ et al., 2010a; DE KNIJF et al., 2013). *Trithemis annulata* has expanded its range during the last few decades in Europe, especially in the western Mediterranean (BOUDOT et al., 2009). Nevertheless, the species remains very rare in southeastern Europe and is only found in Greece (BOUDOT et al., 2009). In the last few years, some populations were discovered in Montenegro (DE KNIJF et al., 2013).

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