Odonata species and habitats at Livanjsko polje karst wetland area

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Abstract

Karst poljes (or poljes) are specific geological formations of the Dinaric Alps and are important wetland areas of high biodiversity value. The dragonfly fauna of poljes in Bosnia and Herzegovina is poorly researched and mostly unknown. In order to investigate dragonfly species and habitats in these specific and interesting habitats, field research was conducted from April to October 2011 in Livanjsko polje (west Bosnia), the largest periodically flooded karst polje in the world. The number of recorded species indicates high species richness of this area, 41 dragonfly species in total were observed, of which 25 species are new for the research area. Description of habitats and dragonfly communities from 34 surveyed localities is presented. The most interesting are the records of *Chalcolestes viridis* (Vander Linden, 1825), nationally rare species and NATURA 2000 species *Coenagrion ornatum* (Selys, 1850). The results of this research significantly contribute not only the knowledge of dragonfly fauna of poljes but also the overall knowledge of dragonfly fauna of Bosnia and Herzegovina.

Introduction

Bosnia and Herzegovina is a small, predominantly mountainous country located in the western part of the Balkan Peninsula (Fig. 1.). The karst mountains of Dinaric Alps cover the largest part of the country (56,8%). One of the specificities of Dinaric Alps are poljes, large karst formations characteristic for karst area from Slovenia to Montenegro (the local name “polje” = field, is the internationally accepted term when referring to these karst formations). The poljes are large depression characterized by a flat floor covered with deposition that allows surface runoff and are surrounded by steep mountain slopes (Gams, 1978; Prohić et al. 1998). Both springs and ponors (draining holes or shafts where the water disappears underground) are present at the borders of poljes. Many of poljes are temporarily flooded during the winter and the

spring when ponors are not sufficient to drain all the surface water. They are periodical or permanent wetland areas, surrounded by dry and rocky karst mountains. More than 130 poljes exist in the Dinaric Alps, most of them located in Bosnia and Herzegovina and covering an area of app. 1.350 km^2 (Schneider-Jacoby et al. 2006). Karst areas of Bosnia and Herzegovina are among the best preserved in Europe, but are still insufficiently legally protected and under direct threat by water extraction and unsustainable use of natural resources.

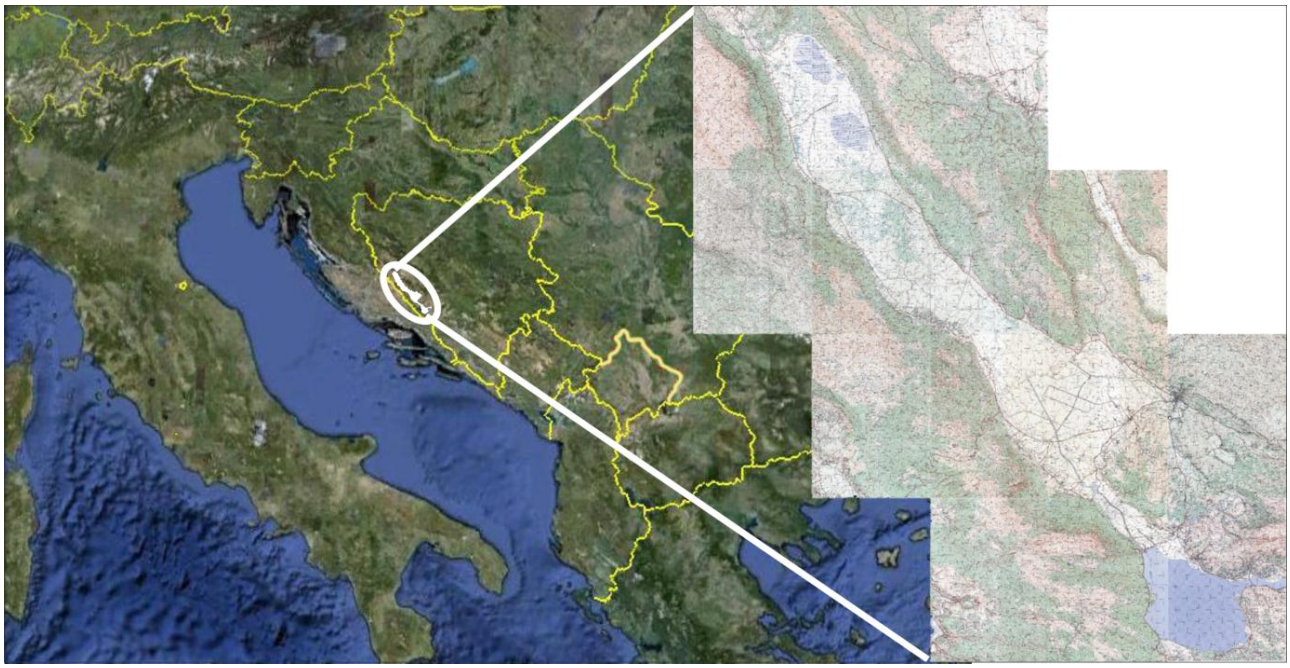

Figure 1. Geographical position of Livanjsko polje.

Livanjsko polje is the largest karst polje (458 km^2) in the Dinaric Alps and probably the largest periodically flooded karst field in the world (Ritter-Studnićka & Grgić, 1971). It is located in the western part of Bosnia and Herzegovina and spreads from northwest to southeast, which is typical for in the Dinaric Alps. It is situated between the Dinara and Kamešnica mountains in the west, the Tušnica mountains in the south-east, Cincar and Golija mountains to the east, and Šator and Staretina mountains to the north-east. The polje has a length of 65 km and is on average 7 km width (max. 11,5 km). Buško jezero (or Buško Lake) located in the southeastern part of the polje, is the largest artificial water body in this part of the Dinaric Alps. The reservoir covers an area of 55 km^2 and has a depth of 17 m. The altitude of Livanjsko polje is app. 700-720 m and the surrounding mountain peaks are 2,000 m a.s.l. high.

The climate in Livanjsko polje is highly influenced by altitude and distance from the sea. Mediterranean and Alpine climates cause sharp changes, from moderate Mediterranean to sub-Alpine climate. Summers are mostly dry and warm with prevailing maritime influence, while the cold alpine climate prevails during the winter months.

A complex network of surface and underground water bodies exist in the polje. A great diversity of different freshwater habitats can be found in the polje, among these are peat bogs, swamps, fens, swamp forests, seasonally flooded forests, artificial lakes, gravel pits, mining pools, seasonal and permanent rivers and streams, drainage channels and ditches. Fast flowing, cold and carbonate rich permanent karst rivers (Sturba, Žabljak, Bistrica) are confined to the southeastern part of the polje. Additionally, several temporary rivers run through the polje, which disappear mainly during the dry season in depressions (ponors) (Schneider-Jacoby et al. 2006; Redžić et al. 2008).

Figure 2. Livanjsko polje, pastures and meadows in the central part of the polje.

The polje is flooded during the winter and becomes dry in summer. Schneider-Jacoby et al. (2006) estimates the coverage of temporary lakes at about 230 km^2. The depth of the water of most of them is app. 1,5 m, but varies from year to year. An impressive network of streams and rivers are formed in the polje during the wet season, but most of them dry out during summer.

The area of Livanjsko polje has been under strong anthropogenic influence for over a century. The hydrology of the polje was significantly altered with the construction of a

reservoir, called Buško jezero with an adjacent network of canals, as well as with smaller Lipa accumulation in 1973 in the southeastern part of the polje (Šilić & Abadžić 1989; Schneider-Jacoby et al. 2006). The network of drainage systems consists of more than 250 kilometers of large and small canals (Fig. 3).

Figure 3. Main drainage canal near the Lipa reservoir

First works in the peatlands in Livanjsko polje started in 1887. Peatland at Jagma (app. 23 km^2) was dried out around 100 years ago and peatland areas in the former Buško blato have been destroyed by Buško jezero reservoir in 1973. The largest peatland in the polje, Ždralovac, is located in north part of the polje. In this area peat and peat-topped soil cover app. 78 km^2 (Štumberger et al. 2008). This peatland is also affected by large scale excavation of peat from 1970's.

Apart from its geological, geomorphological and hydrological specificities that make it a unique among poljes, Livanjsko polje (Fig. 2.) is also characterized by a high level of biodiversity, including landscape and ecosystem diversity (Schneider-Jacoby et al. 2006, Redžić et al. 2008).

The diversity of the fauna and flora in Livanjsko polje, as well as the size of the wetland habitats and the largest peatland in the Balkans are all exceptional for the Dina-

Figure 4. Flooding in central part of Livanjsko polje during the winter season

Figure 5. Dry riverbed and grasslands in late summer

rides and the eastern Adriatic. Dry grasslands, peatlands, marshes, wet meadows and alluvial forests are the main habitats with numerous unique and relict plant associations. Their existence is based on seasonal water gradient fluctuations, naturally occurring in the polje. The unique phenomenon of karst fields of the Dinaric Alps are habitats shared by hydrophilous and thermophilous communities throughout the year, depending on variable water levels. The high water level during the spring and autumn influences rich development of hydrophilous communities, but as water level falls down considerably during the summer, the thermophilous communities dominate in the polje (Redžić et al. 2008.) (Fig. 4 & 5). The marsh forests of Livanjsko polje consists of alder, pedunculate oak and ash, and are the largest alluvial forests on karst soil in the Dinarides (Fig. 6). They are mostly found in the central and northern part of the polje.

Figure 6. Alluvial forests of pedunculate oak in the northern part of the polje.

The vegetation of Livanjsko polje is a special mix of northern European elements of grasslands and forest, as well as plants characteristic for the Mediterranean coast (Ritter-Studnićka, 1974). Specific vegetation (such as bogs, fens, reed beds and sedges) is well developed and especially characteristic for the northern part of the polje.

Nowadays, most of Livanjsko polje is covered by meadows and agricultural land (243 km^2), seasonal freshwater lakes (between 26 and up to 230 km^2), water storage areas (55 km^2), non-forested peatlands (60 km^2) and alluvial forests (21 km^2) (Štumberger et al. 2008).

The dragonfly fauna of the country is only roughly known and many records are very old. Although numerous studies and researches had been carried out the last 120 years, large areas of the country are still insufficiently explored. The lack of good data is the main problem in conservation planning and protection of dragonflies and freshwater habitats in Bosnia and Herzegovina.

Poljes are important wetlands characterized by rich and diverse freshwater habitats and have large potential in terms of dragonfly fauna. Unfortunately, they are still poorly investigated and their Odonata fauna is mostly unknown. Only a few published records for several poljes exist e.g. Klapalek (1898), Adamović (1948) and Kiauta & Kotarac (1995). Recent additional data from poljes in eastern Herzegovina is given by Jović et al. (2010).

Data of dragonflies from Livanjsko polje are mainly restricted to the southeastern part. The only historical record from Livanjsko polje is *Sympetrum sanguineum* that was found in the entomological collection of the National Museum of Bosnia and Herzegovina. The specimens were collected at Troglav, part of Dinara mountain, which is the western border of the polje. Recently, more data were collected by several researchers (unpublished data), including records of 17 species from the southeastern part of the polje. They were mainly gathered from ponds and water reservoirs. Other habitat types have never been visited, including a large marshland area and peatland in the northern part.

The main aim of this research was to gather distributional and ecological data of Odonata in these specific and biodiversity rich habitats in Livanjsko polje. Results of this research are necessary for a better understanding of dragonfly communities of poljes and will be the base for conservation planning and protection of these unique and ecologically specific habitats.

Methods

Field investigations were conducted in all parts of Livanjsko polje from April to October 2011. Mostly adults were studied, but also some data on larvae and exuviae were gathered. Data were collected from 34 localities (Fig. 7.) and 15 localities of them were visited at least twice.

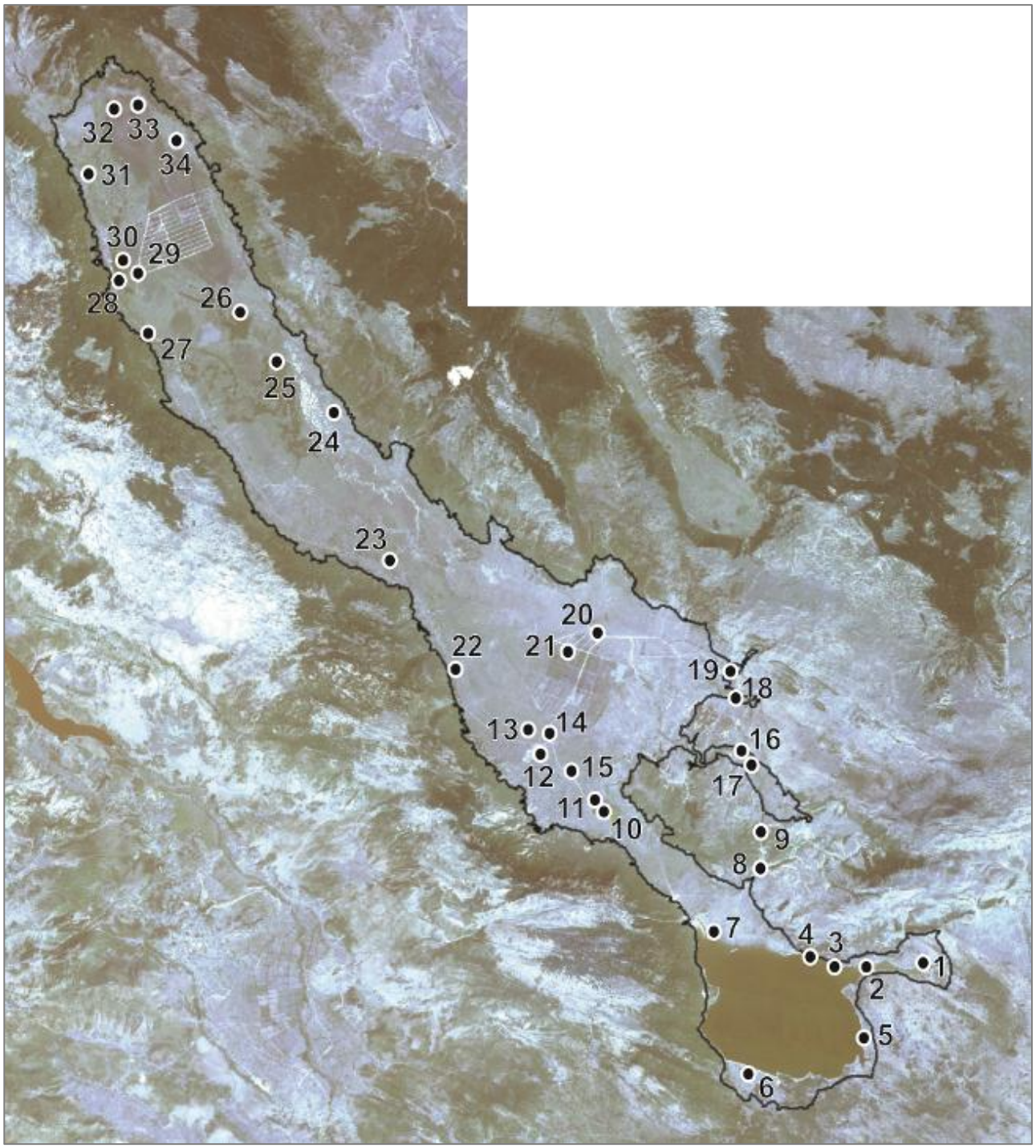

Figure 7. Surveyed localities in Livanjsko polje (border on the map is the border of the Ramsar site Livanjsko polje).

Surveyed localities include a large variety of habitats: artificial lakes, ponds, oxbows, marshes, peat bogs, rivers, streams, ditches and canals. The list of localities with geographical coordinates, altitude and survey dates is given in Table 1.

Table 1. Localities surveyed during this study.

No.	Sample site	Geographical coordinates	Altitude (m)	Survey date (all in 2011)
1	Vrilo	N 43°41'06'' E 17°07'07''	700	23.06., 13.08.
2	Buško lake near Prisoje village	N 43°41'01.6'' E 17°04'42.2''	702	24.06.
3	Streamlet near Prisoje village	N 43°41'11.8'' E 17°03'19.4''	704	25.06., 13.08.
4	road along north side of Buško lake	N 43°41'27.6'' E 17°02'35.7''	718	23.06.
5	Buško lake near Grabovica village	N 43°39'35.5'' E 17°04'28.0''	706	24.06.
6	Ričina	N 43°38'16.0'' E 17°00'02.8''	700	23.06.
7	Buško lake near Podgradina village	N 43°42'07.3'' E 16°58'57.2''	702	24.06.
8	Mandek stream	N 43°43'57.4'' E 17°00'51.8''	759	17.06., 13.08.
9	Ponds at Ploča	N 43°44'31.0'' E 17°00'50.0''	803	26.05., 05.06., 17.06.
10	Lipa lake reservoir	N 43°45'31.5'' E 16°54'18.2''	703	26.05., 05.06., 23.-25. 06., 20.07., 13.08., 05.10.
11	Ditch near Lipa lake	N 43°45'53.9'' E 16°54'09.9''	703	24.06.
12	Ponds north of the Orguz village	N 43°47'20.0'' E 16°52'19.2''	705	26.05., 24.06., 20.07., 13.08., 28.08., 05.10.
13	Pond west of main drainage canal	N 43°47'49.3'' E 16°52'30.3''	705	25.06.
14	Drainage ditch north of Orguz village	N 43°47'44.8'' E 16°52'42.7''	705	24.-25.06., 28.08.
15	Opaćica	N 43°46'25.1'' E 16°53'50.4''	703	05.10.
16	Sturba river	N 43°46'40.1'' E 17°01'08.7''	735	17.06., 20.07.
17	Stream at Vidoši	N 43°46'31.3'' E 17°01'01.5''	734	26.05.

No.	Sample site	Geographical coordinates	Altitude (m)	Survey date (all in 2011)
18	Žabljak river	N 43°48'37.2'' E 17°00'14.4''	714	17.06., 20.07.
19	Bistrica river in Livno	N 43°49'30.7'' E 16°59'46.5''	736	20.07.
20	Table I	N 43°50'33.1'' E 16°54'50.1''	706	20.07.
21	Table II	N 43°49'44.3'' E 16°53'21.6''	705	28.08.
22	Ponor of the Plovuča river	N 43°49'46.1'' E 16°49'04.1''	700	05.10.
23	Veliki Ponor	N 43°53'56.6'' E 16°43'18.8''	700	25.06.
24	Pit hole near Čelebić village	N 43°57'02.9'' E 16°44'40.0''	712	25.06.
25	Pond near Bojmute village	N 43°58'26.9'' E 16°42'54.8''	702	24.06., 20.07.
26	The oxbow near Vrbice village	N 43°59'51.8'' E 16°41'23.3''	706	17.06., 25.06., 20.07.
27	Ponor at Donji Kazanci village	N 43°59'25.4'' E 16°37'22.1''	705	17.06., 25.06.
28	Gornji Kazanci	N 44°00'45.4'' E 16°36'13.9''	705	17.06., 20.07., 05.10.
29	Ždralovac canal	N 44°01'06.3'' E 16°37'06.4''	706	17.06.
30	Peatland at Pržine	N 44°01'26.6'' E 16°36'29.5''	704	17.06.
31	Streamlet near Crni Lug village	N 44°04'22.5'' E 16°34'27.6''	727	17.06.
32	Veliki Ždralovac peatland	N 44°05'53.0'' E 16°36'23.6''	704	24.06., 20.07.
33	Ponor lake at Veliki Ždralovac peatland	N 44°06'00.3'' E 16°37'06.7''	705	24.06.
34	Spring of Bastašica river	N 44°04'52.0'' E 16°38'53.9''	712	17.06.

Results

As a result of this study, 41 dragonfly species were recorded in Livanjsko polje. Due to the lack of former dragonfly data from the area, this research represents an important contribution to the knowledge of dragonfly fauna of Bosnia and Herzegovina and Livanjsko polje. The list of recorded species with the localities at which they were observed is presented in Tab. 2.

Table 2. Checklist of the recorded species with localities (species marked with * are recorded for the first time in the study area).

	Species	Localities
1	*Calopteryx splendens* (Harris,1782) *	2, 8, 16, 18, 20, 27
2	*Calopteryx virgo* (Linnaeus,1758)	8, 16, 18
3	*Lestes dryas* Kirby, 1890	6, 9, 10, 11, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33,
4	*Lestes barbarus* (Fabricius, 1798) *	10, 13, 25, 28, 32
5	*Lestes virens* (Charpentier, 1825)	10, 12, 13, 14, 15, 20, 21, 23, 24, 25, 27, 28, 32, 33
6	*Chalcolestes viridis* (Vander Linden, 1825) *	15
7	*Sympecma fusca* (Vander Linden, 1820)	10, 12, 14, 26
8	*Ischnura elegans* (Vander Linden, 1820)	1, 2, 3, 5, 6, 7, 8, 9, 10, 12, 13, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 29, 32
9	*Ischnura pumilio* (Charpentier, 1825) *	3, 6, 8, 9, 10, 11, 12, 14, 16, 17, 18, 25, 26, 27, 28, 32, 33, 34
10	*Enallagma cyathigerum* Charpentier, 1840 *	9, 10, 12, 13, 18, 26
11	*Coenagrion puella* (Linnaeus,1758) *	6, 9, 10, 11, 12, 16, 17, 18, 20, 25, 26, 29, 32
12	*Coenagrion ornatum* (Selys, 1850) *	17
13	*Coenagrion scitulum* (Rambur, 1842) *	9
14	*Erythromma viridulum* (Charpentier, 1840) *	6, 25, 26
15	*Erythromma lindenii* (Selys, 1840)	1, 2, 3, 4, 5, 6, 7, 10, 12, 13, 14
16	*Pyrrhosoma nymphula* (Sulzer, 1776) *	18
17	*Platycnemis pennipes* (Pallas, 1771)	1, 3, 8, 10, 12, 13, 14, 16, 18, 19, 21, 23, 27
18	*Aeshna mixta* Latreille, 1805 *	10, 12, 15, 20, 21, 22
19	*Aeshna affinis* Vander Linden, 1820 *	12, 14, 21, 26, 28, 32, 33
20	*Aeshna isoceles* (Müller, 1767) *	6, 10, 12, 26
21	*Aeshna cyanea* (Müller, 1764) *	10, 12, 26
22	*Anax imperator* Leach, 1815	2, 5, 6, 10, 12, 18, 21, 23, 25, 26, 32, 33
23	*Brachytron pratense* (Müller, 1764) *	6, 25, 26, 27, 28, 29
24	*Gomphus vulgatissimus* (Linnaeus, 1758) *	27, 29
25	*Onychogomphus forcipatus* (Linnaeus, 1758)	2, 8, 18, 19
26	*Cordulia aenea* (Linnaeus, 1758) *	10, 27

	Species	Localities
27	*Somatochlora meridionalis* Nielsen, 1935 *	6, 11, 21, 26
28	*Somatochlora flavomaculata* (Vander Linden, 1825) *	10, 11
29	*Libellula quadrimaculata* Linnaeus, 1758 *	6, 9, 10, 25, 26, 32
30	*Libellula depressa* Linnaeus, 1758	2, 6, 8, 9, 10, 12, 25, 26, 28, 32
31	*Libellula fulva* (Müller, 1764) *	10
32	*Orthetrum cancellatum* (Linnaeus, 1758)	1, 2, 3, 5, 6, 7, 10, 12, 25
33	*Orthetrum albistylum* (Selys, 1848) *	1, 5, 7, 10
34	*Orthetrum coerulescens* (Fabricius, 1798) *	3, 8, 10, 28, 32
35	*Orthetrum brunneum* (Fonscolombe, 1837)	3, 8, 28
36	*Sympetrum sanguineum* (Müller, 1764)	1, 5, 6, 7, 10, 12, 13, 15, 20, 21, 25, 26, 27, 28, 29, 30, 31, 32, 33
37	*Sympetrum flaveolum* (Linnaeus, 1758)	1, 6, 7, 10, 12, 20, 21, 24, 25, 26, 32, 33
38	*Sympetrum fonscolombii* (Selys, 1840) *	2, 3, 7, 10, 33, 34
39	*Sympetrum striolatum* (Charpentier, 1840) *	10, 12, 15, 21, 22, 23, 25, 26, 27, 28, 32, 33
40	*Sympetrum meridionale* (Selys, 1841)	2, 5, 10, 12, 21, 23, 24, 25, 28, 32, 33
41	*Crocothemis erythraea* (Brullé, 1832)	10, 12, 20, 25, 32

Overview of surveyed localities and observed dragonfly species

(♂ – male, ♀ – female, A – adult, L – larva, Ex – exuvia):

Locality 1. Vrilo

Geographical coordinates: N 43°41'06'' E 17°07'07''

Survey date: 23.06.2011., 13.08.2011.

Habitat: Shore of the large water reservoir Buško Lake near the source of the lake. The water level of the lake shows high fluctuations and the shore is muddy with scarce vegetation. Wetland vegetation is not developed. Water level drops significantly during summer months and water retreats to the river bed that existed before the building of the reservoir. As a consequence most of the area becomes dry and get in use as pasture land.

Recorded dragonfly species:

23.06.2011.

- *Ischnura elegans*, 1♂ (adult and copula)
- *Erythromma lindenii*, 2♀♀

13.08.2011.

- *Ischnura elegans*, 1♂
- *Platycnemis pennipes*, 1♂
- *Orthetrum cancellatum*, 6♂♂, 1♀
- *Orthetrum albistylum*, 2♂♂
- *Sympetrum sanguineum*, 2♂♂, 1♀
- *Sympetrum flaveolum*, 2♂♂, 2♀♀

Locality 2. The Buško lake near Prisoje

Geographical coordinates: N 43°41'01.6'' E 17°04'42.2''

Survey date: 24.06.2011.

Habitat: Lake shore and small pools formed in the holes made by the extraction of sand and gravel. Lake shore similar to Loc. 1. Water level is very variable and most of the pools dry out during the summer. Some shrubs of willow trees and *Typha angustifolia* grow in and around these pools. In some parts, floating communities of *Polygonum amphibium*, one of the rare plants that can adapt on highly variable water levels, cover water surface along the lake shore during summer months. Some of the recorded species like *C. splendens* and *O. forcipatus* probably don't reproduce in the lake but in the nearby stream.

Figure 8. Lake surface covered with Polygonum amphybium at the north-east side of the lake.

Recorded dragonfly species:

- *Calopteryx splendens*, 1♂
- *Ischnura elegans*, 60A (adult and teneral)
- *Erythromma lindenii*, 50A
- *Anax imperator*, 1♂
- *Onychogomphus forcipatus*, 1♂
- *Orthetrum cancellatum*, 10A
- *Libellula depressa*, 1♂, 1♀
- *Sympetrum fonscolombii*, 10A
- *Sympetrum meridionale*, 2♂♂

Locality 3. Streamlet near Prisoje village

Geographical coordinates: N 43°41'11.8'' E 17°03'19.4''

Survey date: 25.06.2011., 13.08.2011.

Habitat: Streamlet flowing down the slope on the north-east side of the Buško lake. The streamlet is overgrown with tall trees and disappears at a small depression covered with wet meadow vegetation near the lake shore. Dragonfly species were recorded at the meadow near the stream or along the path that goes through the small forest stand.

Recorded dragonfly species:

25.06.2011.

- *Ischnura pumilio*, 3♂♂, 1♀♀
- *Erythromma lindenii*, 60A
- *Orthetrum cancellatum*, 2♀♀
- *Sympetrum fonscolombii*, 1♂

13.08.2011.

- *Ischnura elegans*, 5A
- *Platycnemis pennipes*, 3♂
- *Orthetrum cancellatum*, 2♂♂
- *Orthetrum coerulescens*, 1♂
- *Orthetrum brunneum*, 1♂

Locality 4. Road along the north side of the Buško lake

Geographical coordinates: N 43°41'27.6'' E 17°02'35.7''

Survey date: 23.06.2011.

Habitat: Shrub and tall herb vegetation by the road at the north side of the Buško lake, app. 20m above the lake. Lake border is covered with mud.

Recorded dragonfly species:

- *Erythromma lindenii*, 1♂, 1♀

Locality 5. The Buško lake near Grabovica village

Geographical coordinates: N 43°39'35.5'' E 17°04'28.0''

Survey date: 24.06.2011.

Habitat: Rocky lake shore with scarce shrubs, small trees and grassland vegetation on the east side of the Buško lake.

Recorded dragonfly species:

24.06.2011.

- *Ischnura elegans*, 10's A
- *Erythromma lindenii*, 5A
- *Anax imperator*, 1♂
- *Orthetrum cancellatum*, 1♀
- *Orthetrum albistylum*, 6A
- *Sympetrum sanguineum*, 1♂
- *Sympetrum meridionale*, 5A

Figure 9. Rocky shore on the east side of the lake.

Locality 6. Ričina

Geographical coordinates: N 43°38'16.0'' E 17°00'02.8''

Survey date: 23.06.2011.

Habitat: In the past, Ričina river flowed through the vast marshland Buško blato that was destroyed with the building of the hydro accumulation dam in 1973. This oxbow is now probably the only remnant of this marshland, located in the south of the researched area. The oxbow is developed some 250 m from the original riverbed of the Ričina river in the channel that was built during the construction of the dike and the accumulation. It is probably fed with water going under the dike. Other parts of

this area, previously flooded by water from the marshland, are now dry pastures. Rich marshland vegetation with willow and alder trees, water lilies and reedbeds is developed in this oxbow.

Recorded dragonfly species:

- *Lestes dryas*, 3♂♂, 8A
- *Ischnura elegans*, 50A
- *Ischnura pumilio*, 2♂
- *Coenagrion puella*, 60A
- *Erythromma viridulum*, 10A
- *Erythromma lindenii*, 2♂♂, 2♀♀
- *Aeshna isosceles*, 3A
- *Anax imperator*, 5♂♂, 2L, 6Ex
- *Brachytron pretense*, 2♂♂
- *Somatochlora meridionalis*, 1♂, 1♀, 3A
- *Libellula quadrimaculata*, 2♂♂, 1♀, 1Ex
- *Libellula depressa*, 1♂
- *Orthetrum cancellatum*, 1♀
- *Sympetrum sanguineum*, 2♂♂, 1♀, 8A
- *Sympetrum flaveolum*, 2♂♂, 2♀♀, 6A

Locality 7. The Buško lake near Podgradina village

Geographical coordinates: N 43°42'07.3'' E 16°58'57.2''

Survey date: 24.06.2011.

Habitat: Muddy shore on the east side of the lake near the locality where water from the main drainage canal from Livanjsko polje enters into the lake. Due to high fluctuation of water level, large parts transform into the fields during the summer months and serve as pasture for cattle grazing.

Recorded dragonfly species:

- *Ischnura elegans*, 50 (adult and copula)
- *Erythromma lindenii*, 50A
- *Orthetrum cancellatum*, 8A
- *Orthetrum albistylum*, 2♂♂
- *Sympetrum sanguineum*, 1♂
- *Sympetrum flaveolum*, 1♂
- *Sympetrum fonscolombii*, 2♂♂

Locality 8. Mandek stream

Geographical coordinates: N 43°43'57.4'' E 17°00'51.8''

Survey date: 17.06.2011., 13.08.2011.

Habitat: Small stream with gravel and rocky bottom flowing down the slope of the hill, north of the Buško lake reservoir, mostly overgrown with various shrubs and with several small temporary pools fed by the water from the stream.

Recorded dragonfly species:

17.06.2011.

- *Calopteryx virgo*, 10A
- *Ischnura pumilio*, 20A (adult and copula)
- *Platycnemis pennipes*, 1♂, 3♀♀
- *Libellula depressa*, 1♀

13.08.2011.

- *Calopteryx splendens*, 1♂
- *Calopteryx virgo*, 3♂♂, 3♀♀
- *Ischnura elegans*, 2♂♂
- *Platycnemis pennipes*, 5♂♂ (adult and copula)
- *Onychogomphus forcipatus*, 2♂♂
- *Libellula depressa*, 1♂
- *Orthetrum coerulescens*, 1♂
- *Orthetrum brunneum*, 2♂♂

Locality 9. Ponds at Ploča

Geographical coordinates: N 43°44'31'' E 17°00'50''

Survey date: 26.05.2011., 05.06.2011., 17.06.2011.

Figure 10. Lipa reservoir in the spring

Habitat: Two shallow ponds with the size between 300 and 500m^2 developed in small depressions on the hill between the city of Livno and the Buško lake. One of the

ponds is fed by the water from the nearby spring. The ponds are fully overgrown during the summer.

Recorded dragonfly species:

26.05.2011.
- *Ischnura elegans*, 1♂
- *Ischnura pumilio*, 10A
- *Coenagrion puella*, 2♂♂
- *Libellula depressa*, 20Ex

05.06.2011.
- *Ischnura pumilio*, 5♂♂, 1♀
- *Coenagrion puella*, 1♂
- *Libellula quadrimaculata*, 1♀ (teneral)

17.06.2011.
- *Lestes dryas*, 2♂♂, 3♀♀, 4A
- *Ischnura pumilio*, 40A (adult and copula)
- *Enallagma cyathigerum*, 2♂♂
- *Coenagrion puella*, 5♂♂, 3♀♀
- *Coenagrion scitulum*, 1♀

Locality 10. Lipa lake reservoir

Geographical coordinates: N 43°45'31.5'' E 16°54'18.2''

Survey date: 26.05.2011., 05.06.2011., 23-25.06.2011., 20.07.2011., 13.08.2011., 05.10.2011.

Habitat: Lipa lake is a water reservoir that receives water from the rivers that flow through the southeastern part of the polje and then through the network of canals to the Lipa reservoir and the Buško lake. South and west parts of the lake shore are covered with rocks and concrete, with only small patches of vegetation, mainly *Typha sp*. On the north and east side and on the small isles in the center of the lake, rich vegetation dominated by willow and alder trees, reedbeds and sedges is developed.

Recorded dragonfly species:

26.05.2011.
- *Ischnura elegans*, 5A
- *Coenagrion puella*, 2♂♂
- *Anax imperator*, 1♂
- *Libellula depressa*, 2♂, 2A

05.06.2011.
- *Ischnura elegans*, 5A
- *Cordulia aenea*, 1♂
- *Libellula quadrimaculata*, 5A
- *Libellula depressa*, 1♂

23.06.2011.
- *Ischnura elegans*, 3♂
- *Ischnura pumilio*, 1♂
- *Anax imperator*, 1♂

24.06.2011.
- *Lestes dryas*, 2♂♂,1♀
- *Ischnura elegans*, 6A
- *Ischnura pumilio*, 8A

- *Erythromma lindenii*, 1♀
- *Sympetrum flaveolum*, 3A

25.06.2011.

- *Lestes dryas*, 10A
- *Lestes barbarus*, 1♀
- *Lestes virens*, 10A
- *Ischnura elegans*, 20A (adult and copula)
- *Ischnura pumilio*, 15A (adult and copula)
- *Enallagma cyathigerum*, 2♂♂
- *Coenagrion puella*, 5♂, 1♀, 2A (adult and copula)
- *Erythromma lindenii*, 2♂♂
- *Platycnemis pennipes*, 8A
- *Anax imperator*, 10A
- *Cordulia aenea*, 2♂♂
- *Somatochlora flavomaculata*, 1♀
- *Libellula quadrimaculata*, 2♂♂
- *Libellula depressa*, 1♂
- *Libellula fulva*, 1♂
- *Orthetrum coerulescens*, 1♂
- *Sympetrum flaveolum*, 10A
- *Sympetrum fonscolombii*, 1♂
- *Sympetrum meridionale*, 7A

20.07.2011.

- *Enallagma cyathigerum*, 3♂♂
- *Aeshna isosceles*, 1A
- *Anax imperator*, 5♂♂
- *Orthetrum cancellatum*, 1♂
- *Orthetrum albistylum*, 2♂♂
- *Crocothemis erythraea*, 5♂♂

13.08.2011.

- *Lestes virens*, 20A
- *Ischnura elegans*, 20A
- *Erythromma lindenii*, 3♂♂
- *Platycnemis pennipes*, 5A
- *Aeshna cyanea*, 1♂
- *Anax imperator*, 4♂♂
- *Orthetrum cancellatum*, 1♂
- *Sympetrum sanguineum*, 10A
- *Sympetrum flaveolum*, 2♂♂

05.10.2011.

- *Lestes virens*, 10♂♂, 7♀♀ (adult and copula)
- *Sympecma fusca*, 1♂
- *Aeshna mixta*, 15♂♂, 2♀♀ (adult and copula)
- *Sympetrum sanguineum*, 1♂, 1♀
- *Sympetrum striolatum*, 7♂♂, 5♀♀
- *Sympetrum meridionale*, 5♂♂, 2♀♀

Locality 11. Small drainage ditch near Lipa lake

Geographical coordinates: N 43°45'53.9'' E 16°54'09.9''

Survey date: 24.06.2011.

Habitat: North of the Lipa lake, small shallow ditches are found on the outer sides of the dikes that are built along the concrete canal. These large canals have no vegetation, probably due to fast water current during some parts of the year and their concrete bottom. Ditches are mostly overgrown with *Typha angustifolia*, *Sparganium* sp. and *Salix* sp. During summer months, large parts of them dry out, leaving only small stretches with muddy water and wet ground.

Figure 11. A small ditch along the main drainage canal near the Lipa reservoir

Recorded dragonfly species:

- *Lestes dryas*, 15♂♂, 10♀♀
- *Ischnura pumilio*, 20A
- *Coenagrion puella*, 8♂♂, 4♀♀ (adult and copula)
- *Somatochlora meridionalis*, 1♂
- *Somatochlora flavomaculata*, 1♂

Locality 12. Ponds north of the village Orguz

Geographical coordinates: N 43°47'20.0'' E 16°52'19.2''

Survey date: 26.05.2011., 24.06.2011., 20.07.2011., 13.08.2011., 28.08.2011., 05.10.2011.

Habitat: Several artificial ponds with a size of 1-2 ha were found in the polje near the village of Orguz. They are all formed in large pits remaining after coal excavation. Reedbeds are well developed and dominate along the margins of all these ponds. Only small parts of the shore are cleaned up by fishermen.

Recorded dragonfly species:

26.05.2011.

- *Sympecma fusca*, 2♂♂, 5A
- *Ischnura elegans*, 20A
- *Ischnura pumilio*, 2♂♂
- *Anax imperator*, 1♂
- *Libellula depressa*, 1♂ (teneral)

24.06.2011.

- *Ischnura elegans*, 30A
- *Erythromma lindenii*, 1♂
- *Platycnemis pennipes*, 20A
- *Sympetrum flaveolum*, 1♂

20.07.2011.

- *Ischnura elegans*, 50A
- *Enallagma cyathigerum*, 1♀
- *Coenagrion puella*, 10♂♂, 2♀♀
- *Platycnemis pennipes*, 10A
- *Aeshna isosceles*, 2A
- *Anax imperator*, 3♂♂
- *Libellula depressa*, 2♂♂
- *Orthetrum cancellatum*, 2♂♂, 1♀
- *Sympetrum sanguineum*, 2♂♂ (teneral), 5Ex
- *Sympetrum flaveolum*, 2♂♂
- *Crocothemis erythraea*, 10♂♂

13.08.2011.

- *Lestes virens*, 5♂♂, 1♀
- *Sympecma fusca*, 1♂
- *Erythromma lindenii*, 1♂
- *Platycnemis pennipes*, 3♂♂, 2♀♀
- *Aeshna affinis*, 1♂
- *Aeshna cyanea*, 1♂,1♀
- *Anax imperator*, 1♂
- *Sympetrum sanguineum*, 20A, 2Ex
- *Sympetrum flaveolum*, 30A
- *Sympetrum striolatum*, 1♂
- *Sympetrum meridionale*, 2♂♂
- *Crocothemis erythraea*, 1♂

28.08.2011.

- *Lestes virens*, 4♀♀
- *Ischnura elegans*, 16♂♂, 4♀♀
- *Platycnemis pennipes*, 1♂
- *Aeshna mixta*, 1♂, 1♀ (copula)
- *Sympetrum sanguineum*, 5♂♂
- *Sympetrum flaveolum*, 1♀
- *Sympetrum meridionale*, 1♂

05.10.2011.

- *Lestes virens*, 3♂♂, 1♀ (adult and copula)
- *Aeshna mixta*, 4♂♂
- *Sympetrum sanguineum*, 2♂♂
- *Sympetrum striolatum*, 1♂

Locality 13. Pond west of main drainage canal

Geographical coordinates: N 43°47'49.3'' E 16°52'30.3''

Survey date: 25.06.2011.

Habitat: A pond similar to the ones near the village of Orguz is located app. 1km further north. The banks are mainly overgrown with reed and partly with sedges. Small temporary pools and tranches with water are present near the pond.

Figure 12. Pond in coal excavation pit north of the village of Orguz

Recorded dragonfly species:

- *Lestes barbarus*, 1♂, 1A
- *Lestes virens*, 1♂
- *Ischnura elegans*, 3♂♂, 1♀
- *Enallagma cyathigerum*, 1♂
- *Erythromma lindenii*, 3♂♂
- *Platycnemis pennipes*, 2A
- *Sympetrum sanguineum*, 1♂

Locality 14. Small drainage ditch north of Orguz

Geographical coordinates: N 43°47'44.8'' E 16°52'42.7''

Survey date: 24.06.2011., 25.06.2011., 28.08.2011.

Habitat: A small drainage ditch, less than 1m in diameter, along the main drainage canal near the Orguz village overgrown with *Typha angustifolia* and *Alisma plantago-*

aquatica were almost dry at the time of visits. The species observed here were mainly found on the vegetation in the ditch or in the field near the channel.

Recorded dragonfly species:

24.06.2011.

- *Lestes virens*, 2♂♂

25.06.2011.

- *Lestes virens*, 10A
- *Ischnura pumilio*, 2♂♂
- *Erythromma lindenii*, 2♂♂
- *Platycnemis pennipes*, 1♂, 4A

28.08.2011.

- *Lestes virens*, 4♂♂, 2♀♀
- *Sympecma fusca*, 3♂♂ (teneral)
- *Aeshna affinis*, 1♀

Figure 13. Almost a dry drainage ditch at Opaćica

Locality 15. Opaćica

Geographical coordinates: N 43°46'25.1'' E 16°53'50.4''

Survey date: 05.10.2011.

Habitat: A small ditch and a dry temporary stream that enters a concrete channel at Opaćica, the only locality where *Chalcolestes viridis* is observed. The site does not

seem typical for the species, the channel is almost dry with scarce *Typha angustifolia*, *Alisma plantago-aquatica* and sedge vegetation. Only small stretches with shallow pools and muddy water were found. Scarce willow bushes, not higher than 50 cm, are present along the channel and only a few other small trees and bushes at the margins.

Recorded dragonfly species:

- *Lestes virens*, 20♂♂, 2♀♀, 10A (adult and copula)
- *Chalcolestes viridis*, 6♂♂, 7♀♀ (adult and copula)
- *Aeshna mixta*, 2♂♂
- *Sympetrum sanguineum*, 1♂
- *Sympetrum striolatum*, 7♂♂, 3♀♀

Locality 16. Sturba river

Geographical coordinates: N 43°46'40.1'' E 17°01'08.7''

Survey date: 17.06.2011., 20.07.2011.

Habitat: Sturba is one of three karst rivers that have their source in the southeastern part, south of the city of Livno. After only a few kilometers, all of three rivers present in this area are captured into concrete canals and directed into hydro accumulations. The Sturba river at the survey locality in the Sturba village is fast and cold with rich submerged vegetation and partly overgrown with willow trees on the banks.

Recorded dragonfly species:

17.06.2011.

- *Ischnura pumilio*, 2♂♂

20.07.2011.

- *Calopteryx splendens*, 2♂♂, 1♀
- *Calopteryx virgo*, 2♂♂
- *Ischnura elegans*, 20A
- *Ischnura pumilio*, 1♀
- *Coenagrion puella*, 10A
- *Platycnemis pennipes*, 20A

Locality 17. Stream at Vidoši

Geographical coordinates: N 43°46'31.3'' E 17°01'01.5''

Survey date: 26.05.2011.

Habitat: A small stream at the Vidoši plain near the Sturba village and the Sturba river. Partly overgrown with bushes and with several stretches overgrown with *Iris pseudacorus, Caltha palustris*. The only locality where *Coenagrion ornatum* was found. Several other similar streams in the vicinity were also checked, but they were either completely overgrown with bushes or dried out. Although natural water circulation is altered in this part of the field, the species is possibly present at other sites, as

some of artificially made channels could be good habitats for the species. However, they could not be visited during this research. The problem for this species is that, due to water management, large parts of the field, including many channels and streams, dry out during the summer months.

Recorded dragonfly species:

- *Ischnura elegans*, 2♂, 10A
- *Ischnura pumilio*, 1♂
- *Coenagrion puella*, 1♂
- *Coenagrion ornatum*, 1♂

Locality 18. Žabljak river

Geographical coordinates: N 43°48'37.2'' E 17°00'14.4''

Survey date: 17.06.2011., 20.07.2011.

Habitat: Wide and slow flowing at the survey spot, similar to Sturba, the Žabljak river also has richly developed submerged vegetation, cold water and mostly rocky bottom. The shore near D. Žabljak village is overgrown with tall trees and clear, 50m long stretch with meadow vegetation. This is the only locality where *Pyrrhosoma nymphula* was found. Several individuals were recorded at the small pool connected to the river and also along the path going parallel with the river through the small forest stand.

Recorded dragonfly species:

17.06.2011.

- *Ischnura pumilio*, 2♂♂, 1♀ (adult and copula)
- *Coenagrion puella*, 4♂♂
- *Pyrrhosoma nymphula*, 3♂♂, 1♀
- *Anax imperator*, 2♂♂, 1♀

20.07.2011.

- *Calopteryx splendens*, 10A
- *Calopteryx virgo*, 1♂
- *Ischnura elegans*, 10A
- *Ischnura pumilio*, 1♂
- *Enallagma cyathigerum*, 1♀
- *Coenagrion puella*, 10♂♂, 2♀♀
- *Platycnemis pennipes*, 10A
- *Onychogomphus forcipatus*, 1♂

Figure 14. Žabljak river near the village Donji Žabljak

Locality 19. Bistrica river in Livno

Geographical coordinates: N 43°49'30.7'' E 16°59'46.5''

Survey date: 20.07.2011.

Habitat: The source of the river is almost in the center of the city of Livno and water supply is partly captured at the spring. Part of the river is canalized and goes through the city leaving the river bed dry during the summer months. The river banks at the sample site were completely overgrown with various shrubs and small trees and hardly accessible. The river has a fast current and a rocky bottom.

Recorded dragonfly species:

- *Ischnura elegans*, 2♂♂
- *Platycnemis pennipes*, 2♂♂, 1♀
- *Onychogomphus forcipatus*, 1♂

Locality 20. Table I

Geographical coordinates: N 43°50'33.1'' E 16°54'50.1''

Survey date: 20.07.2011.

Habitat: A large canal that captures water from the Bistrica and Plovuća rivers from the area north of the Livno city. There are patches of *Typha* and *Iris* vegetation growing around this canal. Most of the species were recorded in the field at the bank of the canal.

Recorded dragonfly species:

- *Calopteryx splendens*, 1♂
- *Lestes dryas*, 5♂♂
- *Lestes virens*, 6♀♀, 2A
- *Ischnura elegans*, 30A (adult and copula)
- *Coenagrion puella*, 8A (adult and copula)
- *Aeshna mixta*, 2♂♂
- *Sympetrum sanguineum*, 1♂
- *Sympetrum flaveolum*, 2♀♀
- *Crocothemis erythraea*, 2♂♂

Locality 21. Table II

Geographical coordinates: N 43°49'44.3'' E 16°53'21.6''

Survey date: 28.08.2011.

Habitat: A small, mainly dry, drainage channel in the fields with some Typha vegetation. Most of species were recorded flying on the fields near the channel, as well. Several ponds with some reed vegetation were formed after sand excavation.

Recorded dragonfly species:

- *Lestes dryas*, 20A
- *Lestes virens*, 20A
- *Ischnura elegans*, 50A (adult and copula)
- *Platycnemis pennipes*, 30A (adult and copula)
- *Aeshna mixta*, 10A
- *Aeshna affinis*, 1♂, 1♀
- *Anax imperator*, 3♂♂, 1♀
- *Somatochlora meridionalis*, 1♂
- *Sympetrum sanguineum*, 40A (adult and copula), 6Ex
- *Sympetrum flaveolum*, 8A
- *Sympetrum striolatum*, 1♂
- *Sympetrum meridionale*, 5♂♂

Locality 22. Ponor of the Plovuča river

Geographical coordinates: N 43°49'46.1'' E 16°49'04.1''

Survey date: 05.10.2011.

Habitat: The Plovuča river is one of the temporary rivers that flows through the south part of Livanjsko polje. At the time of the field survey, the riverbed was completely dry and only two species were recorded flying, over the field and bushes that grow along the river margins.

Recorded dragonfly species:

- *Aeshna mixta*, 1♂
- *Sympetrum striolatum*, 1♂

Locality 23. Veliki Ponor

Geographical coordinates: N 43°53'56.6'' E 16°43'18.8''

Survey date: 25.06.2011.

Habitat: An almost dry riverbed with only small ponds near the ponor of the Jaruga river. Most of the dragonflies were observed on the nearby shrubs or flying over the meadows and fields in the vicinity.

Recorded dragonfly species:

- *Lestes dryas*, 20A
- *Lestes virens*, 10A
- *Ischnura elegans*, 20A
- *Platycnemis pennipes*, 3♂♂
- *Anax imperator*, 2♂♂
- *Sympetrum striolatum*, 2♂♂, 20A
- *Sympetrum meridionale*, 10A

Locality 24. Pit hole near Čelebić village

Geographical coordinates: N 43°57'02.9'' E 16°44'40.0''

Survey date: 25.06.2011.

Habitat: Few small ponds formed after sand excavation in large pit holes near the main road and the Čelebići village. The ponds are shallow and already mostly dry, dominated by *Typha sp*.

Recorded dragonfly species:

- *Lestes dryas*, 50A
- *Lestes virens*, 50A
- *Ischnura elegans*, 10A
- *Sympetrum flaveolum*, 2♂♂, 40A
- *Sympetrum meridionale*, 20A

Locality 25. Pond near Bojmute village

Geographical coordinates: N 43°58'26.9'' E 16°42'54.8''

Survey date: 24.06.2011., 20.07.2011.

Habitat: A small pond less than 200m^2 in size with rich vegetation. Developed near the road in the vicinity of the swamp forest area that is unfortunately inaccessible to research due to presence of mine fields from the recent war.

Recorded dragonfly species:

24.06.2011.

- *Lestes dryas*, 10A
- *Lestes virens*, 10A (adult and copula)
- *Ischnura elegans*, 15A (adult and copula)
- *Ischnura pumilio*, 2♂♂
- *Coenagrion puella*, 10♂♂
- *Erythromma viridulum*, 2♂♂
- *Anax imperator*, 2♂♂, 1♀, 5Ex
- *Brachytron pretense*, 1♂
- *Libellula quadrimaculata*, 5♂♂
- *Libellula depressa*, 1♂, 2Ex
- *Orthetrum cancellatum*, 1♂
- *Sympetrum sanguineum*, 2♂♂, 1♀
- *Crocothemis erythraea*, 1♂

20.07.2011.

- *Lestes dryas*, 2♂♂
- *Lestes barbarus*, 5♂♂, 1♀
- *Lestes virens*, 20A
- *Anax imperator*, 2♂♂
- *Libellula quadrimaculata*, 10♂♂
- *Libellula depressa*, 4♂♂
- *Sympetrum sanguineum*, 20A
- *Sympetrum flaveolum*, 1♂
- *Sympetrum fonscolombii*, 3♂♂, 1♀♀
- *Sympetrum meridionale*, 2♀♀ (teneral)
- *Crocothemis erythraea*, 2♂♂, 1F

Locality 26. The oxbow near Vrbice village

Geographical coordinates: N 43°59'51.8'' E 16°41'23.3''

Survey date: 17.06.2011., 25.06.2011., 20.07.2011.

Habitat: Stretch of Jaruga, a temporary river that drains water from the Ždralovac peatland during the wet season. It is mostly dry in the summer, but some oxbows, large ponds or small pools with rich water vegetation are still present. By the end of the summer, they are fully overgrown with marsh vegetation. Some parts of these stretches are also overgrown with tall trees.

Figure 15. Oxbow of the Jaruga river near the village of Vrbice

Recorded dragonfly species:

17.06.2011.

- *Lestes dryas*, 50A
- *Sympecma fusca*, 1♂
- *Ischnura elegans*, 2♂♂, 5A
- *Ischnura pumilio*, 3♂♂, 1♀, 8A
- *Coenagrion puella*, 40A
- *Erythromma viridulum*, 1♂
- *Anax imperator*, 15♂, 2♀♀
- *Brychytron pretense*, 6♂♂
- *Somatochlora meridionalis*, 2A (teneral), 1Ex
- *Libellula quadrimaculata*, 40A
- *Libellula depressa*, 15A
- *Sympetrum flaveolum*, 2♀♀ (teneral)

25.06.2011.

- *Ischnura elegans*, 5♂♂, 2♀♀
- *Ischnura pumilio*, 1♂

- *Enallagma cyathigerum*, 3♂♂, 1♀ (adult and copula), 1Ex
- *Coenagrion puella*, 3♂♂
- *Erythromma viridulum*, 60A
- *Anax imperator*, 1♂, 2Ex
- *Somatochlora meridionalis*, 6A
- *Libellula quadrimaculata*, 8A
- *Libellula depressa*, 1♀
- *Sympetrum flaveolum*, 1♂

20.07.2011.

- *Ischnura elegans*, 50A
- *Enallagma cyathigerum*, 40A
- *Erythromma viridulum*, 40A
- *Aeshna affinis*, 1♂
- *Aeshna isosceles*, 1♂
- *Aeshna cyanea*, 1♂
- *Anax imperator*, 15A, 1L
- *Somatochlora meridionalis*, 1♂, 10A
- *Libellula quadrimaculata*, 20A
- *Libellula depressa*, 10♂♂
- *Sympetrum sanguineum*, 70A
- *Sympetrum striolatum*, 2♂♂ (teneral)

Locality 27. Ponor at D. Kazanci village

Geographical coordinates: N 43°59'25.4'' E 16°37'22.1''

Survey date: 17.06.2011., 25.06.2011.

Habitat: A stream flowing into a ponor near the D. Kazanci village, mainly overgrown with tall herb vegetation and willow bushes. It is dry in late summer.

Recorded dragonfly species:

17.06.2011.

- *Lestes dryas*, 1♀
- *Ischnura pumilio*, 3♂♂, 2♀ (adult and copula)
- *Brachytron pretense*, 1♂
- *Cordulia aenea*, 1♂
- *Sympetrum sanguineum*, 1A (teneral)

25.06.2011.

- *Calopteryx splendens*, 1♂
- *Lestes dryas*, 50A
- *Lestes virens*, 20A
- *Ischnura elegans*, 20A (adult and copula)
- *Platycnemis pennipes*, 1♂
- *Gomphus vulgatissimus*, 1♂
- *Sympetrum striolatum*, 1♂

Locality 28. Gornji Kazanci

Geographical coordinates: N 44°00'45.4'' E 16°36'13.9''

Survey date: 17.06.2011., 20.07.2011., 05.10.2011.

Habitat: Reed at the border of the marsh, overgrown with alder trees. Several small springs are present on a small slope at the border of the marsh. The water is flowing down the slope to a nearby reedbed, disappearing after 10-20 meters.

Recorded dragonfly species:

17.06.2011.

- *Lestes dryas*, 1♂, 3♀♀
- *Ischnura pumilio*, 3♂♂, 3♀♀ (adult and copula)
- *Aeshna affinis*, 1♀ (teneral)
- *Brachytron pretense*, 1♂, 1♀
- *Libellula depressa*, 1♀
- *Orthetrum coerulescens*, 40A (adult, teneral and copula)
- *Sympetrum sanguineum*, 2♂♂

20.07.2011.

- *Lestes dryas*, 20A
- *Lestes barbarus*, 1♂, 1♀
- *Lestes virens*, 30A
- *Aeshna affinis*, 2♂♂, 1♀, 1Ex
- *Orthetrum coerulescens*, 10♂♂, 2♀♀
- *Orthetrum brunneum*, 1♂
- *Sympetrum sanguineum*, 10A
- *Sympetrum striolatum*, 1♂
- *Sympetrum meridionale*, 1♀

05.10.2011.

- *Lestes virens*, 3♀♀
- *Sympetrum sanguineum*, 1♀
- *Sympetrum striolatum*, 1♂, 1♀

Figure 16. The edge of the wetland area with dense alder woods near Donji Kazanci village in the northwestern part of the polje.

Locality 29. Ždralovac canal

Geographical coordinates: N 44°01'06.3'' E 16°37'06.4''

Survey date: 17.06.2011.

Habitat: Large concrete canal flowing from the Ždralovac peatland with patches of *Typha angustifolia*, *Iris pseudacorus* and *Alisma plantago-aquatica* growing along the bank.

Recorded dragonfly species:

- *Lestes dryas*, 2♂♂
- *Ischnura elegans*, 1♂, 1♀
- *Coenagrion puella*, 1♂
- *Brachytron pretense*, 1♀
- *Gomphus vulgatissimus*, 2♂♂, 1A
- *Sympetrum sanguineum*, 1A (teneral)

Locality 30. Peatland at Pržine

Geographical coordinates: N 44°01'26.6'' E 16°36'29.5''

Survey date: 17.06.2011.

Habitat: In this area, the peatland is covered with sedges and the soil is saturated with water and with numerous small pools 5 to 10 cm deep.

Recorded dragonfly species:

- *Lestes dryas*, 1♂
- *Sympetrum sanguineum*, 40A (teneral)

Locality 31. Streamlet near Crni Lug village

Geographical coordinates: N 44°04'22.5'' E 16°34'27.6''

Survey date: 17.06.2011.

Habitat: A small spring near the road. A short stream is flowing to the nearby meadow and disappearing shortly. Tenerals of *S. sanguineum* were observed in the part where the meadow is saturated with water from the stream.

Recorded dragonfly species:

- *Sympetrum sanguineum*, 1A (teneral)

Locality 32. Veliki Ždralovac peatland

Geographical coordinates: N 44°05'53.0'' E 16°36'23.6''

Survey date: 24.06.2011., 20.07.2011.

Habitat: A large area of dense reedbeds that is mostly dry during the summer months. Species were found flying over the reedbeds, no open water was present. Large parts of the peatland are not accessible due to danger from landmines.

Recorded dragonfly species:

24.06.2011.

- *Lestes dryas*, 40A (adult and copula)
- *Lestes barbarus*, 10A
- *Lestes virens*, 40A
- *Ischnura elegans*, 20A
- *Ischnura pumilio*, 2♂♂
- *Sympetrum sanguineum*, 4♂♂, 2♀♀, 8A, 4Ex
- *Sympetrum flaveolum*, 5♂♂, 1♀, 20A
- *Sympetrum striolatum*, 2♂♂

20.07.2011.

- *Lestes barbarus*, 1♀
- *Lestes virens*, 50A
- *Ischnura elegans*, 1♂
- *Coenagrion puella*, 2♂♂
- *Aeshna affinis*, 3♂♂
- *Anax imperator*, 1♂
- *Libellula quadrimaculata*, 2♂♂
- *Libellula depressa*, 1♂
- *Orthetrum coerulescens*, 1♂
- *Sympetrum sanguineum*, 20A
- *Sympetrum striolatum*, 1♂, 5A
- *Sympetrum meridionale*, 1♀
- *Crocothemis erythraea*, 1♂

Locality 33. Ponor lake at Veliki Ždralovac

Geographical coordinates: N 44°06'00.3'' E 16°37'06.7''

Survey date: 24.06.2011.

Habitat: Ponor lake is a wet depression in the northeastern part of the Ždralovac peatland bog. The depression is completely overgrown with vegetation.

Recorded dragonfly species:

- *Lestes dryas*, 20A
- *Lestes virens*, 20A
- *Ischnura pumilio*, 1♂
- *Aeshna affinis*, 1♂
- *Anax imperator*, 1♂
- *Sympetrum sanguineum*, 5♂♂
- *Sympetrum flaveolum*, 1♂
- *Sympetrum fonscolombii*, 2♂♂
- *Sympetrum striolatum*, 2♀♀
- *Sympetrum meridionale*, 3♂♂

Figure 17. Wet depression near the ponor at Ždralovac peatland

Locality 34. Spring of Bastašica

Geographical coordinates: N 44°04'52.0'' E 16°38'53.9''

Survey date: 17.06.2011.

Habitat: A temporary spring rich with water in the spring. At the time of visit, the spring was dry and only a small temporary pool with water was found in the field without any hydrophilous vegetation.

Recorded dragonfly species:

- *Ischnura pumilio*, 1♂
- *Sympetrum fonscolombii*, 1♀

Discussion

Although Livanjsko polje is a wetland of international importance (Ramsar site) and Important Bird Area (IBA site) the habitats in the polje are not protected. Numerous activities that can significantly affect or completely destroy freshwater habitats in the polje are conducted or planned for the future.

Water management that started in the 19th century seriously affected freshwater habitats in Livanjsko polje. It is positive that natural flooding of the polje still occurs and that the floodplain is largely preserved, but plans for additional water extraction (e.g. extension of the existing canals) for energy production are in progress.

Peat excavation and drainage that is currently practiced in Livanjsko polje is unsustainable and threatens to destroy the largest Balkan peatland. Uncontrolled burning of peat, grassland and scrub areas in the spring and autumn at Livanjsko Polje is also a serious problem for the marshland and peat areas (Fig. 18).

Figure 18. Fire at Veliki Ždralovac peatland in October 2011

During this research, 41 species were recorded in Livanjsko polje, two-thirds of all species known to occur in Bosnia and Herzegovina. After Hutovo blato Nature Park,

this is the second highest number of species recorded at one area in the country. This study confirms the importance of habitats of poljes for dragonflies. It is the result of the presence of different kinds of freshwater habitats in the polje. Although large number of species was recorded in the Livanjsko polje, due to size and complexity of the area, many habitats could not be surveyed during this research, this research resulted with many new data and better knowledge of the dragonfly communities and habitats in poljes. Future research will most likely show that these habitats are home to additional species of dragonflies and other aquatic insects in Livanjsko polje and potentially also in other poljes. Due to a high variety of freshwater habitats present in Livanjsko polje its biodiversity is potentially enormous.

One of the major problems during this research was the fact that a large area of the polje was a battlefield during the recent war and the numerous mine fields that are still present in the polje. This is especially a problem for research in the alluvial forests and in the peatland area in the central and northern part of the Livanjsko polje. Unfortunately, this is also the most valuable and the most preserved part of the polje.

Additionally, in 2011, weather conditions were not favorable for dragonflies. The year was exceptionally dry, winter flooding was very short and the spring almost without any rainfall. As a consequence, many habitats had dried out at the beginning of the summer. Storms and strong winds during the summer also negatively affected the results of the research.

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References

Adamović, Ž.R., 1948: Spisak vilinskih konjica (Odonata Fabr.) u Biološkom institutu u Sarajevu. Godišnjak Biološkog Instituta u Sarajevu 1: 79-84.

Gams, J., 1978: The polje: the problem of definition. Zeitschrift für Geomorphologie 55: 170– 181.

Jović, M., Gligorović, B. & Stanković, M., 2010: Review of faunistical data on Odonata in Bosnia and Herzegovina. Acta entomologica serbica. 15(1): 7-27

Kiauta, B. & Kotarac, M., 1995: Two dragonfly records from karst caves in Bosnia-Herzegovina and Slovenia (Anisoptera: Aeshnidae, Corduliidae). Notulae odonatologicae. 4(6): 106-107.

Klapalek, F., 1898: Notes on Neuroptera and Pseudoneuroptera collected in Bosnia and Herzegovina. Vestnik Ceské Akedemie cisare Fantiška Josefa pro vedy, slovesnost a umeni. 7(2): 126-134.

Prohić, E., Peh, Z. & Miko, S., 1998: Geochemical characterization of a karst polje. An example from Sinjsko Polje, Croatia. Environmental Geology 33(4): 263– 273.

Redžilć, S., Barudanović, S. & Radević, M., 2008: Bosnia and Herzegovina – Land of Diversity, First national Report of Bosnia and Herzegovina for the Convention on Biodiversity, Sarajevo. 164 pp.

Ritter-Studnićka, H., 1974: Die Karstpolje Bosniens und der Hercegovina als Reliktstandorte und die Eigentümlichkeiten ihrer Vegetation. Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 94(2): 139–189.

Ritter-Studnićka, H. & Grgić, P., 1971: Die Reste der Stieleichenwälder in Livanjsko Polje (Bosnien). Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 91(2/3): 330–347.

Schneider-Jacoby, M., Rubinić, B., Sackl, P. & Štumberger, B., 2006: A preliminary assessment of the ornithological importance of Livanjsko Polje (Cetina River Basin, Bosnia and Herzegovina). Acrocephalus 27(128-129): 45-47.

Štumberger, B., Schneider-Jacoby, M. & Gotovac, M., 2008: Information Sheet on Ramsar Wetlands (RIS): Livanjsko polje. Prepared by EuroNature, Radolfzell. (online: http://www.wetlands.org/reports/ris/3BA003%20RIS%202008%20final.pdf)

Šilić, Č. & Abadžić, S., 1989: A review of macrophyte vegetation of the Buško lake (Bosnia) and its closer shore-line region. Glasnik Zemaljskog Muzeja Bosne i Hercegovine u Sarajevu 28: 129-142.