

Entomol. Croat. 2011, Vol. 15, Num. 1-4: 131-143

Proceedings of the XXII Symposium Internationale Entomofaunisticum Europae Centralis

STONEFLY (PLECOPTERA) FAUNA IN THE LOWER REACH OF THE UNA RIVER IN CROATIA

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Accepted: December 19th 2011

A study of the stonefly fauna on the left bank of the border river Una was carried out during April and May 2009, and from July to November 2010. Qualitative samples of adult Plecoptera were collected at nine different locations in the lower part of the Una River catchment area in Croatia. The aim of this study was to investigate the richness and the distribution of stoneflies along the lower reach of the Una River and its tributaries. The results are based on the identification of adult insects and only in a few cases were larvae and exuviae taken into consideration. Altogether, eleven species of stoneflies were recorded, from five families and ten different genera. Three belong to the family Nemouridae (*Amphinemura*, *Nemoura*, *Protonemura*), three to the family Perlodidae (*Besdolus*, *Isoperla*, *Perlodes*), two to the family Perlidae (*Marthamea*, *Perla*), one to the family Taeniopterygidae (*Brachyptera*), and one to the family Leuctridae (*Leuctra*). The location with the highest richness of stonefly fauna was the lower reach of Čatlan Stream, with five species recorded. The lowest richness of stonefly fauna (1 species) was recorded at the lowest Una River locality (250 m above the confluence with the Sava River in Jasenovac) and at the only spring locality (Jantalovića Spring). Despite the small number of recorded stonefly species in the study area, we found some remarkable species, which have not been recorded for quite a long time in many countries in Europe. *Marthamea vitripennis* was re-discovered again in Croatia after one century, together with *Perla burmeisteriana* and *Besdolus imhoffi*. These species are included on the list of 50 strictly protected Plecoptera species in Croatia. Therefore, the conservation of this important area should be one of the key concerns of environmental policies in Croatia and in Bosnia and Herzegovina.

Plecoptera, fauna, Una River, Croatia, Bosnia and Herzegovina

A. POPIJAČ i I. SIVEC: Fauna Plecoptera donjeg toka rijeke Une u Hrvatskoj. Entomol. croat. Vol. 15, Num. 1-4: 131-143.

Prvo istraživanje faune obalčara duž lijeve obale granične rijeke Une obavljano je u razdoblju od travnja do svibnja 2009. te od srpnja to studenog 2010. godine. Sakupljali smo kvalitativne uzorke odraslih jedinki Plecoptera na devet lokacija duž lijeve obale u donjem dijelu toka rijeke Une u Hrvatskoj. Većina vrsta dokumentirana je pomoću digitalne makro-fotografije. Cilj ovoga istraživanja bio je istražiti bogatstvo i rasprostranjenost obalčara donjeg toka rijeke Une i njenih pritoka u Hrvatskoj. Rezultati se uglavnom zasnivaju na identifikaciji odraslih jedinki, a samo u nekim slučajevima u obzir su uzimani svlakovi i ličinke. Zabilježeno je jedanaest vrsta iz pet porodica i deset različitih rodova obalčara: tri iz porodice Nemouridae (*Amphinemura*, *Nemoura*, *Protonemura*), tri iz porodice Perlodidae (*Besdolus*, *Isoperla*, *Perlodes*), dva iz porodice Perlidae (*Marthamea*, *Perla*), jedan iz porodice Taeniopterygidae (*Brachyptera*) te jedan iz porodice Leuctridae (*Leuctra*). Najveće bogatstvo faune obalčara s pet zabilježenih vrsta bila je u donjem toku potoka Čatlan. Najmanje bogatstvo (s jednom vrstom) zabilježeno je na najnižem lokalitetu na rijeci Uni (250 m uzvodno ušća u rijeku Savu kod Jasenovca) te na jedinom izvorskom lokalitetu (Jantalovića vrelo). Unatoč malom broju zabilježenih vrsta obalčara na istraživanom području, ipak smo pronašli neke značajne vrste koje već duže vrijeme nisu zabilježene u većini zemalja Europe. Tako je u Hrvatskoj nakon jednog stoljeća ponovo pronađena vrsta *Marthamea vitripennis* zajedno s vrstama *Perla burmeisteriana* i *Besdolus imhoffi*. Sve tri vrste nedavno su uključene na popis 50 strogo zaštićenih vrsta obalčara u Hrvatskoj. Zbog toga bi zaštita ovog značajnog područja prirode trebala biti među glavnim prioritetima u politici zaštite prirode i okoliša u Hrvatskoj te Bosni i Hercegovini.

Plecoptera, fauna, Una, Hrvatska, Bosna i Hercegovina

Introduction

Till recently, the Plecoptera fauna of Croatia was poorly known and the Una River was completely un-investigated. Only 28 species of Plecoptera were officially recorded for Croatia (Sivec, 1980, 1985) until the last few years, when we started intense studies on Plecoptera in Croatia. Currently, 50 stonefly species have been recorded (Popijač & Sivec, 2008, 2009a, b, c, 2010), based on determination of adult stages. Most likely, this number represents just a half of the actually present species in Croatia because, for example, for neighbouring Slovenia (Sivec, 2001) and Bosnia and Herzegovina (Kačanski, 1976) about 100 stonefly species are known (Fochetti & Tierno de Figueroa, 2011). The aim of this work was to study the diversity and the distribution of stoneflies along the lower reach of the Una River and its tributaries in Croatia.

Materials and Methods

Sampling sites comprise perennial springs, streams and rivers. Table 1 lists the exact localities, and Figures 1 and 2 show the sampling sites as well as the study area.

Table 1. Sampling sites in the lower reach of the Una River.

Abbreviation	Location	Elevation	Distance from confluence with Sava (km)
UJA	Una Jasenovac bridge	89	0.25
UDJ	Una between Dubica & Jasenovac	91	13
UDU	Una Dubica bridge	94	18
JV	Jantalovića vrelo (spring)	114	33 (0.45 into Una)
URO	Una Rosulje	101	36
UHK	Una Hrvatska Kostajnica bridge	104	41
UKO	Una Kozibrod	110	53
PC	Čatlan potok (stream)	116	56 (0.75 into Una)
ZDV	Žirovnica Dvor bridge	125	68 (1 into Una)



Figure 1. Terrain and watercourses map of Croatia with the study area.



Figure 2. Map of the study area with sampling sites in the lower reach of the Una River.

Qualitative samplings of adult Plecoptera, exuviae and larvae were conducted during April and May 2009, and from July to November 2010 at nine different locations in the lower part of the Una River catchment area in Croatia. All samples were fixed in 96 % ethyl alcohol. In the laboratory, we analyzed them with a stereomicroscope and stored them again in 96 % ethyl alcohol. For identification of stonefly species we used available literature of the nearest regions (Illies, 1955; Aubert, 1959, 1963; Kačanski & Zwick, 1970; Kis, 1974; Raušer, 1980; Ravizza, 2002; Graf & Schmidt-Kloiber, 2003; Zwick, 2004). The results are based mainly on identification of adult insects and only in some cases are larvae and exuviae taken into consideration. Nomenclature and systematics are according to Zwick (1973) and DeWalt et al. (2011). The collected material is stored mainly in the private Popijač Plecoptera Collection and some specimens are deposited in the Plecoptera Collection of the Slovenian Museum of Natural History in Ljubljana.

Results and Discussion

Our samplings along the lower reach of the Una River and its tributaries (Jantalovića Spring, Čatlan Stream and Žirovnica River) included eleven stonefly

species. Ten different genera from five families were recorded, three of which belong to the family Nemouridae (*Amphinemura*, *Nemoura*, *Protonemura*), three to the family Perlodidae (*Besdolus*, *Isoperla*, *Perlodes*), two to the family Perlidae (*Marthamea*, *Perla*), one to the family Taeniopterygidae (*Brachyptera*), and one to the family Leuctridae (*Leuctra*).

The location with the highest richness of stonefly fauna was the lower reach of the Čatlan Stream with five species recorded. The lowest richness of stonefly fauna (one species) was recorded at the lowermost locality on the Una River (250 m above the confluence with the Sava River in Jasenovac) and at one spring locality (Jantalovića Spring) (Table 2).

Table 2. Distribution of recorded stonefly species across sampling sites in the lower reach of the Una River with their abundance estimation: common (C), rare (R) and very rare (V).

	Species	UJA	UDJ	UDU	JV	URO	UHK	UKO	PC	ZDV
1.	<i>Marthamea vitripennis</i>	R	R	V	-	-	V	-	-	-
2.	<i>Perla burmeisteriana</i>	-	-	V	-	-	-	-	-	-
3.	<i>Besdolus imhoffi</i>	-	-	-	-	-	V	-	-	R
4.	<i>Perlodes microcephalus</i>	-	-	-	-	-	-	-	R	-
5.	<i>Brachyptera risi</i>	-	-	-	-	-	-	-	C	-
6.	<i>Amphinemura standfussi</i>	-	-	-	-	-	-	V	C	-
7.	<i>Isoperla grammatica</i>	-	-	-	-	C	-	-	C	-
8.	<i>Nemoura cinerea</i>	-	-	V	-	-	-	-	C	C
9.	<i>Nemoura marginata</i>	-	-	-	C	-	-	-	-	-
10.	<i>Protonemura intricata</i>	-	-	-	-	-	-	-	-	V
11.	<i>Leuctra fusca</i>	-	C	-	-	C	C	C	-	C
	Number of species:	1	2	3	1	2	3	2	5	4

A list of the recorded stonefly species with the Red List status in Croatia (Popijač, 2008) and the level of official protection in Croatia (Official Gazette, No. 99/2009) is presented in Table 3.

Table 3. List of recorded stonefly species with the Red list status in Croatia (Popijač, 2008) and the level of official protection in Croatia (Official Gazette, No. 99/2009).

	Species	Red list Croatia	Protection in Croatia
1.	<i>Marthamea vitripennis</i>	RE	strictly protected
2.	<i>Perla burmeisteriana</i>	EN	strictly protected
3.	<i>Besdolus imhoffi</i>	VU	strictly protected
4.	<i>Perlodes microcephalus</i>	DD	strictly protected
5.	<i>Brachyptera risi</i>	LC	protected
6.	<i>Amphinemura standfussi</i>	LC	protected
7.	<i>Isoperla grammatica</i>	DD	-
8.	<i>Nemoura cinerea</i>	LC	-
9.	<i>Nemoura marginata</i>	LC	-
10.	<i>Protonemura intricata</i>	LC	-
11.	<i>Leuctra fusca</i>	LC	-

Systematic list of stoneflies along the lower reach of the Una River and its tributaries

Order PLECOPTERA

Suborder ARCTOPERLARIA

Superfamily group EUHOLOGNATHA

Superfamily NEMOUROIDEA Newman, 1853

Family LEUCTRIDAE Klapálek, 1905

Subfamily LEUCTRINAE Klapálek, 1905

Genus *Leuctra* Stephens, 1836

1. *Leuctra fusca* (Linnaeus, 1758) (Figure 3)

- Material. Una between Dubica & Jasenovac, 16.09.2010, 6 larvae, leg. A. Popijač; Žirovnica Dvor bridge, 16.09.2010, 4 larvae, leg. A. Popijač; Una Rosulje, 24.10.2010, 3 ♂, 1 ♀, leg. A. Popijač; Una Hrvatska Kostajnica bridge, 24.10.2010, 2 ♂, leg. A. Popijač; Una Kozibrod, 24.10.2010, 3 ♂, leg. A. Popijač; Una Rosulje, 15.11.2010, 2 ♀, leg. A. Popijač; Una Hrvatska Kostajnica bridge, 15.11.2010, 5 ♂, 19 ♀, leg. A. Popijač.
- Comments. It is one of the most common stonefly species in all types of streams and rivers; it is very tolerant to organic pollution. Least Concern

(LC) according the Red List of Stoneflies (Plecoptera) of Croatia (Popijač, 2008). Not protected species in Croatia.



Figure 3. *Leuctra fusca* (Linnaeus, 1758) - Una Rosulje, 24.10.2010, 1 ♀ (Photo: A. Popijač). Least Concern (LC) and not a protected species in Croatia (Popijač, 2008)

Family NEMOURIDAE Newman, 1853

Subfamily AMPHINEMURINAE Baumann, 1975

Genus *Amphinemura* Ris, 1902

2. *Amphinemura standfussi* (Ris, 1902)

- Material. Čatlan potok (stream), 10.05.2009, 8 ♂, 7 ♀, leg. A. Popijač; Una Kozibrod, 20.05.2009, 1 ♂, leg. A. Popijač.
- Comments. Least Concern (LC) according the Red List of Stoneflies (Plecoptera) of Croatia (Popijač, 2008). Protected species in Croatia (Official Gazette, No. 99/2009).

Genus *Protonemura* Kempny, 1898

3. *Protonemura intricata* (Ris, 1902)

- Material. Žirovnica Dvor bridge, 10.05.2009, 1 ♂, leg. A. Popijač.
- Comments. Least Concern (LC) according the Red List of Stoneflies (Plecoptera) of Croatia (Popijač, 2008). Not protected species in Croatia.

Subfamily NEMOURINAE Newman, 1853

Genus *Nemoura* Latreille, 1796

4. *Nemoura cinerea* (Retzius, 1783)

- Material. Čatlan potok (stream), 05.04.2009, 3 larvae, leg. A. Popijač; Žirovnica Dvor bridge, 05.04.2009, 3 larvae, leg. A. Slavikovski; Una Dubica bridge, 10.05.2009, 1 ♀, leg. A. Popijač; Čatlan potok (stream), 10.05.2009, 6 ♀, leg. A. Popijač; Žirovnica Dvor bridge, 10.05.2009, 1 ♀, leg. A. Popijač; Žirovnica Dvor bridge, 24.10.2010, 1 larva, leg. A. Popijač.
- Comments. One of the most common stonefly species. It is very tolerant to organic pollution. In addition, it is one of few stonefly species living in standing water habitats as well as in streams and rivers. Least Concern (LC) according the Red List of Stoneflies (Plecoptera) of Croatia (Popijač, 2008). Not protected species in Croatia.

5. *Nemoura marginata* Pictet, 1835

- Material. Jantalovića vrelo (spring), 05.04.2009, 3 ♂, 2 ♀, leg. A. Popijač; Jantalovića vrelo (spring), 10.05.2009, 1 ♂, 5 ♀, leg. A. Popijač.
- Comments. Least Concern (LC) according the Red List of Stoneflies (Plecoptera) of Croatia (Popijač, 2008). Not protected species in Croatia.

Family TAENIOPTERYGIDAE Klapálek, 1905

Subfamily BRACHYPTERAINAE Zwick, 1973

Genus *Brachyptera* Newport, 1848

6. *Brachyptera risi* (Morton, 1896)

- Material. Čatlan potok (stream), 05.04.2009, 1 ♀, 2 exuviae, 21 larvae, leg. A. Slavikovski & A. Popijač; Čatlan potok (stream), 10.05.2009, 7 ♀, 18 exuviae, leg. A. Popijač.
- Comments. Least Concern (LC) according the Red List of Stoneflies (Plecoptera) of Croatia (Popijač, 2008). Protected species in Croatia (Official Gazette, No. 99/2009).

Superfamily group SYSTELLOGNATHA

Superfamily PERLOIDEA Latreille, 1802

Family PERLIDAE Latreille, 1802
Subfamily PERLINAE Latreille, 1802
Tribe PERLINI Latreille, 1802

Genus *Marthamea* Klapálek, 1907

7. *Marthamea vitripennis* (Burmeister, 1839) (Figure 4)

- Material. Una Jasenovac bridge, 10.05.2009, 7 exuviae, leg. A. Popijač; Una between Dubica & Jasenovac, 10.05.2009, 1 ♂, leg. I. Stanković & Z. Mihaljević; Una Dubica bridge, 10.05.2009, 2 ♀, 1 exuvia, leg. A. Popijač; Una Hrvatska Kostajnica bridge, 10.05.2009, 2 (♀) exuviae, leg. A. Popijač; Una Jasenovac bridge, 20.05.2009, 6 larvae, 1 exuvia, leg. A. Popijač; Una Jasenovac bridge, 03.06.2009, 2 ♀, leg. W. Graf, A. Previšić & I. Sivec; Una between Dubica & Jasenovac, 16.09.2010, 2 larvae (released), leg. A. Popijač; Una between Dubica & Jasenovac, 24.10.2010, 10 larvae (released), leg. A. Popijač.
- Comments. Re-discovered again in Croatia after one century (Sivec, 1985). Regionally extinct (RE) according the Red List of Stoneflies (Plecoptera) of Croatia (Popijač, 2008). Strictly protected species in Croatia (Official Gazette, No. 99/2009).



Figure 4. *Marthamea vitripennis* (Burmeister, 1839) - Una Jasenovac bridge, 03.06.2009, 1 ♀ (Photo: I. Sivec). Regionally extinct (RE) and strictly protected species in Croatia (Popijač, 2008; Official Gazette, No. 99/2009).

Genus *Perla* Geoffroy, 1762

8. *Perla burmeisteriana* Claassen, 1936

(synonym *Perla abdominalis* Burmeister, 1839)

- Material. Una Dubica bridge, 20.05.2009, 1 larva, leg. A. Popijač.
- Comments. Endangered (EN) according the Red List of Stoneflies (Plecoptera) of Croatia (Popijač, 2008). Strictly protected species in Croatia (Official Gazette, No. 99/2009).

Family PERLODIDAE Klapálek, 1909

Subfamily ISOPERLINAЕ Frison, 1942

Tribe ISOPERLINI Frison, 1942

Genus *Isoperla* Banks, 1906

9. *Isoperla grammatica* (Poda, 1761) (Figure 5)

- Material. Una Rosulje, 05.04.2009, 2 ♀, leg. A. Popijač; Čatlan potok (stream), 05.04.2009, 1 larva, leg. A. Popijač; Una Rosulje, 10.05.2009, 1 ♂, 1 ♀, 1 exuvia, leg. A. Popijač; Čatlan potok (stream), 10.05.2009, 6 exuviae, leg. A. Popijač.
- Comments. Data Deficient (DD) according the Red List of Stoneflies (Plecoptera) of Croatia (Popijač, 2008). Not protected species in Croatia.



Figure 5. *Isoperla grammatica* (Poda, 1761) - Una Rosulje, 05.04.2009, 1 ♀ (Photo: A. Popijač). Data Deficient (DD) and not a protected species in Croatia (Popijač, 2008).

Subfamily PERLODINAE Klapálek, 1909

Tribe PERLODINI Klapálek, 1909

Genus *Besdolus* Ricker, 1952

10. *Besdolus imhoffi* (Pictet, 1841)

- Material. Una Hrvatska Kostajnica bridge, 10.05.2009, 1 exuvia, leg. A. Popijač; Žirovnica Dvor bridge, 10.05.2009, 1 ♂, 2 ♀, leg. A. Popijač.
- Comments. Vulnerable (VU) according the Red List of Stoneflies (Plecoptera) of Croatia (Popijač, 2008). Strictly protected species in Croatia (Official Gazette, No. 99/2009).

Genus *Perlodes* Banks, 1903

11. *Perlodes microcephalus* (Pictet, 1833)

- Material. Čatlan potok (stream), 05.04.2009, 10 exuviae, leg. A. Popijač; Čatlan potok (stream), 10.05.2009, 3 exuviae, leg. A. Popijač.
- Comments. Data Deficient (DD) according the Red List of Stoneflies (Plecoptera) of Croatia (Popijač, 2008). Strictly protected species in Croatia (Official Gazette, No. 99/2009).

Conclusions

Altogether, 11 stonefly species were documented during spring 2009 and summer/autumn 2010 in the lower reach of the Una River and its tributaries in Croatia. Despite the small number of recorded stonefly species in the study area, we found some remarkable species, which have for some considerable time not been found in many countries in Europe. *Marthamea vitripennis* was re-discovered in Croatia after one century, together with *Perla burmeisteriana* and *Besdolus imhoffi*. These species are included on the list of 50 strictly protected Plecoptera species in Croatia. Therefore, conservation of this important area should be one of the key concerns of environmental policies in Croatia and in Bosnia and Herzegovina.

Acknowledgments

We wish to express our gratitude to Ana Slavikovski (2010 project co-leader for Ephemeroptera), Dr Bogdan Horvat, Igor Stanković, Professor Dr Zlatko Mihaljević, Dr Ana Previšić and Dr Wolfram Graf for help in collecting some

samples. We would like to thank to the Ministry of Interior of Republic of Croatia for the permission to collect below the bridges on the Una River, which serve as the official border passages between Croatia and Bosnia and Herzegovina. This research was financially supported by the State Institute for Nature Protection of Republic of Croatia as a part of two expert studies of the Association for Biological Research – BIOM: “Spring stoneflies (Plecoptera) in the lower reach of the Una River” (2009) and “Summer and autumnal fauna of stoneflies (Insecta: Plecoptera) and mayflies (Insecta: Ephemeroptera) in the lower reach of the Una River” (2010).

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