

# THE AQUATIC DANCE FLIES FAUNA (DIPTERA, EMPIDIDAE: HEMERODROMIINAE AND CLINOCERINAE) OF THE PLITVICE LAKES NATIONAL PARK

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Adult aquatic dance flies were collected in the Plitvice Lakes National Park from 2005 to 2009 using various sampling methods. Sampling was done at 13 sampling sites representing four main types of karst aquatic habitats: spring, stream, tufa barriers and lakes. A total of 22 species were recorded belonging to 6 genera. Four species (*Chelifera pyrenaica* Vaillant, 1981; *Hemerodromia laudatoria* Collin, 1927; *Clinocera wesmaeli* (Macquart, 1835); *Wiedemannia (Philolutra) aquilex* (Loew, 1869)) are new to Croatian fauna. The highest species richness was recorded for the Bijela rijeka Spring. The cluster analysis showed that sites group together not just by similarity of community composition but as well in similarity of habitat types. Clustering of geographically nearby sites is also observed. This study represents an important contribution to the knowledge of dance flies fauna of Croatia and of various karstic habitats in general.

**Key words:** aquatic Empididae, fauna, NP Plitvice, species richness, karst habitats

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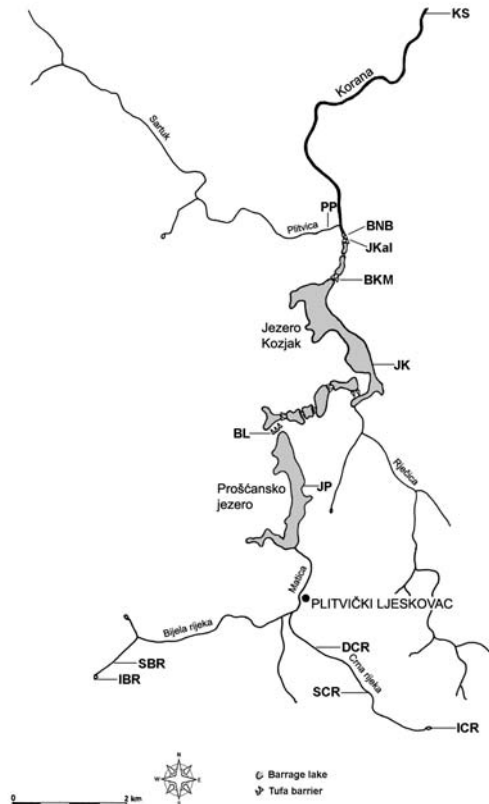
Vodne muhe plesačice su sakupljane raznim metodama na području Nacionalnog parka Plitvička jezera u razdoblju od 2005. do 2009. godine. Uzorci su sakupljeni na 13 lokacija na četiri osnovna tipa krških staništa: izvor, potok, sedrena barijera i jezero. Ukupno su zabilježene 22 vrste iz 6 rodova. Četiri vrste predstavljaju nove nalaze za faunu Hrvatske (*Chelifera pyrenaica* Vaillant, 1981; *Hemerodromia laudatoria* Collin, 1927; *Clinocera wesmaeli* (Macquart, 1835); *Wiedemannia (Philolutra) aquilex* (Loew, 1869)). Najveći broj vrsta zabilježen je na lokaciji Izvor Bijele rijeke. Klaster analizom je utvrđeno da se istraživane lokacije grupiraju po sličnosti sastava zajednice, ali i po sličnosti tipova staništa, također je utvrđeno grupiranje geografski bliskih lokacija. Ovo istraživanje pridonijet će boljem poznavanju faune vodenih muha plesačica Hrvatske, ali i različitih krških staništa općenito.

**Ključne riječi:** vodene Empididae, fauna, NP Plitvice, brojnost vrsta, krška staništa

## INTRODUCTION

Aquatic dance flies (Empididae: Hemerodromiinae, Clinocerinae) represent a taxonomically heterogeneous group with common ecological features. The larvae of both subfamilies are aquatic and predaceous as well as adults, which are terrestrial (WAGNER, 1997).

Plitvice Lakes National Park is located in the karst region of the Dinarid Mountains in Croatia. The Plitvice Lakes system comprises 16 oligotrophic, dimictic and fluvial lakes divided by tufa barriers. The streams Bijela rijeka and Crna rijeka form the Matica River, which is the main surface-water supplier of the lakes. National Park Plitvice is under the protection of UNESCO as a world natural heritage site. The area is rich in habitat types of the karst system (STILINOVIĆ & BOŽIČEVIĆ, 1998) and the region is known for its high endemism, especially in freshwater (BĂNĂRESCU, 2004).



**Fig. 1.** Map of the investigated area. Locations: Bijela rijeka Spring (IBR), Bijela rijeka 2 (SBR), Crna rijeka Spring (ICR), Crna rijeka 2 (SCR), Crna rijeka bridge (DCR), Prošće Lake (JP), Labudovac Tufa barrier (BL), Lake Kozjak (JK), Kozjak-Milanovac Tufa barrier (BKM), Kaluderovac Lake (JKal), Novakovića Brod Tufa barrier (BNB), Plitvica Stream (PP) and Korana village (KS).

The main objective of this paper is to document species richness of aquatic dance flies fauna of the National Park Plitvice that is gathered using various sampling methods.

## MATERIAL AND METHODS

Adult aquatic dance flies were collected monthly using 2 types of semiquantitative pyramidal emergence traps from March 2007 up to March 2009 on 13 different locations in the National Park Plitvice (Fig. 1). Locations were: Bijela rijeka Spring (IBR), Bijela rijeka 2 (SBR), Crna rijeka Spring (ICR), Crna rijeka 2 (SCR), Crna rijeka bridge (DCR), Prošće Lake (JP), Labudovac Tufa barrier (BL), Lake Kozjak (JK), Kozjak-Milanovac Tufa barrier (BKM), Kaluđerovac Lake (JKal), Novakovića Brod Tufa barrier (BNB), Plitvica Stream (PP) and Korana village (KS). Fixed emergence pyramidal traps in sediment, of surface area 25×25 cm (h = 45 cm), were used on 9 locations (Bijela rijeka Spring, Bijela rijeka 2, Crna rijeka Spring, Crna rijeka 2, Labudovac Tufa barrier, Kozjak-Milanovac Tufa barrier, Novakovića Brod Tufa barrier, Korana village and Plitvica Stream) and on every location there were 6 traps. On other 4 locations (Crna rijeka bridge, Prošće Lake, Kozjak Lake, Kaluđerovac Lake) floating pyramidal emergence traps with a surface area 50×50 cm (h = 80 cm) were used and on each location 3 traps were installed. On the top of each pyramidal trap there was a container with a 1–2 % formaldehyde preservative with detergent for breaking surface tension. Additional sampling using an aspirator and a sweeping net took place in June and July 2005, in May and August 2006, in June 2007 and in the beginning and at the end of May 2009 on the Bijela rijeka Spring and in June 2007 on Labudovac Tufa barrier, Kozjak-Milanovac Tufa barrier and Crna rijeka Spring. In May and June 2007 on all of the studied locations sampling was done using yellow water traps as additional semi quantitative sampling method. All the collected aquatic dance flies were preserved in 80% ethanol. Male genitalia were removed and boiled in potassium hydroxide and then transferred to a mixture of acetic acid and clove oil and finally placed in a small dish with glycerine for examination with a Zeiss Semi 2000-C microscope. Identification and nomenclature followed that of ENGEL (1938–1946), COLLIN (1961), WAGNER (1984) and SINCLAIR (1995). Cluster analysis was conducted using Primer 5, Bray-Curtis similarity was used and data was log – transformed.

## RESULTS AND DISCUSSION

During the investigation a total of 4236 individuals were collected. Most of the empidids, 3753 individuals, were recorded in pyramidal emergence traps, 147 were recorded in yellow water traps and 336 were recorded by using aspirator and entomological net. Altogether 22 species were recorded belonging to 2 subfamilies and 6 genera. Among the determined species 13 belong to the subfamily Hemerodromiinae and 9 to subfamily Clinocerinae (Tab. 1). The most diverse genera was *Chelifera* represented with 8 species, followed by 5 species of genus *Hemerodromia*. Genus *Wiedemannia* was represented with 3 species and genera *Dolichocephala*, *Clinocera*,

Tab. 1. Aquatic dance flies species on investigated locations.

Species/Location	IBR	SBR	ICR	SCR	DCR	JP	BL	JK	BKM	JKal	BNB	PP	KS
Hemerodromiinae													
<i>Chelifera concinnicauda</i> Collin, 1927													
<i>Chelifera flavella</i> (Zetterstedt, 1838)		•	•	•	•				•	•	•	•	•
<i>Chelifera precabunda</i> Collin, 1961		•	•	•	•	•							
<i>Chelifera precatoria</i> (Fallén, 1816)		•	•	•									
<i>Chelifera pyrenaica</i> Vaillant, 1981									•		•	•	•
<i>Chelifera siveci</i> Wagner, 1984		•	•	•	•	•						•	•
<i>Chelifera stigmatica</i> (Schiner, 1962)								•		•	•	•	•
<i>Chelifera trapezina</i> (Zetterstedt, 1838)		•	•	•	•	•						•	•
<i>Hemerodromia laudatoria</i> Collin, 1927						•	•				•	•	•
<i>Hemerodromia melangyna</i> Collin, 1927							•				•	•	•
<i>Hemerodromia oratoria</i> (Fallén, 1816)										•	•	•	•
<i>Hemerodromia raptoria</i> Meigen, 1830								•					
<i>Hemerodromia unilineata</i> Zetterstedt, 1842								•	•	•	•	•	•
Clinocerinae													
<i>Dolichocephala guttata</i> (Haliday, 1833)		•	•	•	•								•
<i>Dolichocephala ocellata</i> Costa, 1854		•	•										
<i>Clinocera stagnalis</i> (Haliday, 1833)				•									•
<i>Clinocera wesmaeli</i> (Macquart, 1835)		•											
<i>Kowarzia barbatula</i> Mik, 1880			•	•	•			•		•			•
<i>Kowarzia bipunctata</i> (Haliday, 1833)			•										
<i>Wiedemannia (Eucelidia) zetterstedti</i> (Fallén, 1826)		•											
<i>Wiedemannia (Philolutra) aquilex</i> (Loew, 1869)		•	•	•	•	•							•
<i>Wiedemannia (Pseudowiedemannia) jamellata</i> (Loew, 1869)		•											•
<b>Number of species</b>	<b>13</b>	<b>9</b>	<b>9</b>	<b>7</b>	<b>8</b>	<b>1</b>	<b>5</b>	<b>1</b>	<b>5</b>	<b>3</b>	<b>8</b>	<b>12</b>	<b>6</b>

Tab. 2. Aquatic dance flies species on different types of karstic habitats.

Species/Location	Spring	Stream	Tufa rim	Lake
Hemerodromiinae				
<i>Chelifera concinnicauda</i> Collin, 1927			•	•
<i>Chelifera flavella</i> (Zetterstedt, 1838)		•	•	
<i>Chelifera precabunda</i> Collin, 1961		•	•	
<i>Chelifera precatoria</i> (Fallén, 1816)		•	•	
<i>Chelifera pyrenaica</i> Vaillant, 1981			•	
<i>Chelifera siveci</i> Wagner, 1984		•	•	
<i>Chelifera stigmatica</i> (Schiner, 1962)			•	
<i>Chelifera trapezina</i> (Zetterstedt, 1838)		•	•	
<i>Hemerodromia laudatoria</i> Collin, 1927		•	•	•
<i>Hemerodromia melangyna</i> Collin, 1927		•	•	
<i>Hemerodromia oratoria</i> (Fallén, 1816)		•	•	•
<i>Hemerodromia raptoria</i> Meigen, 1830				•
<i>Hemerodromia unilineata</i> Zetterstedt, 1842			•	•
Clinocerinae				
<i>Dolichocephala guttata</i> (Haliday, 1833)		•	•	
<i>Dolichocephala ocellata</i> Costa, 1854		•	•	
<i>Clinocera stagnalis</i> (Haliday, 1833)		•		
<i>Clinocera wesmaeli</i> (Macquart, 1835)		•		
<i>Kowarzia barbatula</i> Mik, 1880		•	•	
<i>Kowarzia bipunctata</i> (Haliday, 1833)			•	
<i>Wiedemannia (Eucelidia) zetterstedti</i> (Fallén, 1826)		•		
<i>Wiedemannia (Philolutra) aquilex</i> (Loew, 1869)		•	•	
<i>Wiedemannia (Pseudowiedemannia) jamellata</i> (Loew, 1869)		•	•	
<b>Number of species</b>	<b>13</b>	<b>18</b>	<b>9</b>	<b>5</b>

*Kowarzia* were represented with 2 species each. The most abundant species was *Hemerodromia unilineata* Zetterstedt, 1842 with a total of 2038 specimens collected. It was the most abundant species on tufa barrier habitats and it was not present on springs. The highest species richness was recorded at Bijela rijeka Spring (IBR) where 13 species were recorded which is to our knowledge the highest number of species recorded on any spring area in Croatia. Springs and streams have higher number of species recorded than tufa barriers and lakes. Of 22 species of aquatic dance flies, *Chelifera pyrenaica* Vaillant, 1981; *Hemerodromia laudatoria* Collin, 1927;

*Clinocera wesmaeli* (Macquart, 1835); *Wiedemannia (Philolutra) aquilex* (Loew, 1869) were not previously recorded in Croatian fauna (BECKER, 1889; HORVAT, 1990, 1993; IVKOVIĆ & HORVAT, 2007a, 2007b; SIVEC & HORVAT, 2002; WAGNER, 1981, 1995).

In Tab. 2 species richness is presented according to the four main habitat types and it is obvious that aquatic dance flies prefer streams as their main living habitat which corroborates previous studies (HARPER, 1980; JOOST, 1980; CASPERS & WAGNER 1982; WAGNER, 1982; LANDRY & HARPER, 1985; WAGNER & GATHMANN, 1996; HARKRIDER, 2000; WAGNER *et al.*, 2004). Although there are some species, like *Hemerodromia raptor*, that seem to prefer lentic water bodies, like lakes and slow rivers (WAGNER, 1995; IVKOVIĆ & HORVAT, 2007a).

A cluster analysis revealed similarities and differences between the sampling sites (Fig. 2). Springs and streams Bijela and Crna rijeka cluster together. Tufa barriers cluster together as well with location Plitvica Stream, Korana village and Kaluđerovac Lake while lakes Prošće and Kozjak are separated from every other location. This was an expected result because physical and chemical characteristics (especially the temperature) of water at locations that cluster together are similar. The only clustering that is different from expected is Kaluđerovac Lake, which is clustering together with tufa barriers. That is probably due to the fact that this location is geographically very close to Novakovića Brod Tufa barrier and therefore has similar fauna. The same can be argued for Plitvica Stream which is an affluent of the Korana River. The current study represents an important contribution to the knowledge of dance flies fauna of various karstic habitats in general.

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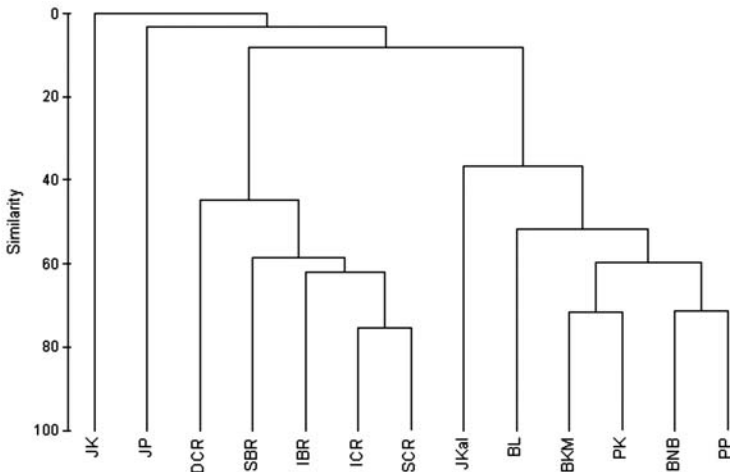


Fig. 2. Cluster analysis of the investigated locations on the basis of fauna composition.

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## S A Ž E T A K

### Fauna vodenih muha plesačica (Diptera, Empididae: Hemerodromiinae i Clinocerinae) Nacionalnog parka Plitvička jezera

M. Ivković, M. Miliša & Z. Mihaljević

Od 2005. do 2009. godine na području Nacionalnog parka Plitvice sakupljane su vodene muhe plesačice. Metode koje su korištene u tu svrhu su bile: semikvantitativne metode emergencijskih piramida, žutih lovnih posuda, aspirator i entomološka mrežica. Uzorkovalo se na 13 lokacija duž Plitvičkih jezera te na četiri osnovna tipa krških staništa: izvor (Izvor Bijele rijeke, Izvor Crne rijeke), potok (Bijela rijeka 2, Crna rijeka 2, Most Crna rijeka, Potok Plitvica, selo Korana), sedrena barijera (Barijera Labudovac, Barijera Kozjak-Milanovac, Barijera Novakovića brod) i jezero (Jezero Prošće, Jezero Kozjak, Jezero Kaluđerovac). Svrha istraživanja je bila odrediti raznolikost faune vodenih muha plesačica. Ukupno je prikupljeno 4236 jedinki iz potporodica Hemerodromiinae i Clinocerinae te su zabilježene 22 vrste iz 6 različitih rodova. Dva roda (*Chelifera*, *Hemerodromia*) pripadaju potporodici Hemerodromiinae, a četiri roda potporodici Clinocerinae (*Dolichocephala*, *Clinocera*, *Kowarzia*, *Wiedemannia*). Četiri vrste su nove za faunu Hrvatske (*Chelifera pyrenaica* Vaillant, 1981; *Hemerodromia laudatoria* Collin, 1927; *Clinocera wesmaeli* (Macquart, 1835); *Wiedemannia (Philolutra) aquilex* (Loew, 1869)). Najveći broj vrsta zabilježen je na lokaciji Izvor Bijele rijeke, gdje je zabilježeno 13 vrsta. Klaster analizom je utvrđeno da se istraživane lokacije grupiraju po sličnosti sastava zajednice, ali i po sličnosti tipova staništa, također je utvrđeno grupiranje geografski bliskih lokacija. Najveća važnost ovog istraživanja je u tome što će pridonijeti poznavanju faune vodenih muha plesačica, ali i različitih krških staništa općenito.