NAT. CROAT. | VOL. 25 | No 1 | 101–108 | ZAGREB | June 30, 2016

original scientific paper / izvorni znanstveni rad
DOI: 10.20302/NC.2016.25.6

CONTRIBUTION TO CROATIAN MAYFLY FAUNA (INSECTA: EPHEMEROPTERA)

Svjetlana Dekić*[1], Renata Ćuk[2] & Carlo Belfiore[3]

[1]Jurja Križanića 10, 44000 Sisak, Croatia (svjetlana.dekic@gmail.com)

[2]Hrvatske vode, Central Water Management Laboratory, Ulica grada Vukovara 220, 10000 Zagreb, Croatia

[3]DEB, Università della Tuscia, Largo dell'Università snc, I-01100 Viterbo, Italy

Dekić, S., Ćuk, R. & Belfiore, C.: Contribution to Croatian mayfly fauna (Insecta: Ephemeroptera). Nat. Croat., Vol. 25, No. 1, 101–108, 2016, Zagreb.

Caenis lactea (Burmeister, 1839) from the family Caenidae has been recorded for the first time in Croatia in the reservoirs of HPP Dubrava and Čakovec on the Drava River. Additionally, new data on distribution of the species *Heptagenia longicauda* (Stephens, 1836) and *Ephemerella mucronata* (Bengtsson, 1909) are presented.

Key words: *Caenis lactea*, *Heptagenia longicauda*, *Ephemerella mucronata*, Ephemeroptera, Mura River, Drava River, Croatia

Dekić, S., Ćuk, R. & Belfiore, C.: Doprinos poznavanju faune vodencvjetova Hrvatske (Insecta: Ephemeroptera). Nat. Croat., Vol. 25, No. 1, 101–108, 2016, Zagreb.

Vrsta *Caenis lactea* (Burmeister, 1839) iz porodice Caenidae po prvi puta je zabilježena u Hrvatskoj u akumulacijama HE Dubrava i Čakovec na rijeci Dravi. Također, u radu su prikazani i novi podaci o rasprostranjenosti vrsta *Heptagenia longicauda* (Stephens, 1836) i *Ephemerella mucronata* (Bengtsson, 1909).

Ključne riječi: *Caenis lactea*, *Heptagenia longicauda*, *Ephemerella mucronata*, Ephemeroptera, rijeka Mura, rijeka Drava, Hrvatska

INTRODUCTION

Mayflies (Ephemeroptera) are a very old insect order dating back to early Carboniferous and Late Permian (Brittain & Sartori, 2003). They spend most of their life in the larval stage. Imagos are short lived and emerge in large swarms (Giller & Malmqvist, 1998; Brittain & Sartori, 2003). They have a hemimetabolous life cycle, and are the only insects which moult one more time after emerging (Giller & Malmqvist, 1998; Brittain & Sartori, 2003). In aquatic habitats mayflies play an important role as primary consumers, feeding on the periphyton, macrophytes or fallen leaves participating in nutrient circulation. They also serve as an important prey for numerous predators, while some species are even predators themselves (Sartori & Landolt, 1999). Mayfly larvae of different species vary greatly in their tolerance to oxygen concentration and are sensitive to acid conditions, which makes them good bio-indicators of water quality (Giller & Malmqvist, 1998).

So far, 3045 mayfly species have been recorded worldwide, belonging to 405 genera and 42 families (Barber-James *et al*., 2008). In Europe and North Africa, 369 species occur

* corresponding author

(Bauernfeind & Soldán, 2012) and in in Croatia, 79 species have are known from literature data (Bauernfeind & Soldán, 2012; Kovács & Murányi, 2013; Ćuk *et al*., 2015) and recent mayfly studies (Vilenica *et al*., 2014, 2015).

The main goal of this paper is to present the first record of the mayfly *Caenis lactea* (Burmeister, 1839) and to enrich the knowledge about the Croatian mayfly fauna by providing new data on the distribution of two mayflies, *Heptagenia longicauda* (Stephens, 1836) and *Ephemerella mucronata* (Bengtsson, 1909).

MATERIAL AND METHODS

Study area

Sampling was conducted at two sites on the Drava River in August 2015: the reservoirs of HPP Čakovec (S1) and Dubrava (S2), and at two sites on the Mura River in February 2015: Mursko Središće (S3) and Goričan (S4) (Figs. 1, 2). According to Croatian river typology, both the Mura River and the reaches of the Drava River studied are classified as Very large lowland rivers – lower reaches of the Mura River and middle reaches of the Sava and Drava Rivers (Narodne Novine, 73/13, 151/14).

The Drava River, with a total length of 749 km and a catchment area of 42238 km^2 (Narodne Novine, 91/08), flows through five European countries: Italy, Austria, Slovenia, Croatia and Hungary. The length of the Drava River in Croatia is 323 km, 136 km forming the Croatian-Hungarian border. It has rainy-glacial hydrological regime with low water

Fig. 1. Map of Croatia with the study sites in the Drava and Mura Rivers.

Fig. 2. The study sites. a) Drava River at the reservoir of HPP Čakovec (Photo I. Stanković); b) Drava River at the reservoir of HPP Donja Dubrava (Photo I. Stanković); c) Mura River near Mursko Središće (Photo M. Miličić); d) Mura River near Goričan (Photo M. Miličić).

quantities in winter and higher in late spring and early summer. Up to the year 1970, 19 hydropower plants were constructed in Austria and Slovenia on the Drava River. Several years later, another three were built in the Croatian part of the River: HPP Varaždin in 1975 (area of the reservoir is 3.0 km^2), HPP Čakovec in 1982 (area of the reservoir is 10.5 km^2) and HPP Dubrava in 1989 (area of the reservoir is 16.6 km^2) (Režek, 2003).

The Mura River is 493 km long, 83 km which run through Croatian territory (Narodne Novine, 91/08). It emerges in Austria at 1898 meters a.s.l, runs through Slovenia and Hungary, and in Croatia it flows into the Drava River at the city of Legrad. The river is characterised by numerous changing branches and meanders.

After the Mura River received the category of a Protected Landscape in 2001, in 2011 it became a Regional Park together with the Drava River. Finally, in 2012 the whole area of the Drava, Mura and Danube Rivers were categorized as the UNESCO Transboundary Biosphere Reserve (Šafarek & Šolić, 2011; Popović Dujmović, 2013).

Sampling and laboratory methods

The samples of benthic macroinvertebrates were collected according to the AQEM protocol (Hering *et al*., 2004) with a hand net (mesh size 500 μm) and preserved with ethanol up to the final concentration of 80 %. Sample sorting and determination of macroscopic invertebrates was done in the laboratory using a stereo microsope (Olympus

Tab. 1. List of dominant substrates and phytal coverage at the study sites at the Drava and Mura Rivers.

Sites	Dominant substrate	Phytal coverage (%)
S1 reservoir of HPP Čakovec	akal, psammopelal	100
S2 reservoir of HPP Dubrava	mesolithal, microlithal, akal, technolithal	30
S3 Mura Mursko Središće	microlithal, akal, psammopelal	0
S4 Mura Goričan	microlithal, akal, psammopelal, technolithal	0

SZX9). Specimens of interest were photographed with a Canon EOS 1100D STL digital camera and stored. Dominant substrates at all study sites together with phytal coverage are presented in Tab. 1 (HRN EN 16150, 2012).

RESULTS AND DISCUSSION

The list of all recorded mayfly taxa is presented in Tab. 2. The most interesting finding is the record of *Caenis lactea* (Burmeister, 1839) (Fig. 3a) which was found at both study sites on the Drava River: 14 specimens at site S1 and 4 specimens at S2. Since, according to Vilenica *et al.* (2015), this species has never been recorded in Croatia, this finding represents the first record for the Croatian mayfly fauna. *C. lactea* can be distinguished from other species of the genus *Caenis* by one row of microtrichia on the plate of the second gill (Fig. 3b) and a pointed last abdominal segment (Fig. 3c) (Bauernfeind &

Tab. 2. List of all recorded mayfly taxa at study sites at the Drava and Mura Rivers, *new record. The abbreviations of the study sites are presented in Tab. 1.

Taxa	S1	S2	S3	S4
Baetidae Gen. sp.		●		
Baetis rhodani (Pictet, 1843)				●
Baetis sp.			●	●
Caenis lactea (Burmeister, 1839)*	●	●		
Caenis gr. *macrura*	●	●		
Cloeon sp.	●			
Epeorus assimilis (Eaton, 1871)				●
Ephemera sp.		●		
Ephemerella mucronata (Bengtsson, 1909)				●
Heptagenia coerulans Rostock, 1877			●	
Heptagenia longicauda (Stephens, 1836)				●
Heptagenia sulphurea (Müller, 1779)			●	●
Leptophlebiidae Gen. sp.				●
Rhithrogena semicolorata (Curtis, 1834)			●	●
Rhithrogena sp.			●	

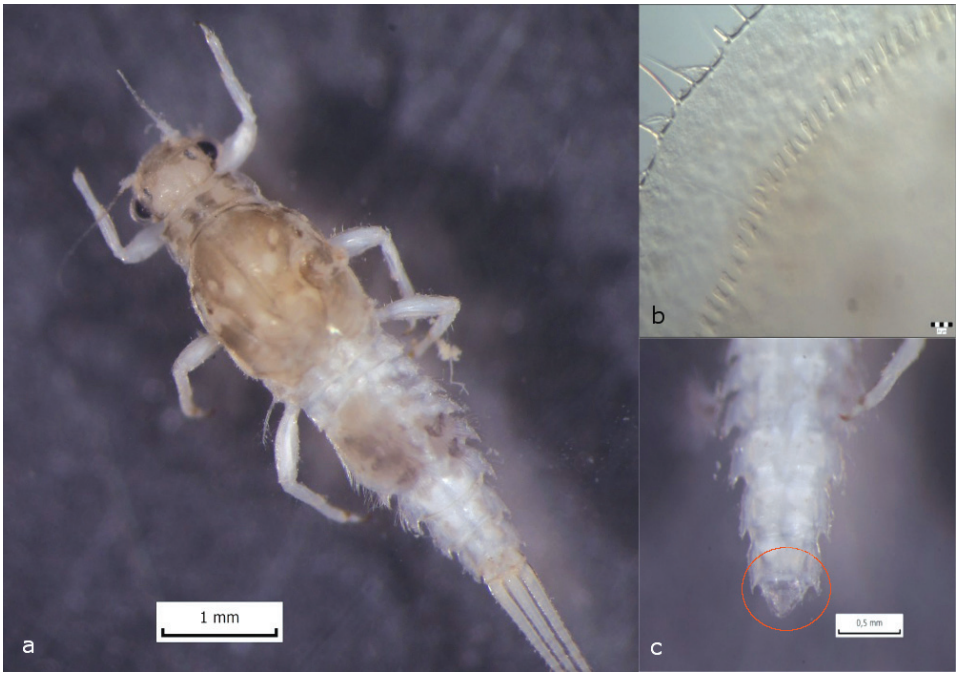

Fig. 3. *Caenis lactea*, larva: a) body dorsal; b) second gill plate microtrichia; c) last abdominal segment ventral (red circle).

Humpesch, 2001; Eisler, 2005). The species has a wide European distribution (Fig. 4) (Thomas & Belfiore, 2013), occurring in still water, preferably lakes, but it can also be occasionally found in the potamalic section of rivers (Mol, 1983). Furthermore, *C. lactea* was recorded from a backwater of the River Drava ('Drau') in Austria (Weichselbaumer *et al*., 2015).

At the same sites on the Drava River we have also recorded larvae from the *Caenis macrura* group.

Other interesting findings are of *Heptagenia longicauda* (Stephens, 1836) and *Ephemerella mucronata* (Bengtsson, 1909) in the Mura River, which were both recorded for the first time in Croatia in recent research (Vilenica *et al*., 2015).

A single larva each of *H. longicauda* and *E. mucronata* were found at site S4 (Figs 5, 6; Tab 2). *H. longicauda* larvae are, like other representatives of the same genus, potamobionts, usually inhabiting stones, gravel, floating trunks and branches in the potamal section of large rivers. It avoids places of poor water quality as does *Heptagenia coerulans* Rostock, 1878 (Vidinova & Russev, 1997; Sartori & Landolt, 1999). In some countries, like Germany, Sweden, Switzerland, the Netherlands and United Kingdom, the species is considered to be extremely rare due to the great anthropogenic stress, such as habitat alteration and pollution (Sartori & Landolt, 1999; Nijboer *et al*., 2004; Macadam, 2006).

In Croatia, *H. longicauda* was previously recorded at only one site – Bukovska Dobra River at Turkovići, located in the Dinaric western Balkan ecoregion (ER5) (Vilenica *et al*., 2015). Our finding in the Mura River is the first one in the Pannonian lowland ecoregion (ER11) (Illies, 1978).

Fig. 4. a) Distribution of *C. lactea* in Europe with records in Croatia (red spots); b) detail of the study area (Thomas & Belfiore, 2013).

Concerning other interesting findings of the Heptageniidae family representatives, we have recorded *H. coerulans* in the Mura River at site S3, which is also a notable contribution to the species distribution.

Larvae of *E. mucronata* are usually rheophilic, cold adapted and prefer aquatic vegetation, especially moss (Bauernfeind & Soldán, 2012). Consequently, they have mostly been recorded in high mountain streams and rivers (Bauernfeind & Humpesch, 2001). Vilenica *et al*. (2015e recorded the species at four sites which all, according to Croatian river typology, belong to mid-altitude and highland rivers (Narodne Novine 73/13, 151/14). Therefore, it is interesting that this species was recorded in the Mura River, which is classified as a very large lowland river. Kovács *et al*. (1998, 2002) suggestee accidental occurrence in lowland rivers caused by floods.

Findings from this study, as well as insufficient data on mayfly fauna from the whole Pannonian ecoregion indicate that future systematic research should be focused on that part of the country.

ACKNOWLEDGEMENT

Many thanks to Mladen Plantak, MSc and Ivan Vučković, PhD from Elektroprojekt d.o.o., Zagreb for designing the maps.

Received September 18, 2015

REFERENCES

Barber-James, H. M., Gattolliat, J.-L., Sartori, M. & Hubbard, M. D., 2008: Global diversity of Mayflies (Ephemeroptera, Insecta) in freshwater. Hydrobiologia (The Hague) **595**, 339–350.

Bauernfeind, E. & Humpesch, U. H., 2001: Die Eintagsfliegen Zentraleuropas (Insecta: Ephemeroptera). Bestimmung und Ökologie. Naturhistorisches Museum Wien, Austria, p. 239.

Bauernfeind, E. & Soldán, T., 2012: The Mayflies of Europe (Ephemeroptera). Apollo Books, Ollerup, Denmark, p. 781.

Brittain, J. E. & Sartori, M., 2003: Ephemeroptera (Mayflies). In Resh V. H. & Cardé, R.T. 8 eds, Encyclopedia of insects. Academic Press, Amsterdam, p. 373–380.

Ćuk, R., Čmrlec, K. & Belfiore, C., 2015: The first record of *Ametropus fragilis* Albarda, 1878 (Insecta: Ephemeroptera) from Croatia. Natura Croatica **24** (1), 151–157.

Eisler, B., 2005: Bildbestimmungsschlüssel für die Eintagsfliegenlarven der deutschen Mittelgebirge und des Tieflandes. Lauterbornia, **53**, 1–112.

Giller, P. S. & Malmqvist, B., 1998: The Biology of Streams and Rivers. – Oxford University Press, Oxford, United Kingdom, p. 296.

Hering, D., Moog, O., Sandin, L. & Verdonschot, P. F. M., 2004: Overview and application of the AQEM assessment system. Hydrobiologia (The Hague) **516**, 1–20.

HRN EN 16150, 2012: Water quality – Guidance on pro-rata Multi-Habitat sampling of benthic macroinvertebrates from wadeable rivers, p. 12.

Illies, J., 1978: Limnofauna Europaea. Gustav Fischer Verlag, Stuttgart and New York, 532 p.

Kovács, T., Ambrus, A., Bankuti, K. & Juhasz, P., 1998: New Hungarian mayfly (Ephemeroptera) species arising from collectings of larvae. Miscellanea Zoologica Hungarica **10**, 69–72.

Kovács, T., Bauernfeind, E., Ambrus, A. & Reisinger, W., 2002: New Records of Mayflies from Austria (Insecta: Ephemeroptera). Linzer biologische Beiträge, **34** (2), 1035–1042.

Kovács, T. & Murányi, D., 2013: New country data of some mayflies (Ephemeroptera) from Europe. Folia Historico Naturalia Musei Matraensis 37: 15–19.

Narodne Novine, 2008: Strategija upravljanja vodama (Water Management Strategy). No. 91/08.

Narodne Novine, 2013: Uredba o standardu kakvoće voda (Regulation on water quality standard). No.73/13.

Narodne Novine, 2014: Uredba o izmjenama i dopunama uredbe o standardu kakvoće voda (Regulation on amendments to the Regulation on water quality standard). No. 151/14.

Nijboer, R. C., Johnson, R. K., Verdonschot, P. F. M., Sommerhäuser, M. & Buffagni, A., 2004: Establishing reference conditions for European streams. Hydrobiologia **516,** 91–105.

Macadam, C. R., 2006: The current status of *Heptagenia longicauda* (Stephens, 1835) (Ephemeroptera: Heptagenidae). Entomologist's monthly magazine, **142**, 163–167.

Mol, A. W. M., 1983: *Caenis lactea* (Burm.) in the Netherlands (Ephemeroptera: Caenidae). Entomologische berichten, **43**, 119–123.

Popović Dujmović, I., 2013: Sedam riječnih čuda Hrvatske, WWF brošura.

Režek, D., 2003: Hidroelektrane na Dravi. Građevinar **55** (11): 647–653.

Sartori, M. & Landolt, P., 1999: Atlas de distribution des Ephemeres de Suisse (Insecta, Ephemeroptera). Fauna helvetica 3, Centre suisse de cartographie de la faune (CSCF/SZKF), Scherizerische Entomologische Gesellschaft (SES/SEG) Neuchâtel, Switzerland, p. 214.

Šafarek, G. & Šolić, T., 2011: Rijeke Hrvatske – Veda, Križevci, Croatia, p. 326.

Thomas, A. & Belfiore, C., 2013: Fauna Europea: Ephemeroptera. Fauna Europaea version 2.6.2., http://faunaeur.org (accessed on October 20th, 2015).

Vidinova, Y. & Russev, B., 1997: Distribution and ecology of the representatives of some Ephemeropteran families in Bulgaria. – In: Ephemeroptera & Plecoptera: Biology-Ecology-Systematics, MTL, Fribourg, Switzerland, 139–146.

Vilenica, M., Gattolliat, J.-L., Ivković, M., Kučinić, M., Mičetić Stanković, V., Mihaljević, Z. & Sartori, M., 2014: The mayfly fauna (Insecta: Ephemeroptera) of the Plitvice lakes National park, Croatia. Natura Croatica **23** (2), 349–363.

Vilenica, M., Gattolliat, J.-L., Mihaljević, Z. & Sartori, M., 2015: Croatian mayflies (Insecta, Ephemeroptera): species diversity and distribution patterns. ZooKeys **523**, 99–127.

Weichselbaumer, P., Bauernfeind, E. & Leitner, P., 2015: Aktualisierte Liste der aus Österreich nachgewiesenen Eintagsfliegenarten (Insecta: Ephemeroptera). Updated checklist of the mayflies (Ephemeroptera) of Austria. Lauterbornia, **80**, 127–142.

SAŽETAK

Doprinos poznavanju faune vodencvjetova Hrvatske (Insecta: Ephemeroptera)

S. Dekić, R. Ćuk & C. Belfiore

Vodencvjetovi (Ephemeroptera) su vodeni kukci koji većinu svog života provode u ličinačkom stadiju. Odrasli oblici žive kratko i izlijeću u velikim rojevima. U Hrvatskoj su istraživanja vodencvjetova malobrojna. Ovim radom nastojimo doprinijeti poznavanju rasprostranjenosti vodencvjetova u Hrvatskoj prvim pronalaskom vrste *Caenis lactea* (Burmeister, 1839) u Hrvatskoj. Vrsta je pronađena u kolovozu 2015. godine u akumulacijama HE Dubrava i Čakovec na rijeci Dravi. Tipična je vrsta koja naseljava jezera i sporotekuće rijeke. U rijeci Muri u veljači 2015. godine pronašli smo i vrste *Heptagenia longicauda* (Stephens, 1836), koja je tada po prvi puta zabilježena u Panonskoj ekoregiji i *Ephemerella mucronata* (Bengtsson, 1909), vrstu koja inače preferira brze tekućice na većim nadmorskim visinama.