

## CONTRIBUTION TO THE KNOWLEDGE OF BLACK FLY (DIPTERA, SIMULIIDAE) FAUNA AT PLITVICE LAKES NATIONAL PARK

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Black flies (Simuliidae) were collected during 2007 and 2008 at three tufa barriers at Plitvice Lakes National Park using pyramid-type emergence traps. In all, nine species were recorded, all belonging to the genus *Simulium*, and of which *Simulium (Eusimulium) angustipes* Edwards, 1915; *Simulium (Obuchovia) auricoma* Meigen, 1818; *Simulium (Nevermannia) costatum* Friederichs, 1920; *Simulium (Simulium) trifasciatum* Curtis, 1839; and *Simulium (Simulium) variegatum* Meigen, 1818 were recorded for the first time in Croatia. The most abundant species was *Simulium (Eusimulium) angustipes*, followed by *Simulium (Nevermannia) costatum*.

**Key words:** black flies, Plitvice lakes, tufa barriers

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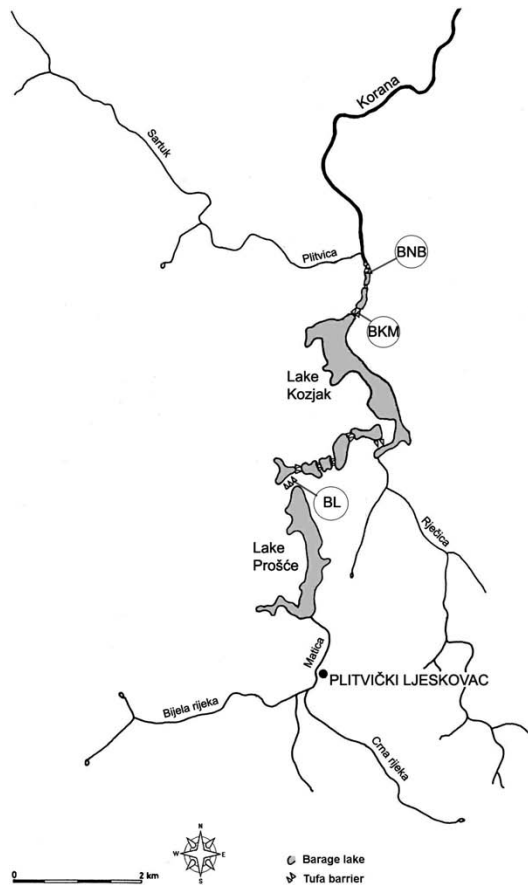
Mušice svrbljivice (Simuliidae) su sakupljane tijekom 2007. i 2008. godine na tri sedrene barijere u Nacionalnom parku Plitvička jezera uz pomoć emergencijskih klopki. Ukupno je zabilježeno devet vrsta koje pripadaju rodu *Simulium* od kojih su *Simulium (Eusimulium) angustipes* Edwards, *Simulium (Obuchovia) auricoma* Meigen, *Simulium (Nevermannia) costatum* Friederichs, *Simulium (Simulium) trifasciatum* Curtis i *Simulium (Simulium) variegatum* Meigen zabilježene po prvi put u Hrvatskoj. Najzastupljenija vrsta je bila *Simulium (Eusimulium) angustipes* te nakon nje *Simulium (Nevermannia) costatum*.

**Ključne riječi:** mušice svrbljivice, Plitvička jezera, sedrene barijere

### INTRODUCTION

Black flies are a very important component of freshwater running habitats and the adults have great veterinary and medical importance, because the majority of females need a blood meal to produce eggs (RUBTSOV, 1990). They are holometabolic insects the immature stages of which are aquatic, while the adults emerge from the water and are active in terrestrial habitats, usually close to breeding sites. The larvae feed by filtering and the adults feed on the sugar they obtain from flower nectar, plant juices and honey. In addition, the females usually need to have a blood meal from warm-blooded animals (mammals or birds) for egg production (ADLER *et al.*, 2004). The current state of knowledge on black fly fauna in Croatia is rather

poor. With respect to the black fly fauna of Plitvice Lakes National Park, several species are listed in publications by MATONIČKIN (1959) and MATONIČKIN KEPČIJA (2006), but they should be taken with reserve because some determinations were made on immature larvae samples. This paper gives a detailed overview of the black fly fauna on the tufa barriers of Plitvice lakes and discusses the importance of the species present in this particular ecological niche. The reason why Plitvice lakes were chosen for such research was due to their high importance because they enjoy UNESCO protection as a world natural heritage site. The 16 Plitvice lakes, which are divided by tufa barriers, are located in the karst region of the Dinaride Mountains in Croatia. The Plitvice lakes represent the most frequently visited national park in Croatia. Taking in account the importance of the area for the economy and tourism on one hand and the species' nuisance potential with their haematophagous activity and the capacity of some black fly species to transmit various pathogens to both humans and animals on the other, the acquisition of data on the present species composition of the black fly fauna in this particular area is highly important.



**Fig. 1.** Map of the study sites: Labudovac Tufa Barrier (BL), Kozjak-Milanovac Tufa Barrier (BKM) and Novakovića Brod Tufa Barrier (BNB).

## MATERIAL AND METHODS

Adult black flies were collected each month from March 2007 to March 2009 using semi-quantitative pyramidal emergence traps on three different tufa barrier locations (Labudovac Tufa Barrier (BL), Kozjak-Milanovac Tufa Barrier (BKM) and Novakovića Brod Tufa Barrier (BNB) in the Plitvice lakes (Fig. 1, Tab. 1). The traps were fixed in sediment with a surface area of 45 × 45 cm (h = 50 cm) and collected samples during the entire study period. At the end of each month the samples from the traps were taken to the laboratory for analysis. All collected black flies were preserved in 80% ethanol. Male genitalia of adults were removed and slides were made of gonostylus and ventral plate. All the samples were examined under Zeiss Semi 2000-C stereomicroscope and AC240V microscope. Identification followed that of KNOZ (1965), RUBTSOV (1990) and DAY *et al.* (2010) and nomenclature followed ADLER & CROSSKEY (2012).

## RESULTS AND DISCUSSION

In the study period 37387 individuals were collected and nine species were identified, all belonging to the genus *Simulium* and to five subgenera (Tab. 2). The most abundant species was *S. angustipes* that was represented altogether with 99 % of individuals in 2007 and 97.48 % in 2008. From the 36095 specimens of *S. angustipes* recorded only 720 (2%) were checked in detail and they seemed to be identical with the *angustipes* described by KNOZ (1965) and DAY *et al.* (2010). The species *Simulium*

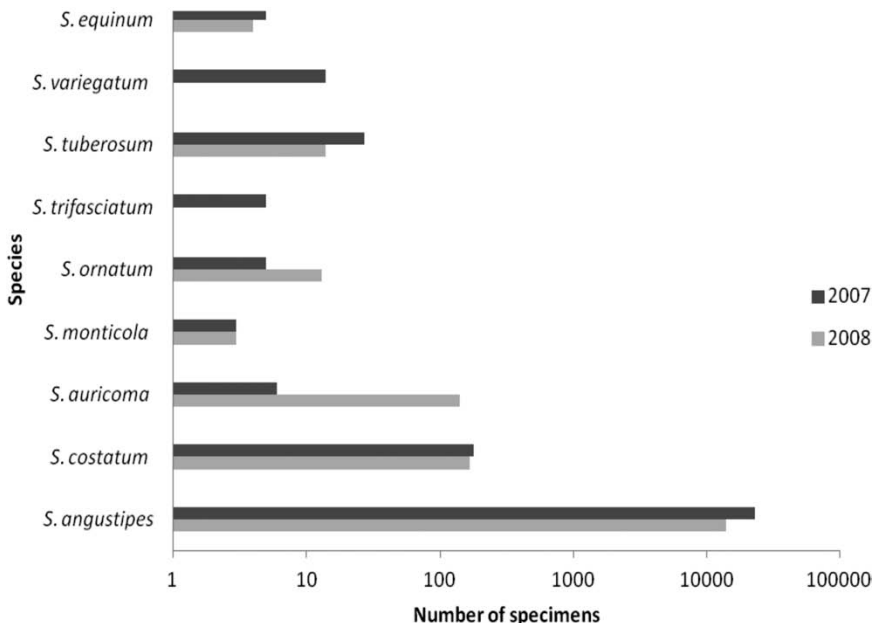
**Tab. 1.** Characteristics of the sampling sites in the Plitvice Lakes National Park. BL – Tufa barrier Labudovac, BKM – Tufa barrier Kozjak-Milanovac, BNB – Tufa barrier Novakovića Brod.

Site	BL	BKM	BNB	
<b>Latitude</b>	N 44°52'17'	N 44°53'39'	N 44°54'07'	
<b>Longitude</b>	E 15°35'59'	E 15°36'32'	E 15°36'38'	
<b>Altitude (m)</b>	630	546	504	
<b>Substrate</b>	Pebbles, Moss on tufa, Tufa with detritus	Pebbles, Moss on tufa, Tufa with detritus, Silt	Pebbles, Moss on tufa, Tufa with detritus, Silt	
<b>Water temperature</b> (°C)	<b>min</b>	2,5	3,1	3,3
	<b>max</b>	20,5	22,9	22,9
<b>O<sub>2</sub> (mg L<sup>-1</sup>)</b>	<b>min</b>	6,7	8,7	8,4
	<b>max</b>	12,3	12	12,4
<b>O<sub>2</sub> (%)</b>	<b>min</b>	59,7	72	77,3
	<b>max</b>	139,2	113,6	117,1
<b>pH</b>	<b>min</b>	6,8	6,9	8,2
	<b>max</b>	8,7	8,4	8,7
<b>Conductivity</b> (μ S cm <sup>-1</sup> )	<b>min</b>	366	354	334
	<b>max</b>	426	443	387
<b>Alkalinity</b> (mg L <sup>-1</sup> CaCO <sub>3</sub> )	<b>min</b>	210	200	185
	<b>max</b>	260	220	230

**Tab. 2.** Black flies at investigated tufa barriers in Plitvice Lakes National Park during 2007 and 2008. For the abbreviations of the sites see the key to Tab. 1.

Species / Location	BL		BKM		BNB	
	2007	2008	2007	2008	2007	2008
	%					
<i>Simulium (Eusimulium) angustipes</i> Edwards, 1915	99,51	99,92	99,37	99,27	87,36	32,17
<i>Simulium (Nevermannia) costatum</i> Friederichs, 1920	0,32	0,03	0,55	0,11	9,26	34,35
<i>Simulium (Obuchovia) auricoma</i> Meigen, 1818	0	0	0,01	0,34	0,50	26,09
<i>Simulium (Simulium) monticola</i> Friederichs, 1920	0,04	0,04	0	0	0	0
<i>Simulium (Simulium) ornatum</i> Meigen, 1818	0	0	0,005	0,21	0	0
<i>Simulium (Simulium) trifasciatum</i> Curtis, 1839	0	0,01	0,005	0	0	0
<i>Simulium (Simulium) tuberosum</i> (Lundström, 1911)	0,12	0	0	0	2,25	7,39
<i>Simulium (Simulium) variegatum</i> Meigen, 1818	0,01	0	0,06	0	0,13	0
<i>Simulium (Wilhelmia) equinum</i> (Linnaeus, 1758)	0	0	0,01	0,07	0,50	0
<b>Number of species</b>	<b>5</b>	<b>4</b>	<b>7</b>	<b>5</b>	<b>6</b>	<b>4</b>

(*Eusimulium*) *velutinum* Santos Abreu, 1922, which usually comes together with *S. angustipes* (KNOZ, 1965) might have been present in small numbers at these locations, but this remains to be confirmed. The second most abundant species in 2007 and 2008 was *S. costatum* (Fig. 2), followed by *S. auricoma* Meigen in 2008, especially at the BNB location. The highest number of species and specimens during the

**Fig. 2.** Abundance of black flies on investigated tufa barriers during 2007 and 2008.

investigation period was recorded at the BKM location in 2007, more than 14400 specimens, represented mostly by *S. angustipes*. In all the localities, the composition of species is similar; the only difference is that *S. monticola* only comes at the highest location, BL, while on the other hand, *S. auricoma* was not present there. Five out of the eight species (*Simulium (Eusimulium) angustipes*, *Simulium (Obuchovia) auricoma*, *Simulium (Nevermannia) costatum*, *Simulium (Simulium) trifasciatum*, *Simulium (Simulium) variegatum*) were recorded for the first time in Croatia. In the available publications (BARANOV, 1937; MATONIČKIN, 1959; MATONIČKIN KEPČIJA *et al.*, 2006; SUDARIĆ BOGOJEVIĆ *et al.*, 2009; ADLER & CROSSKEY, 2012) these species are not listed for Croatia. *Simulium ornatum*, *S. monticola* and *S. tuberosum* (material identical with characters given for *tuberosum* by KNOZ, 1965) were previously recorded at Plitvice Lakes by MATONIČKIN (1959) and MATONIČKIN KEPČIJA *et al.* (2006) as larvae, which has now been confirmed by adult sampling. All the species except *S. auricoma* are known to be mammophilic and species from the subgenus *Eusimulium* and *Nevermannia* are ornithophilic as well and they are present with the highest numbers of specimens. The presence of this species (especially *S. angustipes*) can be a problem because it is known as a vector in the transmission of avian trypanosomes (CROSSKEY, 1990). The highest numbers of Simuliidae were on the tufa barriers. Tufa barriers are barrage lake outlets, and many Simuliidae species (especially *S. angustipes*) prefer such habitats, due to the high amount of seston coming from the lakes (KNOZ, 1965; CARLSSON *et al.*, 1977; WOTTON, 1988; ŠPOLJAR *et al.*, 2007).

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## SAŽETAK

### Prilog poznavanju faune mušica svrbljivica (Diptera, Simuliidae) u Nacionalnom Parku Plitvička jezera

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Mušice svrbljivice (Simuliidae) sakupljane su tijekom 2007. i 2008. na tri sedrene barijere (Barijera Labudovac, Barijera Kozjak-Milanovac i Barijera Novakovića Brod) u Nacionalnom parku Plitvička jezera uz pomoć semikvantitativne metode emergencijskih klopki. Ukupno je zabilježeno devet vrsta zastupljenih unutar 5 podrodova roda *Simulium*. Od svih zabilježenih vrsta pet vrsta je po prvi put zabilježeno za faunu Hrvatske: *Simulium (Eusimulium) angustipes* Edwards, 1915; *Simulium (Obuchovia) auricoma* Meigen, 1818; *Simulium (Nevermannia) costatum* Friederichs, 1920; *Simulium (Simulium) trifasciatum* Curtis, 1839; *Simulium (Simulium) variegatum* Meigen, 1818. Najzastupljenija vrsta je *Simulium (Eusimulium) angustipes*, a slijedi *Simulium (Nevermannia) costatum*. Velika brojnost mušica svrbljivica na sedrenim barijerama Plitvičkih jezera može se povezati s velikim dotokom hranjivih tvari iz jezera budući da barijere služe kao jezerski ispusti, što znatno pogoduje filtratorima kao što su mušice svrbljivice.