

Croatian aquatic dance flies (Diptera: Empididae: Clinocerinae and Hemerodromiinae): species diversity, distribution and relationship to surrounding countries

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Abstract

A checklist of aquatic Empididae (dance flies) from Croatia (36 species in subfamily Clinocerinae and 14 species in subfamily Hemerodromiinae) is presented, including information related to the Ecoregions in which species were found and specific species traits. Clinocerinae are represented by five genera, with *Wiedemannia* Zetterstedt being most species rich (20 species) and *Clinocerella* Engel least numerous with only one species. In Hemerodromiinae there are 8 species of *Cheilifera* Macquart and 6 species and *Hemerodromia* Meigen. In addition, a discussion related to the species included and excluded from the list is provided. Most species are univoltine with adults emerging in Spring and Summer, although *Kowarzia barbatula* Mik and *Wiedemannia (Eucelidia) zetterstedti* (Fallén) are present throughout the year and *Wiedemannia (Chamaedipsia) aequilobata* Mandaron occurs in Winter. The Croatian species assemblage is similar to the well-studied fauna of neighboring Slovenia (63 spp.). It is recommended that some rare species and the streams they inhabit should be considered for greater protection.

Key words: Clinocerinae, Hemerodromiinae, species list, biodiversity, Ecoregions, Croatia

Introduction

The subfamilies Clinocerinae and Hemerodromiinae, also known as aquatic dance flies, belong to the family Empididae. Both larvae and adults are predators, primarily feeding on the larvae of Simuliidae (Vaillant 1952, 1953; Werner & Pont 2003) and Chironomidae (Vaillant 1967; Harkrider 2000; Ivković *et al.* 2007). Adult Hemerodromiinae are relatively poor fliers with raptorial legs. They mainly live and hunt in riparian vegetation. On the other hand, adult Clinocerinae are good and active fliers. They are also found walking over the surface of wet stones or in moss mats (Wagner 1997; Ivković *et al.* 2007).

The aquatic dance fly fauna of Croatia has been sporadically investigated during the last 120 years. The first record was noted by Becker (1889). Since then Wagner (1981, 1995), Horvat (1990, 1993a) and Sivec and Horvat (2002) have made contributions to the knowledge of dance fly systematics and taxonomy, including the description of new species from Croatia. The senior author has also contributed additional distribution records from Croatia resulting from research conducted in the last six years (Ivković & Horvat 2007a; Ivković & Horvat 2007b; Ivković *et al.* 2007, 2010, 2012).

Regional biodiversity and distribution surveys are of immense importance for determining conservation status of species and in studying factors that influence diversity (de Silva & Medellín 2001; DeWalt *et al.* 2012). In addition, reviews such as this are crucial to various state and international agencies interested in the biodiversity and conservation of aquatic dance flies in Croatia. The present paper is based on detailed analysis of all publications on aquatic dance flies known to the authors. The authors have also contributed additional records of Croatian aquatic dance flies resulting from unpublished research conducted over the last two decades.

Material and methods

Specimen records. This paper is based on a review of literature data and on unpublished data from our own researches of the aquatic dance fly fauna in Croatia. Each literature record was georeferenced as precisely as possible using ArcGIS software. The names of taxa, present in this checklist reflect current nomenclature and classifications (Sinclair 1995; Yang *et al.* 2007; Pape & Beuk 2012). Locality records are listed for each species. A list of locality names including latitude, longitude, altitude and number codes (site ID) for the localities are presented in Table 1 and a map with all the sites is also provided (Fig. 1). Specimens were collected using sweep nets, yellow pan traps, emergence traps and by aspirator. They were preserved in aqueous ethanol (EtOH). For the purpose of determination male terminalia were dissected. The abdomens with the genitalia were boiled in 10% KOH; afterwards they were neutralized with acetic acid, rinsed in water and identified to species level. Taxonomic diversity is considered at the level of subfamily, genus and species. European Ecoregions were taken from Limnofauna Europaea (Illies 1978).

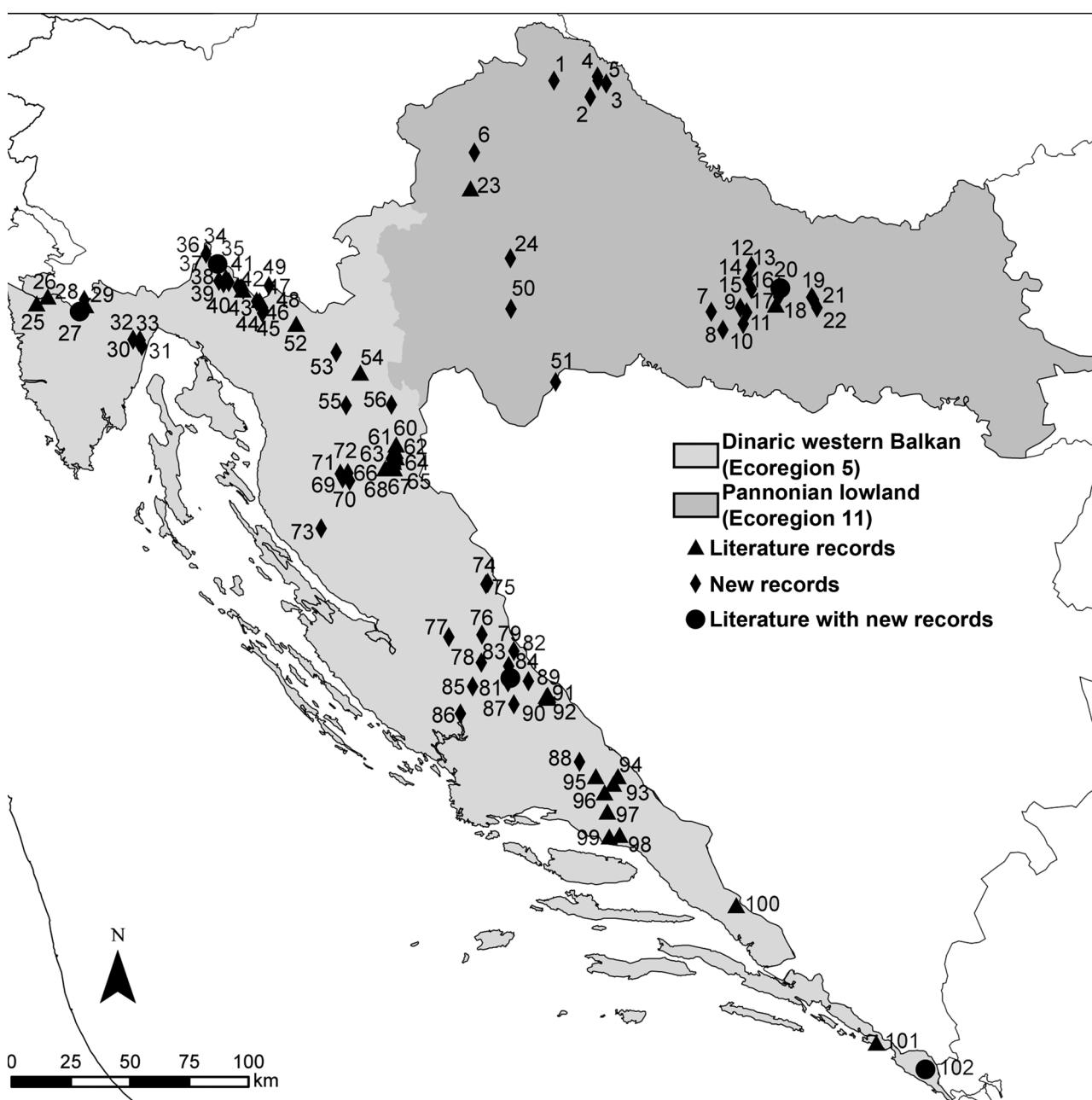


FIGURE 1. Sampling sites of aquatic Empididae recorded from Croatia (See Table 1 for codes).

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TABLE 1. The list of sampling sites in Croatia. Ecoregions are taken from Illies (1978); Dinaric western Balkan (5) & Pannonian lowland (11).

Site ID	Site name	Longitude	Latitude	Altitude (m)	Ecoregion
1*	Čakovec left drainage ditch	E 16° 27' 49"	N 46° 18' 49"	165	11
2*	Dubrava right drainage ditch, 2 km	E 16° 37' 00"	N 46° 18' 32"	149	11
3*	Dubrava right drainage ditch, 8 km	E 16° 42' 15"	N 46° 18' 54"	147	11
4	Dubrava left drainage ditch	E 16° 42' 04"	N 46° 19' 44"	145	11
5	Drava after accumulation Dubrava, old reach	E 16° 45' 03"	N 46° 18' 10"	136	11
6	Dobovec, River Sutla	E 16° 01' 48"	N 46° 02' 23"	150	11
7	Gornja Šumetlica, Psunj Mountain	E 17° 18' 50"	N 45° 25' 58"	360	11
8	Strmac, Psunj Mountain	E 17° 22' 34"	N 45° 21' 51"	420	11
9	Mijači, River Orljava, Psunj Mountain	E 17° 28' 17"	N 45° 26' 49"	245	11
10	Koprivna, Psunj Mountain	E 17° 29' 04"	N 45° 23' 08"	240	11
11	Orlavac, River Orljava	E 17° 30' 14"	N 45° 25' 40"	220	11
12*	Djedovica by Rupnica, Papuk Mountain	E 17° 31' 54"	N 45° 36' 17"	366	11
13*	Brzaja, before N. Zvečeva, Papuk Mountain	E 17° 30' 53"	N 45° 33' 17"	502	11
14	Brzaja after N. Zvečeva, Papuk Mountain	E 17° 31' 53"	N 45° 30' 57"	368	11
15	Veličanka Stream, Velika, Papuk Mountain	E 17° 39' 41"	N 45° 27' 20"	260	11
16*	Dubočanka, Papuk Mountain	E 17° 40' 42"	N 45° 29' 11"	585	11
17*	Stream Kovačica, Papuk Mountain	E 17° 40' 41"	N 45° 31' 21"	360	11
18*	Waterfall Skakavac, Stream Jankovac, Papuk Mountain	E 17° 41' 01"	N 45° 31' 23"	460	11
19*	Spring Jankovac, Papuk Mountain	E 17° 41' 14"	N 45° 31' 06"	525	11
20	Rikino vrilo, Papuk Mountain	E 17° 51' 29"	N 45° 28' 59"	580	11
21	Remetska rijeka, Papuk Mountain	E 17° 51' 59"	N 45° 28' 28"	470	11
22	Kutjevačka Rika, Papuk Mountain	E 17° 53' 04"	N 45° 26' 29"	280	11
23	Trnavica, Medvednica Mountain	E 16° 00' 28"	N 45° 54' 07"	350	11
24*	Selečki most, Odra, Turopolje	E 16° 13' 39"	N 45° 38' 17"	100	11
25	Stream near Kaštel, Istra	E 13° 40' 46"	N 45° 26' 33"	25	5
26	River Dragonja, Oskoruš, Istra	E 13° 43' 32"	N 45° 27' 35"	65	5
27	Ugrini, Mlini, River Reka, Istra	E 13° 54' 37"	N 45° 26' 47"	130	5
28	Stream Bračana, Abrami, Buzet, Istra	E 13° 56' 00"	N 45° 25' 39"	60	5
29	Stream Bračana, Osoje, Buzet, Istra	E 13° 55' 36"	N 45° 24' 57"	40	5
30	Vela Učka, Fontane of Joseph II	E 14° 11' 43"	N 45° 18' 21"	840	5
31	Above Potoka, close to Trebišće, Učka Mountain	E 14° 13' 55"	N 45° 18' 15"	650	5
32	Ranch Bubač, Poklone, Učka Mountain	E 14° 13' 29"	N 45° 17' 55"	735	5
33	Lovrantska Draga, Slap, Učka Mountain	E 14° 14' 27"	N 45° 17' 01"	450	5
34	Prezid	E 14° 34' 41"	N 45° 38' 21"	760	5
35*	Čabranka Spring by Čabar	E 14° 38' 25"	N 45° 36' 04"	570	5
36*	Smreče, River Čabranka	E 14° 38' 54"	N 45° 32' 11"	540	5
37*	Pleše, River Čabranka	E 14° 41' 14"	N 45° 32' 43"	310	5
38	Gerovčica Spring	E 14° 40' 36"	N 45° 31' 43"	390	5
39	Hrvatsko, River Kupa	E 14° 42' 08"	N 45° 32' 00"	285	5

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TABLE 1. (Continued)

Site ID	Site name	Longitude	Latitude	Altitude (m)	Ecoregion
40	River Kupa near Gorenj Žaga	E 14° 55' 11"	N 45° 31' 25"	230	5
41	Turke, River Kupa	E 14° 45' 10"	N 45° 30' 58"	270	5
42*	Sedalce, River Kupa	E 14° 46' 09"	N 45° 30' 43"	260	5
43*	Gašparci, River Kupa	E 14° 46' 57"	N 45° 30' 25"	250	5
44	5 km above Brod na Kupi, River Kupa	E 14° 46' 47"	N 45° 30' 25"	230	5
45	Golik, River Kupa	E 14° 52' 19"	N 45° 28' 04"	220	5
46*	Brod na Kupi, River Kupa	E 14° 51' 18"	N 45° 27' 51"	220	5
47*	Brod na Kupi, Kupica Stream	E 14° 51' 22"	N 45° 27' 48"	220	5
48*	Zeleni Vir, Skrad, Gorski Kotar	E 14° 53' 15"	N 45° 25' 08"	370	5
49	Stream Curak, Skrad, Gorski Kotar	E 14° 53' 27"	N 45° 25' 53"	300	5
50	Novo Selište, Banija	E 16° 13' 57"	N 45° 26' 49"	100	11
51	Kuljani, River Una	E 16° 28' 24"	N 45° 10' 04"	110	11
52	Vrbovsko, River Dobra	E 15° 04' 18"	N 45° 22' 44"	390	5
53	Spring Bistrica	E 15° 17' 28"	N 45° 16' 27"	245	5
54	Watermill on Mrežnica River	E 15° 25' 59"	N 45° 11' 38"	250	5
55	Dretulja Spring	E 15° 20" 52'	N 45° 04' 28"	400	5
56	Slunjčica Spring	E 15° 35' 25"	N 45° 04' 38"	310	5
57*	Korana Village, NP Plitvice	E 15° 37' 09"	N 44° 55' 33"	390	5
58*	Stream Plitvica, NP Plitvice	E 15° 36' 27"	N 44° 54' 08"	555	5
59*	Tufa barrier Novakovića Brod, NP Plitvice	E 15° 36' 38"	N 44° 54' 07"	500	5
60*	Tufa barrier Kozjak-Milanovac, NP Plitvice	E 15° 36' 32"	N 44° 53' 39"	545	5
61*	Lake Kozjak, NP Plitvice	E 15° 37' 07"	N 44° 52' 40"	535	5
62*	Tufa barrier Labudovac, NP Plitvice	E 15° 35' 59"	N 44° 52' 17"	630	5
63*	Lake Prošće, NP Plitvice	N 15° 36' 09"	N 44° 51' 33"	635	5
64*	Crna rijeka by the bridge, NP Plitvice	E 15° 35' 59"	N 44° 50' 22"	665	5
65*	Upper reach of Crna rijeka, NP Plitvice	E 15° 36' 30"	N 44° 50' 10"	670	5
66*	Crna rijeka Spring, NP Plitvice	E 15° 36' 28"	N 44° 50' 14"	680	5
67*	Upper reach of Bijela rijeka, NP Plitvice	E 15° 33' 33"	N 44° 50' 04"	715	5
68*	Bijela rijeka Spring, NP Plitvice	E 15° 33' 43"	N 44° 50' 05"	720	5
69	Majerovo vrelo, River Gacka	E 15° 21' 47"	N 44° 48' 53"	540	5
70	Tonkovića vrelo, River Gacka	E 15° 22' 17"	N 44° 47' 10"	530	5
71	River Gacka by Ličko Lešće	E 15° 19' 16"	N 44° 48' 49"	450	5
72	Kostelka Spring	E 15° 19' 59"	N 44° 47' 44"	480	5
73*	Bužimnica Spring	E 15° 13' 22"	N 44° 36' 11"	640	5
74*	Donja Suvaja, River Una	E 16° 06' 42"	N 44° 24' 09"	370	5
75	Una Spring	E 16° 06' 15"	N 44° 23' 57"	450	5
76*	Zrmanja Spring	E 16° 05' 03"	N 44° 12' 23"	590	5
77*	Krupa Spring	E 15° 54' 33"	N 44° 11' 49"	150	5
78	Pađane, River Zrmanja	E 16° 04' 48"	N 44° 05' 57"	230	5
79	Stream Strmica by Strmica	E 16° 15' 11"	N 44° 08' 44"	335	5

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TABLE 1. (Continued)

Site ID	Site name	Longitude	Latitude	Altitude (m)	Ecoregion
80	Stream Strmica by Golubić	E 16° 13' 27"	N 44° 05' 15"	245	5
81*	Krka Spring	E 16° 14' 07"	N 44° 02' 31"	265	5
82	Stream Orašnica	E 16° 13' 20"	N 44° 03' 13"	225	5
83*	Spring Krčić	E 16° 19' 42"	N 44° 01' 48"	390	5
84	Šarena jezera	E 16° 13' 16"	N 44° 01' 35"	220	5
85	Lake outlet Brljan, River Krka	E 16° 02' 12"	N 44° 00' 34"	200	5
86*	Roški Slap, River Krka	E 15° 58' 22"	N 43° 54' 20"	55	5
87*	Kosovčica Spring	E 16° 15' 10"	N 43° 56' 28"	260	5
88	Stream Sutina, Lučane	E 16° 35' 49"	N 43° 43' 24"	370	5
89*	Spring Glavaš, River Cetina	E 16° 25' 48"	N 43° 58' 36"	385	5
90*	Spring Sveti Spas, River Cetina	E 16° 25' 24"	N 43° 58' 23"	385	5
91*	Spring Preočani, Preočki most, River Cetina	E 16° 25' 53"	N 43° 57' 59"	370	5
92*	Crveni Most, River Cetina	E 16° 25' 53"	N 43° 58' 05"	365	5
93*	Spring of Grab River	E 16° 46' 33"	N 43° 38' 24"	330	5
94*	Spring of Ruda River	E 16° 47' 56"	N 43° 40' 07"	320	5
95	Obrovac Sinjski, River Cetina	E 16° 41' 04"	N 43° 40' 01"	300	5
96	Trilj, River Cetina	E 16° 43' 46"	N 43° 36' 21"	295	5
97*	Čikotina Lađa, River Cetina	E 16° 44' 42"	N 43° 31' 59"	250	5
98	Pavića most, River Cetina	E 16° 48' 27"	N 43° 26' 39"	40	5
99*	Radmanove Mlinice, River Cetina	E 16° 45' 11"	N 43° 26' 16"	15	5
100	Vrgoracko Polje, River Matica	E 17° 24' 42"	N 43° 10' 24"	25	5
101	Cave near Fort Srđ, Dubrovnik	E 18° 07' 33"	N 42° 38' 33"	300	5
102	Konavoski Dvori, River Ljuta	E 18° 22' 41"	N 42° 32' 11"	70	5

* Sites that are used in calculating Shannon and Simpson's diversity indexes and Bray-Curtis Similarity index.

Data analysis. A list of species was compiled from all specimen data. Calculating diversity indexes (Shannon and Simpson index) and cluster analysis (Bray-Curtis Similarity with log-transformed data) was done only for sites which had the same or similar sampling effort. Hence, out of 102 sampled sites, we compared just 46, disregarding the remainder. Cluster analysis of sites was conducted using the similarity matrices attained from calculating the Bray-Curtis Similarity indices to distinguish which sites cluster together according to their aquatic dance fly community composition and its stream reach association. Comparison of species richness and assemblage composition with surrounding countries (Italy, Slovenia, Bosnia & Herzegovina and Hungary) was conducted by compiling species lists for those countries taken from "Fauna Europaea" (Pape & Beuk 2012), Yang *et al.* (2007) and from Horvat (1993b, 1995a). A species by country matrix was constructed and Sørensen Index of Similarity of each pairwise comparison calculated. All indexes and cluster analysis were calculated using Primer v6 software (Clark & Gorley 2006).

Results

Species richness and community composition. Fifty species of aquatic empidids have been recorded from Croatia (Table 2) from 102 locations (Fig. 1, Table 1). The subfamily Clinocerinae is represented by 36 species, in five genera: *Clinocera* Meigen (3 species), *Clinocerella* Engel (1 species), *Dolichocephala* Macquart (7 species),

Kowarzia Mik (5 species) and *Wiedemannia* Zetterstedt (20 species). The subfamily Hemerodromiinae is represented with 14 species, in two genera: *Chelifera* Macquart (8 species) and *Hemerodromia* Meigen (6 species) (Table 2). The Clinocerinae genus *Wiedemannia* is most species rich (40%), followed by the Hemerodromiinae genus *Chelifera* (16%) (Fig. 2). The Dinaric western Balkan (Ecoregion 5) was the richer Ecoregion with 46 species, whereas the Pannonian lowland (Ecoregion 11) had only 15 species (Table 2, Table 3).

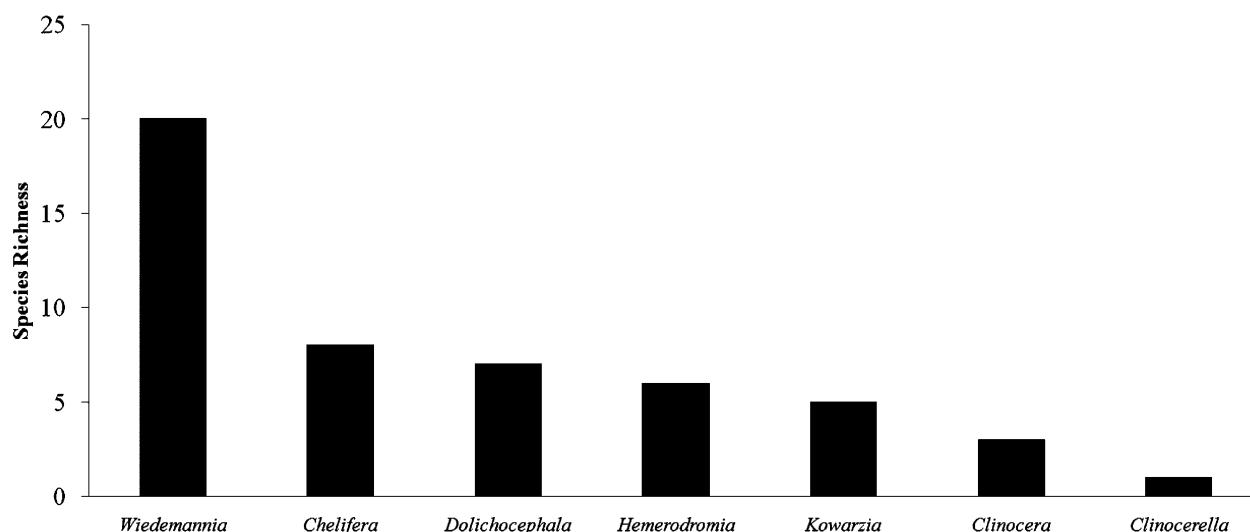


FIGURE 2. Species richness of Croatian aquatic Empididae genera.

Cluster analysis showed, with a few exceptions, that geographically closer sites cluster together. Similarly, sites of the same reach also exhibited close relationship (Fig. 3). Species richness and diversity, calculated for 46 sites are presented in Table 4. They ranged between 1–13 species, 0–2.16 for Shannon index and 0–0.87 for Simpson index, respectively. All sites with higher species richness and higher values of diversity indexes are located in the Dinaric western Balkan (Table 1, Fig 1).

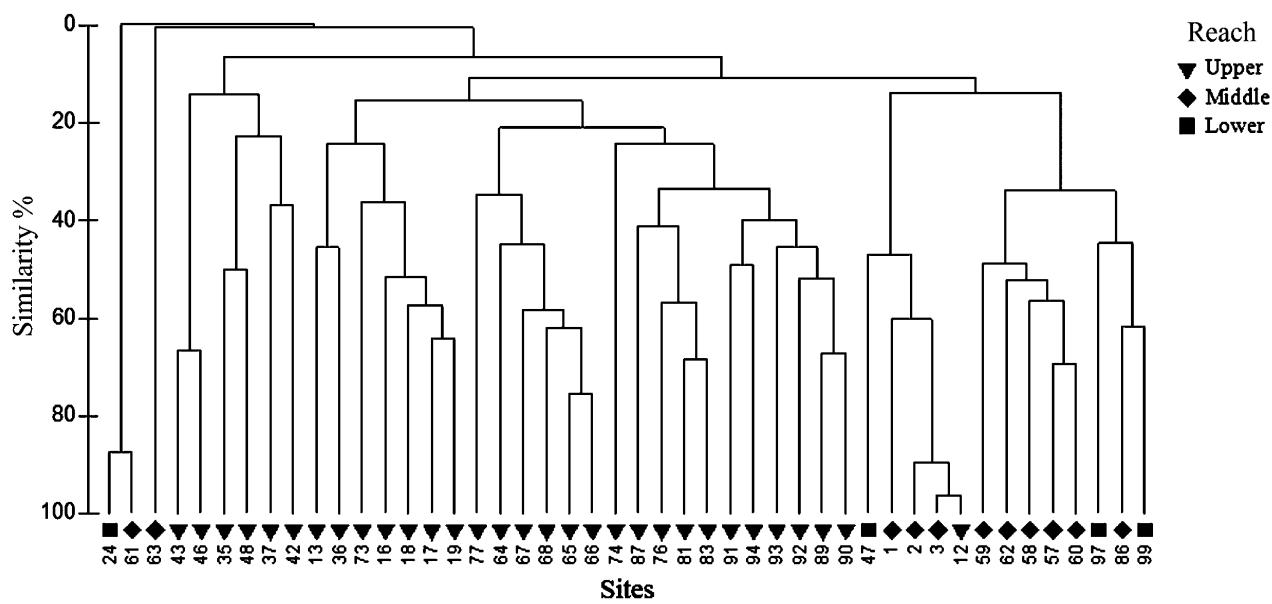


FIGURE 3. Cluster analysis for community composition data of aquatic Empididae, based on Bray-Curtis Similarity.

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TABLE 2. Croatian aquatic dance flies. Functional niche traits. Habitat type: 1 = spring, 2 = stream, 3 = river, 4 = tufa barrier (barrage lake outlet), 5 = lake. Stream Reach: 1 = spring or upper reach, 2 = middle reach, 3 = lower reach. Voltinism U = univoltine, B = bivoltine, P = polivoltine. Occurrence: Sp = Spring, Su = Summer, A = Autumn, W = Winter, AYR = all year round. Distribution in Europe: wd = widely distributed, bd = Balkan distribution, ld = local distribution. Thermal preference (Thermal Pref.): 1 = constant temperature regime during the year, 2 = cool water (maximum temperature < 20°C), 3 = warm water (maximum temperature > 20°C).

Species	Species Niche Traits						
	Habitat type	Stream Reach	Voltinism	Occurrence	Distribution	Thermal Pref.	Ecoregion
Hemerodromiinae							
<i>Chelifera concinnicauda</i> Collin, 1927	2–4	2	U	A	wd	3	5
<i>Chelifera flavella</i> (Zetterstedt, 1838)	1–2	1	U	Sp	wd	1	5, 11
<i>Chelifera precabunda</i> Collin, 1961	1–3	1	B	Sp, Su, A	wd	1–2	5, 11
<i>Chelifera precatoria</i> (Fallén, 1816)	1–2	1	B	Sp, A	wd	1	5
<i>Chelifera pyrenaica</i> Vaillant, 1981	1–2, 4	1–2	B	Sp, A	wd	1–3	5
<i>Chelifera siveci</i> Wagner, 1984	1–3, 5	1	U	Sp, Su	bd	1	5
<i>Chelifera stigmatica</i> (Schiner, 1862)	1–4	1–2	B	Sp, Su, A	wd	1–3	5, 11
<i>Chelifera trapezina</i> (Zetterstedt, 1838)	1–3	1–2	U	Sp, Su, A	wd	1–2	5, 11
<i>Hemerodromia laudatoria</i> Collin, 1927	3, 5	2	U	Sp, Su	wd	2–3	5
<i>Hemerodromia melangyna</i> Collin, 1927	2–4	2–3	U	Sp, Su, A	wd	3	5
<i>Hemerodromia oratoria</i> (Fallén, 1816)	2–4	2–3	U	Sp, Su	wd	3	5
<i>Hemerodromia raptoria</i> Meigen, 1830	4–5	2–3	U	Sp, Su	wd	3	5, 11
<i>Hemerodromia unilineata</i> Zetterstedt, 1842	2–4	2–3	B	Sp, Su, A	wd	3	5
<i>Hemerodromia zwicki</i> Horvat, 1993	2–3	1–2	U	Su	ld	3	5
Clinocerinae							
<i>Clinocera nigra</i> Meigen, 1804	1–2	1	B	Sp, Su, A	wd	1–2	5, 11
<i>Clinocera stagnalis</i> (Haliday, 1833)	1–3	1–3	U	Sp, Su	wd	1–3	5
<i>Clinocera wesmaeli</i> (Macquart, 1835)	1–2	1–2	U	Sp, Su, A	wd	1–2	5, 11
<i>Clinocerella oldenbergi</i> (Engel, 1918)	1–2	1	U	Sp, Su	wd	1	5
<i>Dolichocephala austriaca</i> Vaillant, 1968*	1	1	U	A*	wd	1	5
<i>Dolichocephala cavatica</i> (Becker, 1889)*					wd		5
<i>Dolichocephala guttata</i> (Haliday, 1833)	1–3	1–3	B	Sp, A	wd	1–3	5
<i>Dolichocephala irrorata</i> (Fallén, 1816)	3	3	U	Sp	wd	3	5
<i>Dolichocephala oblongoguttata</i> (Dale, 1878)	1	1	U	Sp	wd	1	5
<i>Dolichocephala ocellata</i> (Costa, 1854)	1–3	1–3	U	Sp, Su	wd	1–3	5
<i>Dolichocephala zwicki</i> Wagner, 1995	1–2	1–2	U	Su, A	bd	1–2	5
<i>Kowarzia barbatula</i> Mik, 1880	1–4	1–3	P	AYR	wd	1–3	5, 11
<i>Kowarzia bipunctata</i> (Haliday, 1833)	1–2	1	B	Sp, A	wd	1	5
<i>Kowarzia plectrum</i> Mik, 1880	1–2	1	U	Sp	wd	1	5
<i>Kowarzia tenella</i> (Wahlberg, 1844)*	2	1–2	U	A*	wd	2	11
<i>Kowarzia tibiella</i> Mik, 1880	1–2	1	B	Sp, Su, A	wd	1	5
<i>Wiedemannia (Chamaedipsia) aequilobata</i> Mandaron, 1964	1–2	1	U	A, W, Sp	wd	1	5
<i>Wiedemannia (Chamaedipsia) ariadne</i> Wagner, 1981	1, 3	1	U	Sp, Su	bd	1	5
<i>Wiedemannia (Chamaedipsia) longicornis</i> (Mik, 1887)	2	1	U	Sp, Su	wd	2	5, 11

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TABLE 2. (Continued)

Species	Species Niche Traits						
	Habitat type	Stream Reach	Voltinism	Occurrence	Distribution	Thermal Pref.	Ecoregion
<i>Wiedemannia (Chamaedipsia) lota</i> Walker, 1851	2	1–2	B	Sp, A	wd	2	11
<i>Wiedemannia (Chamaedipsia) wachtli</i> (Mik, 1880)	1–3	1	B	Sp, A	wd	1	5
<i>Wiedemannia (Eucelidia) zetterstedti</i> (Fallén, 1826)	1–4	1–3	P	AYR	wd	1–3	5
<i>Wiedemannia (Philolutra) aquilex</i> (Loew, 1869)	1–2	1	U	Sp, Su	wd	1	5
<i>Wiedemannia (Philolutra) bohemani</i> (Zetterstedt, 1838)	1–3	1	U	Sp, Su	wd	1	5
<i>Wiedemannia (Philolutra) fallaciosa</i> (Loew, 1873)	1	1	U	A*	wd	1	5
<i>Wiedemannia (Philolutra) hygrobia</i> (Loew, 1858)	1–2	1	U	Sp, Su	wd	1	5
<i>Wiedemannia (Philolutra) kacanskae</i> Horvat, 1993	1–2	1	U	Sp, Su	bd	1	5
<i>Wiedemannia (Philolutra) queyrasiana</i> Vaillant, 1956	1–2	1	U	Sp	wd	1–2	11
<i>Wiedemannia (Pseudowiedemannia) lamellata</i> (Loew, 1869)	1–4	1–3	B	Sp, Su, A	wd	1–3	5, 11
<i>Wiedemannia (Wiedemannia) balkanica</i> Wagner, 1981	2	1–2	U	Sp	bd		5
<i>Wiedemannia (Wiedemannia) bistigma</i> (Curtis, 1834)	1–3	1–3	P	Sp, Su, A	wd	1–3	5
<i>Wiedemannia (Wiedemannia) dinarica</i> Engel, 1940	2–3	1–2	U	Sp	bd	1–3	5
<i>Wiedemannia (Wiedemannia) kroatica</i> Wagner, 1981	2–3	1–3	U	Sp, Su, A	ld	1–2	5
<i>Wiedemannia (Wiedemannia) rhynchops</i> (Nowicki, 1868)	3	2–3	B	Sp, A	wd	2	5
<i>Wiedemannia (Wiedemannia) stylifera</i> Mik, 1889	2	1–2	U	Sp	wd	2	11
<i>Wiedemannia (Wiedemannia) tricuspidata</i> (Bezzi, 1905)	3	2–3	B	Sp, Su, A	wd	3	5, 11

Assemblage composition and species traits. The vast majority of dance fly species inhabiting Croatia are associated with springs and streams (Table 3). Only three species occur in lakes (*Hemerodromia laudatoria* Collin, *H. raptoria* Meigen and *Chelifera siveci* Wagner), but they all inhabit other habitats as well, especially *C. siveci* which is usually found in springs. Some species, such as *Clinocera stagnalis* (Haliday), *Kowarzia barbatula* Mik, *Wiedemannia (Eucelidia) zetterstedti* (Fallén) and *Wiedemannia (Pseudowiedemannia) lamellata* (Loew), were collected from all types of habitats except lakes.

TABLE 3. Species traits distribution for the Croatian aquatic dance fly assemblage. Traits from Table 2.

Habitat type		Voltinism		Occurrence		Thermal Preferences			Distribution		Ecoregion	
1	32	U	32	Sp	41	1	34	wd	42	5	46	
2	37	B	14	Su	26	2	23	bd	6	11	15	
3	25	P	3	A	25	3	19	ld	2			
4	10			W	1							
5	3			AYR	2							

Seasonal phenology revealed that most dance fly species inhabiting Croatia are univoltine, mostly occurring in spring and summer, while *Chelifera concinnicauda* Collin only occurred in autumn. The species *K. barbatula* and *W. (E.) zetterstedti* occurred all year round, while only *Wiedemannia (Chamaedipsia) aequilobata* Mandaron had its flight period in the colder part of the year from late autumn to early spring (Table 2). The majority of species are widely distributed, with only a few (*C. siveci*, *Dolichocephala zwicki* Wagner, *Wiedemannia (Chamaedipsia) ariadne* Wagner, *Wiedemannia (Philolutra) kacanskae* Horvat, *Wiedemannia (Wiedemannia) balkanica* Wagner and *Wiedemannia (Wiedemannia) dinarica* Engel) restricted to the Balkan Peninsula. *Wiedemannia (Wiedemannia)*

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kroatica Wagner and *Hemerodromia zwicki* Horvat have localized distributions, occupying the rivers which are the natural borders between Slovenia and Croatia.

TABLE 4. Species richness (S), Shannon index (H') and Simpson's index of diversity (1- λ) calculated for 46 sampled sites. Sites with the highest S, H' and 1- λ are bolded.

Site ID	S	H'	1- λ
1	2	0.35	0.20
2	1	0	0
3	1	0	0
12	1	0	0
13	5	1.18	0.64
16	6	1.28	0.62
17	2	0.68	0.51
18	5	1.10	0.57
19	4	0.96	0.53
24	1	0	0
35	13	2.16	0.87
36	4	1.09	0.63
37	5	1.33	0.72
42	2	0.27	0.14
43	3	0.53	0.27
46	1	0	0
47	4	1.11	0.63
48	9	1.68	0.76
57	7	0.44	0.21
58	12	1.40	0.71
59	8	1.06	0.54
60	5	0.48	0.22
61	1	0	0
62	5	0.49	0.25
63	1	0	0
64	8	1.52	0.76
65	7	1.01	0.49
66	9	1.09	0.49
67	9	0.91	0.42
68	13	1.76	0.75
73	3	0.18	0.08
74	6	1.36	0.68
76	6	1.15	0.62
77	8	0.99	0.47
81	10	1.14	0.56
83	6	1.16	0.61
86	7	1.19	0.58
87	4	0	0

.....continued on the next page

TABLE 4. (Continued)

Site ID	S	H'	1-λ
89	9	1.44	0.66
90	6	0.78	0.37
91	10	1.52	0.74
92	8	1.24	0.63
93	4	0.87	0.46
94	9	0.26	0.09
97	6	0.60	0.33
99	11	1.73	0.77

The thermal associations of dance flies are not well known, but most species can be found in constant thermal habitats (e.g., springs and ecrenal zone) and cool water with the maximum water temperature (MWT) < 20°C. In contrast, *Hemerodromia* species are usually found in habitats with MWT > 20 °C. *Wiedemannia* species are usually found in constant thermal habitats all year round, with the exception of *W. (E.) zetterstedti*, *Wiedemannia (Wiedemannia) bistigma* (Curtis), *W. (W.) dinarica* and *Wiedemannia (Wiedemannia) tricuspidata* (Bezzi) (Table 2, Table 3).

Aquatic dance flies of Croatia (Empididae: Clinocerinae & Hemerodromiinae)

The following format is used for the distributional data; Literature references: name of the site and in the brackets citation of the reference and site ID; New records: name of the site and in the brackets site ID. All the sites and their numbers are listed in Table 1.

Subfamily Hemerodromiinae

Chelifera concinnicauda Collin, 1927

Literature references. Korana Village, National Park (NP) Plitvice (Horvat 1990; Ivković *et al.* 2010) (57); Stream Plitvica, NP Plitvice (Ivković *et al.* 2010) (58); tufa barrier Novakovića Brod, NP Plitvice (Ivković *et al.* 2010) (59); tufa barrier Kozjak-Milanovac, NP Plitvice (Ivković *et al.* 2010) (60); tufa barrier Labudovac, NP Plitvice (Ivković *et al.* 2010) (62); Crna rijeka by the bridge, NP Plitvice (Ivković *et al.* 2010) (64).

Chelifera flavella (Zetterstedt, 1838)

Literature references. Trnava, Medvednica Mountain (Horvat 1990) (23); upper reach of Crna rijeka, NP Plitvice (Ivković *et al.* 2010) (65); Crna rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (66); upper reach of Bijela rijeka, NP Plitvice (Ivković *et al.* 2010) (67); Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68).

Chelifera precabunda Collin, 1961

Literature references. Veličanka Stream, Velika, Papuk Mountain (Horvat 1990) (15); Spring Jankovac, Papuk Mountain (Horvat 1990) (19); Trnava, Medvednica Mountain (Horvat 1990) (23); Golik, River Kupa (Horvat 1990) (45); Crna rijeka by the bridge, NP Plitvice (Ivković *et al.* 2010) (64); upper reach of Crna rijeka, NP Plitvice (Ivković *et al.* 2010) (65); Crna rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (66); upper reach of Bijela rijeka, NP Plitvice (Ivković *et al.* 2010) (67); Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68); Spring Glavaš,

River Cetina (Ivković & Horvat 2007b) (89); Spring Sveti Spas, River Cetina (Ivković & Horvat 2007b) (90); Spring Preočani, River Cetina (Ivković & Horvat 2007b) (91); Crveni Most, River Cetina (Ivković & Horvat 2007b) (92).

New records. Dubočanka, Papuk Mountain (16); Majerovo vrelo, River Gacka (69); Kostelka Spring (72); Kosovčica Spring (87).

Chelifera precatoria (Fallén, 1816)

Literature references. Crna rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (66); upper reach of Bijela rijeka, NP Plitvice (Ivković *et al.* 2010) (67); Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68); Krka Spring (Horvat 1990) (81); Spring Glavaš, River Cetina (Horvat 1990; Ivković & Horvat 2007b) (89); Spring Sveti Spas, River Cetina (Ivković & Horvat 2007b) (90); Spring Preočani, River Cetina (Ivković & Horvat 2007b) (91); Crveni Most, River Cetina (Ivković & Horvat 2007b) (92).

New record. Dretulja Spring (55).

Chelifera pyrenaica Vaillant, 1981

Literature references. Korana Village, NP Plitvice (Ivković *et al.* 2010) (57); Stream Plitvica, NP Plitvice (Ivković *et al.* 2010) (58); tufa barrier Novakovića Brod, NP Plitvice (Ivković *et al.* 2010) (59); tufa barrier Kozjak-Milanovac, NP Plitvice (Ivković *et al.* 2010) (60); Crna rijeka by the bridge, NP Plitvice (Ivković *et al.* 2010) (64).

New record. Spring Krčić (83).

Chelifera siveci Wagner, 1984

Literature references. Stream Plitvica, NP Plitvice (Ivković *et al.* 2010) (58); Crna rijeka by the bridge, NP Plitvice (Ivković *et al.* 2010) (64); upper reach of Crna rijeka, NP Plitvice (Ivković *et al.* 2010) (65); Crna rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (66); upper reach of Bijela rijeka, NP Plitvice (Ivković *et al.* 2010) (67); Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68); Krka Spring (Horvat 1990); Spring Glavaš, River Cetina (Horvat 1990; Ivković & Horvat 2007b) (89); Spring Preočani, River Cetina (Ivković & Horvat 2007b) (91); Crveni Most, River Cetina (Ivković & Horvat 2007b) (92); Grab Spring (Ivković & Horvat 2007b) (93).

New records. Majerovo vrelo, River Gacka (69); Tonkovića vrelo, River Gacka (70); Kostelka Spring (72); Donja Suvaja, River Una (74); Zrmanja Spring (76); Krupa Spring (77); Spring Krčić (83); Šarena jezera (84).

Chelifera stigmatica (Schiner, 1862)

Literature references. Stream Plitvica, NP Plitvice (Ivković *et al.* 2010) (58); tufa barrier Novakovića Brod, NP Plitvice (Ivković *et al.* 2010) (59); tufa barrier Kozjak-Milanovac, NP Plitvice (Ivković *et al.* 2010) (60); tufa barrier Labudovac, NP Plitvice (Ivković *et al.* 2010) (62); Krka Spring (Horvat 1990) (81); Spring Glavaš, River Cetina (Horvat 1990; Ivković & Horvat 2007b) (89); Spring Sveti Spas, River Cetina (Ivković & Horvat 2007b) (90); Konavoski Dvori, River Ljuta (Horvat 1990) (102).

New records. Dubočanka, Papuk Mountain (16); above Potoka, close to Trebišće, Učka Mountain (31); Spring Krčić (83); Roški Slap, River Krka (86); Kosovčica Spring (87).

Chelifera trapezina (Zetterstedt, 1838)

Literature references. Veličanka Stream, Velika, Papuk Mountain (Horvat 1990) (15); Korana Village, NP

Plitvice (Ivković *et al.* 2010) (57); Stream Plitvica, NP Plitvice (Ivković *et al.* 2010) (58); Crna rijeka by the bridge, NP Plitvice (Ivković *et al.* 2010) (64); upper reach of Crna rijeka, NP Plitvice (Ivković *et al.* 2010) (65); Crna rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (66); upper reach of Bijela rijeka, NP Plitvice (Ivković *et al.* 2010) (67); Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68).

New record. Bužimnica Spring (73).

***Hemerodromia laudatoria* Collin, 1927**

Literature references. Lake Prošće, NP Plitvice (Ivković *et al.* 2010) (63); Crna rijeka by the bridge, NP Plitvice (Ivković *et al.* 2010) (64).

***Hemerodromia melangyna* Collin, 1927**

Literature references. Stream Bračana, Abrami, Buzet, Istra (Horvat 1990) (28); Korana Village, NP Plitvice (Horvat 1990; Ivković *et al.* 2010) (57); Stream Plitvica, NP Plitvice (Ivković *et al.* 2010) (58); tufa barrier Novakovića Brod, NP Plitvice (Ivković *et al.* 2010) (59); tufa barrier Labudovac, NP Plitvice (Ivković *et al.* 2010) (62); Čikotina Lađa, River Cetina (Ivković & Horvat 2007b) (97).

***Hemerodromia oratoria* (Fallén, 1816)**

Literature references. Stream Plitvica, NP Plitvice (Ivković *et al.* 2010) (58); tufa barrier Novakovića Brod, NP Plitvice (Ivković *et al.* 2010) (59); Čikotina Lađa, River Cetina (Ivković & Horvat 2007b) (97); Radmanove Mlinice, River Cetina (Ivković & Horvat 2007b) (99); Konavoski Dvori, River Ljuta (Horvat 1990) (102).

New record. Roški Slap, River Krka (86).

***Hemerodromia raptoria* Meigen, 1830**

Literature references. Selečki most, Odra, Turopolje (Ivković & Horvat 2007a) (24); Lake Kozjak, NP Plitvice (Ivković *et al.* 2010) (61).

New record. tufa barrier Kozjak-Milanovac, NP Plitvice (60).

***Hemerodromia unilineata* Zetterstedt, 1842**

Literature references. Stream Bračana, Abrami, Buzet, Istra (Horvat 1990) (28); Stream Bračana, Osoje, Buzet, Istra (Horvat 1990) (29); Vrbovsko, River Dobra (Horvat 1990) (52); Korana Village, NP Plitvice (Ivković *et al.* 2010) (57); Stream Plitvica, NP Plitvice (Ivković *et al.* 2010) (58); tufa barrier Novakovića Brod, NP Plitvice (Ivković *et al.* 2010) (59); tufa barrier Kozjak-Milanovac, NP Plitvice (Ivković *et al.* 2010) (60); tufa barrier Labudovac, NP Plitvice (Ivković *et al.* 2010) (62); Čikotina Lađa, River Cetina (Ivković & Horvat 2007b) (97); Pavića most, River Cetina (Ivković & Horvat 2007b) (98); Radmanove Mlinice, River Cetina (Ivković & Horvat 2007b) (99).

New records. Novo Selište, Banija (50); Roški Slap, River Krka (86).

***Hemerodromia zwicki* Horvat, 1993**

Literature references. River Dragonja, Oskoruš, Istra (Sivec & Horvat 2002) (26); Ugrini, Mlini, River Reka, Istra (Horvat 1993) (27).

Subfamily Clinocerinae

Clinocera nigra Meigen, 1804

New records. Dubočanka, Papuk Mountain (16); Waterfall Skakavac, Stream Jankovac, Papuk Mountain (18); Čabranka Spring by Čabar (35); Zeleni Vir, Skrad, Gorski Kotar (48); Krupa Spring (77).

Clinocera stagnalis (Haliday, 1833)

Literature references. Stream Plitvica, NP Plitvice (Ivković *et al.* 2010) (58); Crna rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (66); Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68); Spring Glavaš, River Cetina (Ivković & Horvat 2007b) (89); Spring Sveti Spas, River Cetina (Ivković & Horvat 2007b) (90); Spring Preočani, Preočki most, River Cetina (Ivković & Horvat 2007b) (91); Spring of Grab River (Ivković & Horvat 2007b) (93); Spring of Ruda River (Ivković & Horvat 2007b) (94); Obrovac Sinjski, River Cetina (Ivković & Horvat 2007b) (95); Trilj, River Cetina (Ivković & Horvat 2007b) (96); Pavića most, River Cetina (Ivković & Horvat 2007b) (98); Radmanove Mlinice, River Cetina (Ivković & Horvat 2007b) (99); Vrgorac Polje, River Matica (Wagner 1995) (100).

New records. Plešce, River Čabranka (37); Spring Bistrica (53); Dretulja Spring (55); Tonkovića vrelo, River Gacka (70); River Gacka by Ličko Lešće (71); Donja Suvaja, River Una (74); Zrmanja Spring (76); Spring Krčić (83); Roški Slap, River Krka (86).

Clinocera wesmaeli (Macquart, 1835)

Literature references. Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68).

New records. Gornja Šumetlica, Psunj Mountain (7); Strmac, Psunj Mountain (8); Mijači, River Orljava, Psunj Mountain (9); Brzaja, before N. Zvečeva, Papuk Mountain (13); Veličanka Stream, Velika, Papuk Mountain (15); Dubočanka, Papuk Mountain (16); Stream Kovačica, Papuk Mountain (17); Waterfall Skakavac, Stream Jankovac, Papuk Mountain (18); Spring Jankovac, Papuk Mountain (19); Rikino vrilo, Papuk Mountain (20); Remetska rijeka, Papuk Mountain (21); Prezid (34).

Clinocerella oldenbergi (Engel, 1918)

New records. Čabranka Spring by Čabar (35); Brod na Kupi, Kupica Stream (47); Zeleni Vir, Skrad, Gorski Kotar (48).

Dolichocephala austriaca Vaillant, 1968

New record. Čabranka Spring by Čabar (35).

Dolichocephala cavatica (Becker, 1889)

Literature reference. cave near Fort Srđ, Dubrovnik (Becker 1889) (101).

Dolichocephala guttata (Haliday, 1833)

Literature references. Korana Village, NP Plitvice (Ivković *et al.* 2010) (57); upper reach of Crna rijeka, NP Plitvice (Ivković *et al.* 2010) (65); Crna rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (66); upper reach of Bijela

rijeka, NP Plitvice (Ivković *et al.* 2010) (67); Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68); Spring Preočani, Preočki most, River Cetina (Ivković & Horvat 2007b) (91); Čikotina Lađa, River Cetina (Ivković & Horvat 2007b) (97); Pavića most, River Cetina (Ivković & Horvat 2007b) (98); Radmanove Mlinice, River Cetina (Ivković & Horvat 2007b) (99).

New records. Čabranka Spring by Čabar (35); Dretulja Spring (55); Bužimnica Spring (73); Donja Suvaja, River Una (74).

***Dolichocephala irrorata* (Fallén, 1816)**

Literature reference. Radmanove Mlinice, River Cetina (Ivković & Horvat 2007b) (99).

***Dolichocephala oblongoguttata* (Dale, 1878)**

New record. Čabranka Spring by Čabar (35).

***Dolichocephala ocellata* (Costa, 1854)**

Literature references. Upper reach of Bijela rijeka, NP Plitvice (Ivković *et al.* 2010) (67); Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68); Radmanove Mlinice, River Cetina (Ivković & Horvat 2007b) (99).

New records. Stream Bračana, Osoje, Buzet, Istra (29); above Potoka, close to Trebišće, Učka Mountain (31).

***Dolichocephala zwicki* Wagner, 1995**

Literature references. stream near Kaštél, Istra (Wagner 1995) (25); Ugrini, Mlini, Stream Reka, Istra (Horvat 1993) (27); Čabranka Spring by Čabar (Wagner 1995) (35).

***Kowarzia barbatula* Mik, 1880**

Literature references. Stream Plitvica, NP Plitvice (Ivković *et al.* 2010) (58); tufa barrier Kozjak-Milanovac, NP Plitvice (Ivković *et al.* 2010) (60); tufa barrier Labudovac, NP Plitvice (Ivković *et al.* 2010) (62); Crna rijeka by the bridge, NP Plitvice (Ivković *et al.* 2010) (64); upper reach of Crna rijeka, NP Plitvice (Ivković *et al.* 2010) (65); Crna rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (66); Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68); Spring of Ruda River (Ivković & Horvat 2007b) (94); Radmanove Mlinice, River Cetina (Ivković & Horvat 2007b) (99).

New records. Gornja Šumetlica, Psunj Mountain (7); Brzaja, before N. Zvečeva, Papuk Mountain (13); Brzaja after N. Zvečeva, Papuk Mountain (14); Dubočanka, Papuk Mountain (16); Stream Kovačica, Papuk Mountain (17); Waterfall Skakavac, Stream Jankovac, Papuk Mountain (18); Spring Jankovac, Papuk Mountain (19); Vela Učka, Fontane of Joseph II (30); above Potoka, close to Trebišće, Učka Mountain (31); Ranch Bubač, Poklone, Učka Mountain (32); Lovrantska Draga, Slap, Učka Mountain (33); Čabranka Spring by Čabar (35); Smrečje, River Čabranka (36); Gašparci, River Kupa (43); Zeleni Vir, Skrad, Gorski Kotar (48); Bužimnica Spring (73); Donja Suvaja, River Una (74); Zrmanja Spring (76); Krupa Spring (77); Krka Spring (81); Spring Krčić (83); Roški Slap, River Krka (86); Kosovčica Spring (87); Stream Sutina, Lučane (88).

***Kowarzia bipunctata* (Haliday, 1833)**

Literature references. upper reach of Bijela rijeka, NP Plitvice (Ivković *et al.* 2010) (67); Spring Preočani,

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Preočki most, River Cetina (Ivković & Horvat 2007b) (91); Spring of Grab River (Ivković & Horvat 2007b) (93);
Spring of Ruda River (Ivković & Horvat 2007b) (94).

New records. Krupa Spring (77); Krka Spring (81).

***Kowarzia plectrum* Mik, 1880**

New records. Čabranka Spring by Čabar (35); Zeleni Vir, Skrad, Gorski Kotar (48).

***Kowarzia tenella* (Wahlberg, 1844)**

New records. Gornja Šumetlica, Psunj Mountain (7); Strmac, Psunj Mountain (8); Koprivna, Psunj Mountain (10).

***Kowarzia tibiella* Mik, 1880**

New records. Čabranka Spring by Čabar (35); Zeleni Vir, Skrad, Gorski Kotar (48).

***Wiedemannia (Chamaedipsia) aequilobata* Mandaron, 1964**

Literature references. Spring Glavaš, River Cetina (Ivković & Horvat 2007b) (89); Spring Sveti Spas, River Cetina (Ivković & Horvat 2007b) (90); Spring Preočani, Preočki most, River Cetina (Ivković & Horvat 2007b) (91); Crveni Most, River Cetina (Ivković & Horvat 2007b) (92).

New records. Zrmanja Spring (76); Krupa Spring (77).

***Wiedemannia (Chamaedipsia) ariadne* Wagner, 1981**

Literature references. Spring Glavaš, River Cetina (Ivković & Horvat 2007b) (89); Spring Preočani, Preočki most, River Cetina (Ivković & Horvat 2007b) (91); Crveni Most, River Cetina (Ivković & Horvat 2007b) (92); Spring of Ruda River (Ivković & Horvat 2007b) (94).

New records. Gašparci, River Kupa (43); Slunjčica Spring (56); Zrmanja Spring (76); Krka Spring (77).

***Wiedemannia (Chamaedipsia) longicornis* (Mik, 1887)**

New records. Brzaja, before N. Zvečeva, Papuk Mountain (13); Smrečje, River Čabranka (36).

***Wiedemannia (Chamaedipsia) lota* Walker, 1851**

New record. Čakovec left drainage ditch (1).

***Wiedemannia (Chamaedipsia) wachtli* (Mik, 1880)**

New records. Čabranka Spring by Čabar (35); Plešce, River Čabranka (37); Gerovčica Spring (38); Sedalce, River Kupa (42); Brod na Kupi, Kupica Stream (47).

***Wiedemannia (Eucelidia) zetterstedti* (Fallén, 1826)**

Literature references. Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68); Spring Glavaš, River Cetina (Ivković & Horvat 2007b) (89); Spring Sveti Spas, River Cetina (Ivković & Horvat 2007b) (90); Spring Preočani, Preočki most, River Cetina (Ivković & Horvat 2007b) (91); Crveni Most, River Cetina (Ivković & Horvat, 2007b) (92); Spring of Grab River (Ivković & Horvat 2007b) (93); Spring of Ruda River (Ivković & Horvat 2007b) (94); Čikotina Lada, River Cetina (Ivković & Horvat 2007b) (97); Radmanove Mlinice, River Cetina (Ivković & Horvat 2007b) (99).

New records. Vela Učka, Fontane of Joseph II (30); Above Potoka, close to Trebišće, Učka Mountain (31); Lovranksa Draga, Slap, Učka Mountain (33); Čabranka Spring by Čabar (35); Smrečje, River Čabranka (36); Gerovčica Spring (38); Brod na Kupi, Kupica Stream (47); Stream Curak, Skrad, Gorski Kotar (49); Donja Suvaja, River Una (74); Zrmanja Spring (76); Krupa Spring (77); Stream Strmica by Strmica (79); Stream Strmica by Golubić (80); Krka Spring (81); Stream Orašnica (82); Spring Krčić (83); lake outlet Brljan, River Krka (85); Roški Slap, River Krka (86); Kosovčica Spring (87); Konavoski Dvori, River Ljuta (102).

***Wiedemannia (Philolutra) aquilex* (Loew, 1869)**

Literature references. Crna rijeka by the bridge, NP Plitvice (Ivković *et al.* 2010) (64); upper reach of Crna rijeka, NP Plitvice (Ivković *et al.* 2010) (65); Crna rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (66); upper reach of Bijela rijeka, NP Plitvice (Ivković *et al.* 2010) (67); Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68).

New records. Zeleni Vir, Skrad, Gorski Kotar (48); Krupa Spring (77).

***Wiedemannia (Philolutra) bohemani* (Zetterstedt, 1838)**

New records. Čabranka Spring by Čabar (35); Plešce, River Čabranka (37); Hrvatsko, River Kupa (39); Zeleni Vir, Skrad, Gorski Kotar (48); Stream Curak, Skrad, Gorski Kotar (49).

***Wiedemannia (Philolutra) fallaciosa* (Loew, 1873)**

New record. Krka Spring (81).

***Wiedemannia (Philolutra) hygrobia* (Loew, 1858)**

New records. Čabranka Spring by Čabar (35); Plešce, River Čabranka (37); Zeleni Vir, Skrad, Gorski Kotar (48).

***Wiedemannia (Philolutra) kacanskae* Horvat, 1993**

Literature references. Spring Glavaš, River Cetina (Ivković & Horvat 2007b) (89); Spring Preočani, Preočki most, River Cetina (Ivković & Horvat 2007b) (91); Crveni Most, River Cetina (Ivković & Horvat, 2007b) (92); Spring of Ruda River (Ivković & Horvat 2007b) (94).

New record. Una Spring (75).

***Wiedemannia (Philolutra) queyrasiana* Vaillant, 1956**

New records. Waterfall Skakavac, Stream Jankovac, Papuk Mountain (18); Spring Jankovac, Papuk Mountain (19).

***Wiedemannia (Pseudowiedemannia) lamellata* (Loew, 1869)**

Literature references. River Dragonja, Oskoruš, Istra (Sivec & Horvat 2002) (26); watermill on Mrežnica River (Wagner 1981) (54); Korana Village, NP Plitvice (Ivković *et al.* 2010) (57); Stream Plitvica, NP Plitvice (Ivković *et al.* 2010) (58); tufa barrier Novakovića Brod, NP Plitvice (Ivković *et al.* 2010) (59); Bijela rijeka Spring, NP Plitvice (Ivković *et al.* 2010) (68); Spring of Ruda River (Ivković & Horvat 2007b) (94); Radmanove Mlinice, River Cetina (Ivković & Horvat 2007b) (99).

New records. Čakovec left drainage ditch (1); Dubrava right drainage ditch, 2 km (2); Dubrava right drainage ditch, 8 km (3); Dubrava left drainage ditch (4); Drava after accumulation Dubrava, old reach (5); Dobovec, River Sutla (6); Strmac, Psunj Mountain (8); Koprivna, Psunj Mountain (10); Orljavac, River Orljava (11); Djedovica by Rupnica, Papuk Mountain (12); Brzaja, before N. Zvečeva, Papuk Mountain (13); Brzaja after N. Zvečeva, Papuk Mountain (14); Dubočanka, Papuk Mountain (16); Waterfall Skakavac, Stream Jankovac, Papuk Mountain (18); Kutjevačka Rika, Papuk Mountain (22); Smrečje, River Čabranka (36); River Kupa near Gorenj Žaga (40); Brod na Kupi, Kupica Stream (47); Krupa Spring (77); Stream Strmica by Strmica (79); lake outlet Brljan, River Krka (85); Roški Slap, River Krka (86).

***Wiedemannia (Wiedemannia) balkanica* Wagner, 1981**

New record. Stream Strmica by Strmica (79).

***Wiedemannia (Wiedemannia) bistigma* (Curtis, 1834)**

Literature references. Spring Glavaš, River Cetina (Ivković & Horvat 2007b) (89); Spring Preočani, Preočki most, River Cetina (Ivković & Horvat 2007b) (91); Crveni Most, River Cetina (Ivković & Horvat 2007b) (92); Spring of Grab River (Ivković & Horvat 2007b) (93); Spring of Ruda River (Ivković & Horvat 2007b) (94); Obrovac Sinjski, River Cetina (Ivković & Horvat 2007b) (95); Čikotina Lađa, River Cetina (Ivković & Horvat 2007b) (97); Radmanove Mlinice, River Cetina (Ivković & Horvat 2007b) (99).

***Wiedemannia (Wiedemannia) dinarica* Engel, 1940**

New records. Donja Suvaja, River Una (74); Stream Strmica by Golubić (80); Krka Spring (81).

***Wiedemannia (Wiedemannia) kroatica* Wagner, 1981**

Literature references. 5 km above Brod na Kupi, River Kupa (Wagner 1981) (44).

New records. Čabranka Spring by Čabar (35); Plešce, River Čabranka (37); Turke, River Kupa (41); Gašparci, River Kupa (43); Brod na Kupi, River Kupa (46); Zeleni Vir, Skrad, Gorski Kotar (48); Stream Curak, Skrad, Gorski Kotar (49).

***Wiedemannia (Wiedemannia) rhynchops* (Nowicki, 1868)**

New records. Hrvatsko, River Kupa (39); Sedalce, River Kupa (42).

***Wiedemannia (Wiedemannia) stylifera* Mik, 1889**

New record. Brzaja, before N. Zvečeva, Papuk Mountain (13).

***Wiedemannia (Wiedemannia) tricuspidata* (Bezzi, 1905)**

Literature references. Pavića most, River Cetina (Ivković & Horvat 2007b) (98); Radmanove Mlinice, River Cetina (Ivković & Horvat 2007b) (99).

New records. River Kupa near Gorenj Žaga (40); Kuljani, River Una (51); Pađane, River Zrmanja (78).

Discussion

Species richness, diversity and assemblage composition. We compared our list of Croatian species with existing checklists in “Fauna Europea” (Pape & Beuk 2012) and the World Catalogue of Empididae (Yang *et al.* 2007). The following species were not recorded from Croatia in both these works: *D. irrorata*, *W. (C.) aequilobata*, *W. (C.) lota*, *W. (P.) aquilex*, *W. (P.) fallaciosa*, *W. (P.) kacanskae*, *W. (W.) bistigma* and *W. (W.) stylifera* from the subfamily Clinocerinae as well as *C. pyrenaica* and *H. laudatoria* from the subfamily Hemerodromiinae.

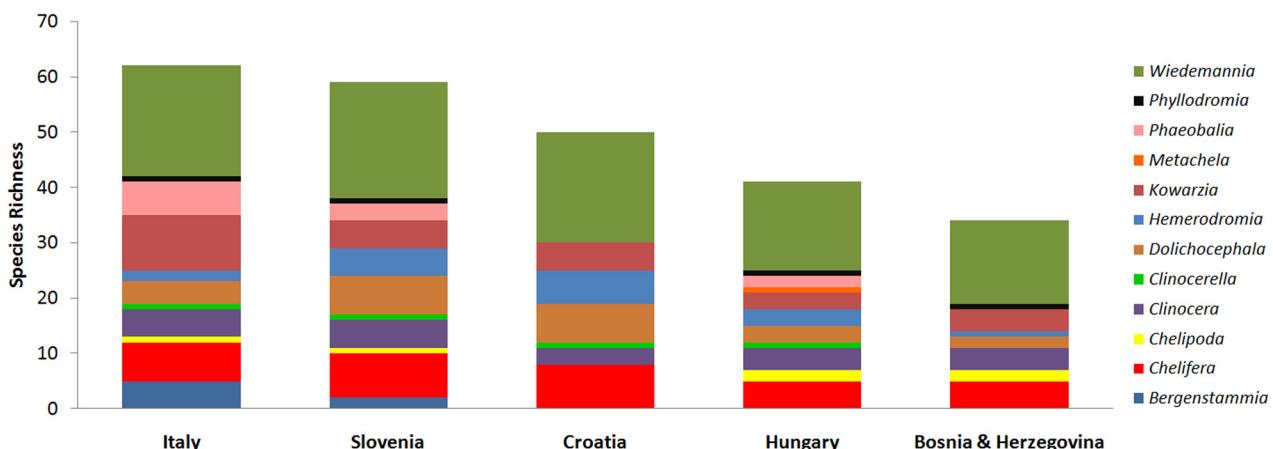
On the other hand, some species which are listed in Pape and Beuk (2012) and Yang *et al.* (2007) are not included in the present checklist. We omitted *Phaeobalia penicissa* Becker recorded by Becker (1889) since this species was described from a site near Njeguš, which is now a part of Montenegro and therefore no longer within Croatia. Further, we excluded *Chelipoda vocatoria* Fallén and *Phyllodromia melanocephala* Fabricius, which are listed by Pape and Beuk (2012) and Yang *et al.* (2007) because their presence has not been confirmed in Croatia. However, it is possible that these two species do occur in Croatia, since they are present in all of the surrounding countries (Pape & Beuk 2012; Horvat 1993b, 1995).

Species richness of both subfamilies varies between geographic regions in Europe. Clinocerinae have greater species richness in alpine streams and rivers (Vaillant 1981; Wagner & Gathmann 1996), but they are also more species rich in streams and rivers in the Dinarids (Horvat 1993b, 1995b, 1997; Ivković *et al.* 2007, 2010, 2012). The highest diversity of species is in the Dinaric western Balkan Ecoregion, usually at sites close to the source of the stream/river with constant water temperatures throughout the year. Cluster analysis showed that sites which are geographically closer and belong to the same reach of watercourses cluster together, while sites 24 (Selečki most, Odra, Turopolje), 61 (Kozjak Lake, NP Plitvice) and 63 (Lake Prošće, NP Plitvice) clustered remotely from all other sites. This is not surprising since majority of sampled sites have faster water velocity, or they are on the mountains, while site 24 is a typical slow lowland river and sites 61 and 63 are lakes. Sites that cluster together have similar physical and chemical characteristics of the water (especially the temperature) and therefore they have similar fauna (Ivković *et al.* 2007, 2012, unpublished data). The majority of species of *Wiedemannia* prefer sites with constant temperatures all year round, while species of *Hemerodromia* prefer sites where water temperatures during summer are > 20 °C.

Phenology patterns of aquatic dance flies in Croatia are similar to those from Central Europe (Wagner & Gathmann 1996). Species mostly occur in spring and summer, with the exception of *W. (C.) aequilobata* that emerges in colder part of the year (winter) and *Kowarzia barbatula* and *W. (E.) zetterstedti* that are present all year round.

Comparison with assemblages found in surrounding countries. The country of Croatia is divided into two Ecoregions, Dinaric western Balkan (Ecoregion 5) and Pannonic lowland (Ecoregion 11). The Pannonic lowland Ecoregion is mostly till plain with mountains sporadically appearing like islands. In contrast, the Dinaric western Balkan Ecoregion consists entirely of karstic mountain ranges with sporadically placed “karst polje” (fields in karstic regions of the world). Croatia supports at least 50 species, but this is definitely not the final number. Italy and Slovenia to the west support 63 species, respectively (Horvat 1995a; Pape & Beuk 2012). It appears that a continuous drop of species occurs from the west toward the east, from Italy to Hungary (Fig. 4). But this has to be taken with caution, because Slovenia has been very well studied (Horvat 1995a), whereas Bosnia & Herzegovina is only poorly known (Horvat 1993b).

Comparison of Sørensen's Index of Similarity suggested that Slovenian assemblages have the greatest similarity with the Croatian assemblage (Table 5). This was expected since the greatest species richness is found at sites located just on the border between the two countries, so they have many species in common. The lowest similarity is observed with Italy, perhaps because Croatia does not have Alps, while vast numbers of aquatic empidids are found in Italian Alps (Yang *et al.* 2007; Pape & Beuk 2012).

**FIGURE 4.** Comparison of Croatian aquatic Empididae assemblage with surrounding countries.**TABLE 5.** Sørensen Index of Similarity between aquatic dance fly assemblages for surrounding countries in relation to Croatia. Codes are HR = Croatia, SLO = Slovenia, B&H = Bosnia & Herzegovina, I = Italy, H = Hungary.

	HR	SLO	B&H	I	H
HR	0				
SLO	71.56	0			
B&H	57.14	51.61	0		
I	41.07	52.89	37.50	0	
H	54.95	58.00	58.67	52.43	0

Concluding remarks

The Croatian aquatic dance fly fauna comprise of Palearctic taxa with the exception of *C. stagnalis*, which is the most widespread clinocerine (known from North America, Asia, and North Africa) (Sinclair 2008). All the species are restricted to Europe and some of them are only found in Balkan Peninsula (e.g., *D. zwicki*, *W. (C.) ariadne*, *W. (P.) kacanskae*, *W. (W.) balkanica* and *W. (W.) dinarica*).

Some species have a small area of distribution, occurring in just one or two streams/rivers (e.g., *H. zwicki* and *W. (W.) kroatica*) and can be considered rare. They should be candidates for protection as should several stream reaches (primarily upper reaches) that support high numbers of species or assemblages that are rare. The fauna of Croatia is most closely aligned with Slovenian assemblages (Table 5). There are still some genera that have not been recorded in Croatia but might be present as they occur in surrounding countries (e.g., *Bergenstammia*, *Chelipoda*, *Phaeobalia* and *Phyllodromia*).

Croatian species are mostly univoltine occurring in spring and summer. The majority of species inhabit thermally constant waters and they prefer habitats close to source of the stream/river.

Within Croatia, most species were reported from the Dinaric western Balkan Ecoregion. This was as expected as Dinaric region is considered as a biodiversity “hot spot” (Kryštufek & Reed 2004). Current knowledge of the diversity of Croatian aquatic empidids is not truly realistic as it is strongly influenced by data from the area on which most research has focused during the last ten years.

The checklist presented here, only includes species for which there is good evidence for their existence in Croatia. As explained previously, we have omitted any ambiguous or doubtful data or references. This paper may serve as a baseline for planning future work, not only in Croatia, but also in surrounding countries with the lack of data on aquatic dance fly fauna (e.g., Montenegro).

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References

- Becker, T. (1889) Neue Dipteren aus Dalmatien. *Berliner Entomologische Zeitschrift*, 33, 335–346.
<http://dx.doi.org/10.1002/mmnd.47918890219>
- Bezzi, M. (1905) Clinocerae tres novae ex Europa. *Annales Historico-Naturales Musei Nationalis Hungarici*, 3, 362–366.
- Clarke, K.R. & Gorley, R.N. (2006) PRIMER v6: user manual/tutorial. Primer-E Ltd, Plymouth. Available from: https://www.google.co.nz/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCsQFjAA&url=ftp%3A%2F%2Fftp.ims.uaf.edu%2Fmueter%2FPERMANOVA%2FGetting%2520started%2520with%2520v6.doc&ei=Rp6_UczQD4-yiQeczYCwAg&usg=AFQjCNEWI8K0SMnithPbniDV6Ub4YGo90g&sig2=wO1t1C4Dw7ZbHFsrQRzSbQ&bvm=bv.47883778,d.aGc (Accessed 18 June 2013)
- Collin, J.E. (1927) Notes on the Empididae (Diptera) with additions and corrections to the British List. *Entomologist's Monthly Magazine*, 63, 2–29, 61–67, 93–98.
- Collin, J.E. (1961) *British Flies: Empididae: Empidinae (Part) and Hemerodrominae. Part III*. At the University Press, Cambridge, pp. 713–724.
- Costa, A. (1854) Frammenti di Entomologia Napolitana. Articolo 1. Nuovo specie di Ditteri. *Annali scientifici. Giornale di scienze fisiche, matematiche, agricoltura. Napoli*, 1, 69–91.
- Curtis, J. (1834) *British entomology; being illustrations and descriptions of the genera of insects found in Great Britain and Ireland: containing coloured figures from nature of the most rare and beautiful species, and in many instances of the plants upon which they are found*, 11, 482–529. [Privately published, London.]
<http://dx.doi.org/10.5962/bhl.title.8148>
- Dale, J.C. (1878) History of Glanville's Wootton. *Diptera*, 239–293.
- de Silva, H.G. & Medellín, R.A. (2001) Evaluating completeness of species lists for conservation and macroecology: a case study of Mexican land birds. *Conservation Biology*, 15, 1384–1395.
<http://dx.doi.org/10.1046/j.1523-1739.2001.00177.x>
- DeWalt, E.R., Cao, Y., Tweddle, T., Grubbs, S.A., Hinz, L., Pessino, M. & Robinson, J.L. (2012) Ohio USA stoneflies (Insecta, Plecoptera): species richness estimation, distribution of functional niche traits, drainage affiliations, and relationships to other states. *Zookeys*, 178, 1–26.
<http://dx.doi.org/10.3897/zookeys.178.2616>
- Engel, E.O. (1918) Das Dipterengenus *Atalanta* Mg. (*Clinocera* ol.). *Deutsche Entomologische Zeitschrift*, 1918, 1–80, 197–268.
- Engel, E.O. (1938–1946) 28. Empididae. In: Linder, E. (Ed.), *Die Fliegen der palaearktischen Region, Bd 4(4)*. E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nägele), Stuttgart, pp. 1–399.
- Fallén, C.F. (1815) *Empidiae Sveciae*. Lundae, 16 pp.
- Fallén, C.F. (1826) *Supplementum Dipterorum Sveciae*. Lundae, 16 pp.
- Haliday, A.H. (1833) Catalogue of Diptera occurring about Holywood in Downshire. *Entomological Magazine, London*, 1, 147–180.
- Harkrider, J.R. (2000) Predation of *Neoplasta* Coquillet larvae (Diptera: Empididae) on larval midges in the genus *Rheotanytarsus* Bause (Diptera: Chironomidae). *Pan-Pacific Entomologist*, 76, 176–183.
- Horvat, B. (1990) Aquatic dance flies of the subfamily Hemerodrominae (Diptera: Empididae) in Yugoslavia. *Scoparia*, 20, 1–27.
- Horvat, B. (1993a) A new *Hemerodromia* species from submediterranean Slovenia and Croatia (Diptera, Empididae: Hemerodromiinae). *Aquatic Insects*, 15, 229–231.
<http://dx.doi.org/10.1080/01650429309361524>
- Horvat, B. (1993b) Aquatic Empididae fauna (Diptera) in Bosnia and Herzegovina. *Scoparia*, 28, 1–25.
- Horvat, B. (1995a) Checklist of the aquatic Empididae recorded from Slovenia, with the description of one new species (Diptera). *Acta Entomologica Slovenica*, 3, 25–35.
- Horvat, B. (1995b) Aquatic Empididae Fauna (Diptera) in Macedonia. *Acta Musei Macedonici Scientiarum Naturalium*, 19, 147–170.
- Horvat, B. (1997) New records of aquatic Empididae (Diptera) from Macedonia. *Studia Dipterologica*, 4, 491–496.

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- Illies, J. (1978) *Limnofauna Europaea. A checklist of the Animals inhabiting European Inland Waters, with Account of their Distribution and Ecology*. G. Fischer, Stuttgart and Swets & Zeitlinger, Amsterdam, 532 pp.
- Ivković, M. & Horvat, B. (2007a) *Hemerodromia raptoria* (Meigen) a newly recorded species of aquatic dance flies (Diptera, Empididae) in Croatia and its distribution on Balkan Peninsula. *Natura Croatica*, 16, 79–82.
- Ivković, M. & Horvat, B. (2007b). Aquatic Dance flies (Diptera, Empididae: Clinocerinae, Hemerodromiinae) of the River Cetina. *Natura Croatica*, 16, 171–179.
- Ivković, M., Matoničkin Kepčija, R., Mihaljević, Z. & Horvat, B. (2007) Assemblage composition and ecological features of aquatic dance flies (Diptera, Empididae) in the Cetina River system, Croatia. *Fundamental and Applied Limnology*, 170, 223–232.
<http://dx.doi.org/10.1127/1863-9135/2007/0170-0223>
- Ivković, M., Miliša, M. & Mihaljević, Z. (2010) The aquatic dance flies fauna (Diptera, Empididae: Hemerodromiinae and Clinocerinae) of the Plitvice Lakes National Park. *Natura Croatica*, 19, 133–139.
- Ivković, M., Mičetić Stanković, V. & Mihaljević, Z. (2012) Emergence patterns and microhabitat preference of aquatic dance flies (Empididae; Clinocerinae and Hemerodromiinae) on a longitudinal gradient of barrage lake system. *Limnologica*, 42, 43–49.
<http://dx.doi.org/10.1016/j.limno.2011.07.003>
- Kryštufek, B. & Reed, J.M. (2004) Pattern and process in Balkan biodiversity - an overview. In: Griffiths, H.I., Kryštufek, B. & Reed, J.M. (Eds.), *Balkan Biodiversity: Pattern and Process in the European Hotspot*. Kluwer Academic Publishers, Dordrecht, pp. 1–8.
http://dx.doi.org/10.1007/978-1-4020-2854-0_1
- Loew, H. (1858) Ueber die Arten der Gattung *Clinocera* Meig. *Wiener Entomologische Monatschrift*, 2, 238–253.
- Loew, H. (1869) *Beschreibungen europäischer Dipteren. Systematische Beschreibung der bekannten europäischen zweiflügeligen Insecten, von Johann Wilhelm Meigen*. Halle, 1, 1–310.
<http://dx.doi.org/10.5962/bhl.title.13731>
- Loew, H. (1873) Diptera nova, in Pannonia inferiori et in confinibus Dacie regionsibus a Ferd. Kowarzio capta. *Berliner Entomologische Zeitschrift*, 17, 33–52.
- Macquart, J. (1835) *Histoire naturelle des insectes. Diptères. Tome deuxième. Ouvrage accompagné de planches*. Roret, Paris, 710 pp.
<http://dx.doi.org/10.5962/bhl.title.14274>
- Mandaron, P. (1964) Un nouveau Diptère récolté en Dauphiné *Wiedemannia (Chamaedipsia) aequilobata* n. sp. *Travaux du Laboratoire d'Hydrobiologie et de Pisciculture de l'Université de Grenoble*, 56, 81–84.
- Meigen, J.W. (1804) *Klassifikation und Beschreibung der europäischen zweiflügeligen Insecten (Diptera Linn.)*. Erster Band. Abt.I. xxviii + 152 pp. Abt.II. vi + pp. 153–314. Reichard, Braunschweig. Mik, J. (1880) Beschreibung neuer Dipteren. I. Eilf neue europäische *Clinocera*-Arten. *Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft*, 30, 347–358.
- Meigen, J.W. (1830) Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten. *Hamm*, 6, IV + 1–401.
<http://dx.doi.org/10.5962/bhl.title.13731>
- Mik, J. (1887) Diagnosen neuer Dipteren. *Wiener Entomologische Zeitung*, 6, 161–164.
- Mik, J. (1889) Eine neue, aus den Beskiden stammende Art der alten Gattung *Clinocera* Meig. *Wiener Entomologische Zeitung*, 8, 150–152.
- Nowicki, M. (1868) Beschreibung neuer Dipteren. *Verhandlungen Naturforschenden Vereins in Brünn*, 6, 70–97.
<http://dx.doi.org/10.5962/bhl.title.7902>
- Pape, T. & Beuk, P. (2012) *Fauna Europaea*. Available from: <http://www.faunaeur.org> (accessed 10 April 2013)
- Schiner, J.R. (1862) *Fauna Austriaca. Die Fliegen (Diptera)*, 1. Wien, LXXX + 672 pp.
<http://dx.doi.org/10.5962/bhl.title.8525>
- Sinclair, B.J. (1995) Generic revision of the Clinocerinae (Empididae), and description and phylogenetic relationships of the Trichopezinae, new status (Diptera: Empidoidea). *The Canadian Entomologist*, 127, 665–752.
<http://dx.doi.org/10.4039/ent127665-5>
- Sinclair, B.J. (2008) *The systematics of New World Clinocera Meigen (Diptera: Empididae: Clinocerinae)*. NRC Research Press, Ottawa, viii + 245 pp.
- Sivec, I. & Horvat, B. (2002) Vrbnice (Plecoptera) in vodne muhe poplesovalke (Diptera, Empididae) reke Dragonje. *Varstvo narave*, 19, 53–58.
- Vaillant, F. (1952) Un empidide destructeur de simulies. *Bulletin de la Société zoologique de France*, 76, 371–379.
<http://dx.doi.org/10.1007/bf00023589>
- Vaillant, F. (1953) *Hemerodromia seguyi*, nouvel d'Algérie destructeur de simulies. *Hydrobiologia*, 5, 180–188.
<http://dx.doi.org/10.1007/bf00023589>
- Vaillant, F. (1956) Quelques *Wiedemannia* de France nouveaux ou peu connus [Diptera Empididae]. *L'Entomologiste*, 12, 11–16.
<http://dx.doi.org/10.1051/limn/1986024>
- Vaillant, F. (1967) La répartition des *Wiedemannia* dans les cours d'eau et leur utilisation comme indicateurs de zones écologiques (Diptera, Empididae). *Annales de Limnologie*, 3, 267–293.
<http://dx.doi.org/10.1051/limn/1967016>

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- Vaillant, F. (1968) Quelques Empididae Hemerodromiinae des Pyrénées [Diptera]. *Annales de Limnologie*, 4, 85–93.
<http://dx.doi.org/10.1051/limn/1968013>
- Vaillant, F. (1981) Dipteres Empididae Hemerodromiinae nouveaux ou peu connus de la région palearctique. *Bonner Zoologische Beiträge*, 32, 351–408.
- Wagner, R. (1981) Über einige Hemerodromiinae vom Balkan und aus der Ägäis. *Spixiana*, 4, 297–304.
- Wagner, R. (1984) Notes on Empididae (3). Description of *Chelifera siveci* sp.n. *Aquatic Insects*, 6, 244.
<http://dx.doi.org/10.1080/01650428409361189>
- Wagner, R. (1995) Empididen aus dem Mittelmeerraum (Diptera, Empididae: Hemerodromiinae und Clinocerinae). *Acta Entomologica Slovenica*, 3, 5–23.
- Wagner, R. (1997) Diptera Dance fly, Dance Flies. In: Nilsson, A. (Ed.), *Aquatic Insects of North Europe, A taxonomic Handbook, Volumen 2*. Apollo Books, Stenstrup, pp. 333–344.
- Wagner, R. & Gathmann, O. (1996) Long-term studies on aquatic Dance Flies (Diptera, Dance fly) 1983–1993: Distribution and size patterns along the stream, abundance changes between years and the influence of environmental factors on the community. *Archive für Hydrobiologie*, 137, 385–410.
- Wahlberg, P.F. (1844) Nya Diptera från Norrbotten och Luleå Lappmark. *Öfversigt af K Vetenskapsakademicns förhandlingar*, 1, 106–110.
- Walker, F. (1851) Diptera. In: *Insecta Britannica*. Vol. 1. Reeve and Benham, London, 314 pp. + 10 pls.
<http://dx.doi.org/10.5962/bhl.title.29929>
- Werner, D. & Pont, A.C. (2003) Dipteran predators of Simuliid blackflies: a worldwide review. *Medical and Veterinary Entomology*, 17, 115–132.
<http://dx.doi.org/10.1046/j.1365-2915.2003.00431.x>
- Yang, D., Zhang, K.Y., Yao, G. & Zhang, J.H. (2007) *World catalog of Empididae (Insecta: Diptera)*. China Agricultural University Press, Beijing, 599 pp.
- Zetterstedt, J.W. (1838) Sectio tertia. Diptera. Dipterologis scandinaviae. amicis et popularibus carissimus. In: *Insecta Lapponica Lipsiae* (=Leipzig), pp. 477–868.
- Zetterstedt, J.W. (1842) Diptera Scandinaviae deposita et descripta. Lundae (Lund) 1, xvi + 1–440.
<http://dx.doi.org/10.5962/bhl.title.8143>