WHAT IS NEW IN CROATIAN MAYFLY FAUNA?

MARINA VILENICA1,* , IVANČICA TERNJEJ2 & ZLATKO MIHALJEVIĆ2

1University of Zagreb, Faculty of Teacher Education, Trg Matice hrvatske 12, Petrinja
2University of Zagreb, Faculty of Science, Department of Biology, Rooseveltov trg 6, Zagreb, Croatia

Vilenica, M., Ternjej, I. & Mihaljević, Z.: What is new in Croatian mayfly fauna? Nat. Croat., Vol. 30, No. 1, 73–83, 2021, Zagreb.

Here we present a first record of *Baetis vardarensis* Ikonomov, 1962 in Croatian freshwater habitats. The species was collected in February and March 2020 at two sites in the Sava River. With this record, Croatian mayfly species richness increased to a total of 85 species. In addition, one of the species previously known only from literature, *Kageronia fuscogrisea* (Retzius, 1783), was confirmed in Croatia. The species was collected in the Rečica River, in March 2020. These results confirm that our knowledge about mayfly fauna in different regions of Balkan Peninsula is still incomplete and is increasing with systematic studies.

Key words: Ephemeroptera, Baetidae, new records, Heptageniidae, species richness, Balkan Peninsula

INTRODUCTION

The species rich mayfly fauna of freshwater ecosystems in the area of North and Central Europe is nowadays well-known, due to long-term systematic studies (e.g. Bauernfeind & Humpesch, 2001; Bauernfeind & Moog, 2000; Bauernfeind & Soldán, 2012; Sartori & Landolt, 1999). For instance, 140 mayfly species have been recorded in Slovakia (Derka, 2003), 113 species in Germany (Haybach & Malzacher, 2003). On the other hand, more detailed faunistic and especially ecological studies of mayflies in the Balkan Peninsula started only approximately two decades ago, and our knowledge is far from complete (e.g. Petrović et al., 2015; Vidinova, 2003; Vilenica et al., 2015; 2016; 2017, 2018a, b; 2019; 2020). Many regions are still rather poorly and unevenly investigated. For instance, in the Balkans, the highest number of mayfly species

*Corresponding author: marina.vilenica@gmail.com, marina.vilenica@ufzg.hr
was recorded for Bulgaria (102, Vidinova, 2003), followed by that for Serbia (85, Petrović et al. 2015), Macedonia (80, Rimcheska, 2020), Slovenia (75, Zabric & Sartori, 1997), Greece (70, Bauernfeind, 2003), and Bosnia and Herzegovina (51, Bauernfeind & Soldán, 2012), reflecting the different durations and levels of systematic research. Therefore, discoveries of new species data can be expected with more frequent surveys.

In Croatia, mayfly-focused research started less than a decade ago (e.g. Vilenica et al., 2015, 2016, 2017; 2018a, b, 2019, 2020). Until then, published data on mayflies were largely parts of various limnological studies that focused mainly on benthic macroinvertebrates and their communities (e.g. Habdija & Primc, 1987; Habdija et al., 1994, 2004; Matonjičkin, 1987; Matonjičkin & Pavletić, 1967). In most of these studies, the identification literature used was not cited, and voucher specimens are not available. Therefore, these identifications could not be verified. Only 51 mayfly species were recorded in Croatia during this period (Bauernfeind & Soldán, 2012; Ćuk et al., 2015; Kovács & Murányi, 2013, Wagner et al. 2011). Vilenica et al. (2015) published the first checklist of mayflies in Croatia and increased this number by 29 additional taxa. However, as a much higher sampling effort was devoted to the Dinaric Western Balkan ecoregion (ER 5; Illies, 1978), the Pannonian lowland assemblages remained rather neglected (ER 11). Vilenica et al. (2015) suggested that it was highly likely that rare, new and taxonomically interesting findings would be recorded in future studies. This proved to be true, and so far, further studies have resulted in 4 new species records (Vilenica et al., 2016, 2019), showing a total of 84 mayfly species for the country.

Many freshwater habitats in the Balkan Peninsula are subject to various anthropogenic pressures: rivers and streams are hydromorphologically modified, numerous hydroelectric power plants are built, and springs are often captured for drinking water supply. In addition, many habitats are exposed to various types of urban, pharmaceutical and agricultural pollution (Lucić et al., 2015; Previšić et al., 2020; Schwarz, 2012; Vilenica et al., 2020). Such activities significantly alter freshwater habitats and their connectivity, i.e. they change the flow regime, water quality, and habitat geomorphology, and enable the establishment of non-native or invasive species. This negatively impacts aquatic organisms, leading to changes in species diversity and composition, homogenization, and even extinction (e.g. Vilenica et al., 2019, 2020). Therefore, in order to properly protect habitats and their biota, it is essential to conduct a qualitative assessment and to have a good knowledge of the species that inhabit them.

MATERIALS AND METHODS

Study area

The territory of Croatia is included in two limno-ecological regions: the Dinaric Western Balkan Ecoregion (ER 5) and the Pannonian Lowland Ecoregion (ER 11) (Illies, 1978). The study area is located in the Croatian part of the ER11. The area is characterised by a temperate humid climate with warm summers (Cfb, Köppen classification). The average temperature of the warmest month is below 22 °C (Šegota & Filipčić, 2003), while the average annual air temperature is around 12 °C. The average annual precipitation is between 800 and 1100 mm (Zaninović et al., 2008).
Sampling and mayfly identification

The study sites are part of the national monitoring program. Macroinvertebrates, including mayfly nymphs, were collected according to the AQEM protocol (AQEM expert consortium 2002), using a benthos hand net (25 × 25 cm; mesh size = 500 μm). At each site, 20 subsamples proportional to the microhabitats present were collected and pooled into one composite sample. Substrates consisted mainly of fine sediment (sand, silt, mud), lithal (stones, gravel), and aquatic vegetation (submerged and emergent), and detailed substrate composition of the study sites are presented in Tab. 1.

At each locality, physico-chemical water parameters were measured (water temperature, dissolved oxygen concentration, oxygen saturation, conductivity, pH) (Tab. 1). Collected samples were stored in 96% alcohol and analysed in the laboratory.

Mayfly nymphs were identified using the relevant identification keys: Bauernfeind & Humpesch (2001) and Müller-Liebenau (1969). All voucher specimens are deposited in the Department of Biology, Faculty of Science, University of Zagreb, Croatia.

RESULTS AND DISCUSSION

As part of the national monitoring of lotic habitats in the Pannonian Lowland ecoregion (Illies, 1978), which included small, medium and large rivers, we recorded a new species for the Croatian mayfly fauna; Baetis vardarensis Ikonomov, 1962. The nymphs were collected on 25th February 2020 along the Sava River in Rugvica (X 478969, Y 5067424), and on 20th March 2020 on the same river but at the site in Jankomir (X 450190, Y 5072319) (Figs. 1 and 2). This record increased the number of mayfly species in Croatia, which now counts 85 species in total (Vilenica et al., 2015, 2016, 2019, Wagner et al., 2011). The current species list is presented in Tab. 2.

Baetis vardarensis (Fig. 3a) is a widespread species, recorded from the Iberian Peninsula to the Caucasus (Bauernfeind & Soldán, 2012). The species’ range is considered to overlap with the morphologically similar species from the same species.
Fig. 1. Map of Croatia, with localities where *Baetis vardarensis* and *Kageronia fuscogrisea* were recorded.

Fig. 2. Habitats of *Baetis vardarensis*: a) Sava River, Jankomir and b) Sava River, Rugvica. Habitat of *Kageronia fuscogrisea*: c) Rečica River.
group, *Baetis lutheri* Müller-Liebenau, 1967. Although the two species are morphologically similar, there are certain differences such as the shape of the labrum bristles, the third segment of the labial palp, the bristles on the posterior margin of the femora, the length of the paracercus (*Bauernfeind & Humpesch, 2001, Bauernfeind & Soldán, 2012; Müller-Liebenau*, 1969).

The biology and ecology of *B. vardarensis* are still poorly known, but the nymphs of this rheophile species have previously been recorded in the epipotamal sections (lower reaches) of large rivers (*Bauernfeind & Soldán, 2012; Buffagni et al., 2009; 2020), where it usually replaces *B. lutheri*, which prefers rhithral sections (upper reaches) (*Bauernfeind & Soldán, 2012; Haybach, 1998; 2006; Sartori & Landolt, 1999). In contrast to *B. lutheri*, which prefers macrophytes and gravel (*Bauernfeind & Soldán, 2012; Vilenica et al., 2018b), *B. vardarensis* was most frequently recorded on lithal substrates (*Buffagni et al., 2009; 2020), which was also the case at localities in the Sava River. More precisely, at the Sava River site at Jankomir the species was collected from small and large pebbles (2–20 cm) (i.e. meso- and microlithal), and at the Sava River in Rugvica from artificial substrate, concrete tiles (i.e. technolithal). Literature data show that sometimes it can also occur on fine to medium-sized gravel (akal) or macrophytes (*Buffagni et al., 2009; 2020*). Our findings of the species at 100–115 m a.s.l. confirm literature data showing that it occurs in the altitudinal range mainly up to the 800 m a.s.l. (*Buffagni et al., 2009; 2020*). Despite the previous research conducted on several large lowland rivers in Croatia, including the Sava River (*Lucić et

Fig. 3a) *Baetis vardarensis* (Inside the red circle is one of the ventral protuberances next to the coxae. Those are pointed in *B. vardarensis*, while in *Baetis lutheri* are rounded (*Müller-Liebenau, 1974*); b) *Kageronia fuscogrisea*. Both species are in dorsal view.
### Tab. 2. Updated checklist of Croatian mayflies. Legend: * – newly recorded species, ** – taxa whose presence in Croatia should be confirmed. Checklist is based on the recent literature (e.g. Vilenica et al. 2015, 2016, 2017, 2018a, b, 2019, 2020; Wagner et al., 2011).

| Family       | Taxa                                                                 |
|--------------|----------------------------------------------------------------------|
| Ametropodidae| *Ametropus fragilis* Albarda, 1878                                   |
| Ameletidae   | *Aneletus inopinatus* Eaton, 1887 **                                 |
|              | *Metreletus balcanicus* (Ulmer, 1920) **                             |
| Siphlonuridae| **Siphlonurus aestivalis** Eaton, 1903                               |
|              | **Siphlonurus annatus** Eaton, 1870 **                               |
|              | **Siphlonurus croaticus** Ulmer, 1920                                |
|              | **Siphlonurus lacustris** Eaton, 1870                                |
| Baetidae     | *Alainites muticus* (Linnaeus, 1758)                                 |
|              | *Baetis alpinus* (Pictet, 1843)                                      |
|              | *Baetis buceratus* Eaton, 1870                                       |
|              | *Baetis fuscatus* (Linnaeus, 1761)                                   |
|              | *Baetis liebenauae* Keffermüller, 1974                              |
|              | *Baetis lutheri* Müller-Liebenau, 1967                              |
|              | *Baetis melanonyx* (Pictet, 1843)                                    |
|              | *Baetis cf. nubecularis* Eaton, 1898                                 |
|              | *Baetis pentaphlebodes* Ujhelyi, 1966                                |
|              | *Baetis rhodani* (Pictet, 1843)                                      |
|              | *Baetis scambus* Eaton, 1870                                         |
|              | *Baetis tricolor* Tshernova, 1928                                    |
|              | **Baetis vardarensis** Ikonomov, 1962 *                             |
|              | *Baetis vernus* Curtis, 1834                                         |
|              | *Baetopus tenellus* (Albarda, 1878)                                  |
|              | *Nigrobaetis nigra* (Linnaeus, 1761)                                 |
|              | *Centroptilum luteolum* (Müller, 1776)                               |
|              | *Cloeon dipterum* (Linnaeus, 1761)                                   |
|              | *Cloeon simile* Eaton, 1870                                          |
|              | *Procloeon bifidum* (Bengtsson, 1912)                               |
|              | *Procloeon nana* (Bogoescu, 1951)                                    |
|              | *Procloeon pennulatum* (Eaton, 1870)                                 |
| Caenidae     | *Brachycercus harrisellus* Curtis, 1834                              |
|              | *Caenis beskindsis* Sowa, 1973                                       |
|              | *Caenis horaria* (Linnaeus, 1758)                                    |
|              | *Caenis luctuosa* (Burmester, 1839)                                  |
|              | *Caenis macrura* Stephens, 1835                                     |
|              | *Caenis pusilla* Navás, 1913                                         |
|              | *Caenis rivulorum* Eaton, 1884                                       |
|              | *Caenis robusta* Eaton, 1884                                         |
| Ephemerellidae| *Ephemerella mucronata* (Bengtsson, 1909)                           |
|              | *Eurylophella karelica* Tiensuu, 1935                               |
|              | *Serratella ignita* (Poda, 1761)                                     |
|              | *Torleya major* (Klapalek, 1905)                                     |
| Family       | Taxa                                                                 |
|-------------|----------------------------------------------------------------------|
| Ephemeridae | *Ephemera danica* Müller, 1764                                       |
|             | *Ephemera glaucops* Pictet, 1843                                      |
|             | *Ephemera lineata* Eaton, 1870                                        |
|             | *Ephemera cf. parnassiana* Demoulin, 1958 **                          |
|             | *Ephemera vulgata* Linnaeus, 1758                                     |
|             | *Ephemera zettana* Kimmins, 1937                                      |
| Palingeniidae| *Palingenia longicauda* (Olivier, 1791) **                             |
| Polymitarcyidae| *Ephoron virgo* (Olivier, 1791) **                                  |
| Leptophlebiidae | *Choroterpes picteti* (Eaton, 1871) **                                |
|             | *Habroleptoides confusa* Sartori & Jacob, 1986                        |
|             | *Habrophlebia fuscus* (Curtis, 1834)                                 |
|             | *Habrophlebia lauta* Eaton, 1884                                      |
|             | *Leptophlebia marginata* (Linnaeus, 1767)                             |
|             | *Leptophlebia vespertina* (Linnaeus, 1758)                            |
|             | *Paraleptophlebia submarginata* (Stephens, 1835)                     |
|             | *Paraleptophlebia werneri* Ulmer, 1920                                |
| Oligoneuriidae| *Oligoneuriella rhenana* (Imhoff, 1852)                              |
| Potamanthidae| *Potamanthus luteus* (Linnaeus, 1767)                                |
| Heptageniidae | *Ecdyonurus aurantiacus* (Burmeister, 1839) **                      |
|             | *Ecdyonurus dispar* (Curtis, 1834)                                   |
|             | *Ecdyonurus insignis* (Eaton, 1870)                                  |
|             | *Ecdyonurus macani* Thomas & Sowa, 1970                              |
|             | *Ecdyonurus siweci* Hefti, Tomka & Zurwerra, 1986 **                 |
|             | *Ecdyonurus starmachi* Sowa, 1971                                    |
|             | *Ecdyonurus submontanus* Land, 1969                                   |
|             | *Ecdyonurus torrentis* Kimmins, 1942                                 |
|             | *Ecdyonurus venosus* (Fabricius, 1775)                               |
|             | *Ecdyonurus vitosensis* Jacob & Braasch, 1984                         |
|             | *Ecdyonurus zelleri* (Eaton, 1885)                                   |
|             | *Electrogena affinis* (Eaton, 1883)                                  |
|             | *Electrogena lateralis* (Curtis, 1834)                               |
|             | *Electrogena mazedonica* (Ikonomov, 1954) **                         |
|             | *Electrogena ujhelyii* (Sowa, 1981)                                  |
|             | *Epeorus assimilis* Eaton, 1885                                       |
|             | *Heptagenia coerulans* Rostock, 1878                                 |
|             | *Heptagenia flava* Rostock, 1878                                      |
|             | *Heptagenia longicauda* (Stephens, 1835)                             |
|             | *Heptagenia sulphurea* (Müller, 1776)                                |
|             | *Kageronia fuscogrisea* (Retzius, 1783)                              |
|             | *Rhithrogena braschi* Jacob, 1974                                    |
|             | *Rhithrogena gr. diaphana*                                           |
|             | *Rhithrogena germanica* Eaton, 1885 **                                |
|             | *Rhithrogena iridina* (Kolenati, 1839)                               |
|             | *Rhithrogena semicolorata* (Curtis, 1834)                            |
al., 2015; Matoničkin et al., 1975; Mihaļjević et al., 1998), the species has not been recorded. It is possible that it was overlooked if it was collected in very juvenile stages, or that it was mistaken for *B. lutheri*. As mentioned above, they are very similar at all stages (Bauernfeind & Soldán, 2012). Also, Petrović et al. (2015) did not record it at downstream sites of the Sava River in Serbia, but it was collected from the Kolubara River, one of the largest right tributaries of the Sava River. Nevertheless, the species was recorded at upstream sites of the Sava River in Slovenia (ARSO, 2011; Zabric & Sartori, 1997).

Many of the species’ habitats across Europe are nowadays exposed to various anthropogenic pressures (e.g. Dolisy & DoHet, 2003; Kail et al., 2012). For instance, several threats have been identified only for the Sava River, such as habitat degradation (water regulation, impoundment, sedimentation), hydrological changes, disruption of longitudinal and lateral connectivity, desiccation of riparian ecosystems, organic and nutrient pollution, biological invasion (Lucić et al., 2015). Baetidae is a mayfly family that shows a wide range of the sensitivity of the species to organic pollution, with *B. vardarensis* being one of the more tolerant species (Dolisy & DoHet, 2003). Moreover, it was listed by Kail et al. (2012) as an indicator taxon for a high proportion of urban land use in the upper reaches of German low mountain rivers. Nevertheless, some of the well-studied countries, such as Germany, listed the species as endangered in their Red Lists due to multiple and increasing anthropogenic threats (HayBach & Malzacher, 2003), while recent studies show that it is extremely rare (Orendt et al., 2019). Therefore, it is important to continue monitoring the species and habitat quality.

As part of this survey, another interesting species was recorded on March 10, 2020: *Kageronia fuscogrisea* (Retzius, 1783) (Fig. 3b). The nymphs were collected at the Rečica River (X 434829, Y 5038250) (Figs. 1 and 2), before its confluence with the Kupa River. The species was previously mentioned only by Bauernfeind & Soldán (2012), who noted its presence in Croatia but without specifying the exact localities. Therefore, this record represents a confirmation of the species’ occurrence in Croatian waters. The species has a Palaearctic distribution. Its broad range spreads from East Asia (far East Russia) westwards through the whole of Europe, and southwards from Macedonia to Great Britain and Ireland (Bauernfeind & Soldán, 2012). This limno-rheophilous species (Buffagni et al., 2009; 2020) mostly occurs in lowland lakes and ponds, but it also inhabits slow-flowing streams (Bauernfeind & Soldán, 2012), as in our case. It has a high potamal preference, although it has been recorded from the epithithral to the metapotamal. Regarding the microhabitats, at Rečica River, fine sediments (argyllal, i.e. mud and clay) dominate. In previous studies, the species was mostly found on lithal substrates and macrophytes (Bauernfeind & Soldán, 2012; Buffagni et al., 2009; 2020). Our results confirmed that this is a typical lowland species, mostly found on sites below 300 m a.s.l. (Buffagni et al., 2009; 2020). Our records may contribute to the knowledge of habitat and microhabitat preferences of the species in Croatian freshwater habitats.

The Balkan Peninsula is considered a biodiversity hotspot (e.g. Griffiths et al., 2004; Ivković & Plant, 2015), encompassing a wide range of freshwater habitats where a very high number of rare and endemic species occur. Therefore, these habitats are of not only local and national but also global importance in terms of biodiversity conservation (Freyhof, 2012; Schwarz, 2012). At the same time, since these habi-
tats are highly threatened by anthropogenic activities, it is important to restore and protect them in order to conserve this diversity. Systematic studies such as this one not only increase our knowledge of the fauna of a given region, but also contribute to our knowledge of the ecology of species and their distribution patterns. Therefore, we would like to emphasize the importance of systematic studies and continuous monitoring of habitats and species, as this could provide a valuable background for further research and conservation practice.

ACKNOWLEDGEMENTS

We thank our colleagues from the University of Zagreb (Faculty of Science, Department of Biology, Division of Zoology) for their indispensable assistance during field investigations and for help with sorting the collected material. We also thank Croatian Waters for funding the research conducted. Miran Katar is thanked for help with the artwork.

Received January 6, 2021

REFERENCES

AQEM consortium, 2002: Manual for application of the AQEM system. A comprehensive method to assess European streams using benthic macroinvertebrates, developed for the purpose of the Water Framework Directive. Version 1.0, February 2002. Contract No: EVK1 CT1999-00027.

ARSO, 2011: Izvajanje monitoringa za ekološko stanje vodotokov v letu 2010– Bentoški nevretenčarji. Agencija Republike Slovenije za okolje.

BAUERNFEIND, E., 2003: The mayflies of Greece (Insecta: Ephemeroptera): a provisional check list. In: Gaino E, editor. Research Update on Ephemeroptera and Plecoptera. Perugia, Italy: University of Perugia. p. 99–107.

BAUERNFEIND, E., & HUMPESCH, U. H., 2001: Die Eintagsfliegen Zentraleuropas – Bestimmung und Ökologie. Verlag NMW, Wien. p. 1–240.

BAUERNFEIND, E., & MOOG, O., 2000: Mayflies (Insecta: Ephemeroptera) and the assessment of ecological integrity: a methodological approach. Hydrobiologia 422, 71–83.

BAUERNFEIND, E., & SOLDÁN, T., 2012: The mayflies of Europe (Ephemeroptera). Apollo Books. Ollerup, Denmark. p. 1–781.

BUFFAGNI, A., ARMANINI, D. G., CAZZOLA, M., ALBA-TERCEDOR, J., LÓPEZ-RODRÍGUEZ, M. J., MURPHY, J., SANDIN, L. & SCHMIDT-KLOIBER, A., 2020: Dataset “Ephemeroptera” www.freshwaterecology.info – the taxa and autecology database for freshwater organisms, version 7.0 (accessed on 26.12.2020).

BUFFAGNI, A., CAZZOLA, M., LÓPEZ-RODRÍGUEZ, M. J., ALBA-TERCEDOR, J. & ARMANINI, D. G., 2009: Distribution and Ecological Preferences of European Freshwater Organisms. Volume 3 – Ephemeroptera. SCHMIDT-KLOIBER, A. & D. HERING (eds), Pensoft Publishers (Sofia-Moscow). p. 1–254.

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

DERRKA, T., 2003: Súpis druhov vodných bezstavovcov (makrovertebrát) Slovenska- Ephemeroptera [Checklist of Slovak aquatic macroinvertebrates – Ephemeroptera]. In: Šporka, F., editor. Vodné bezstavovce (makrovertebráta) Slovenska, súpis druhov a autokologické charakteristiky. Slovak aquatic macroinvertebrates, checklist and catalogue of autecological notes. Bratislava: Slovenský hydrometeorologický ústav. p. 33–37.

DOLISY, D. & DOHET, A., 2003: The use of Ephemeroptera to assess aquatic biodiversity in the rhithral part of the Luxembourgish rivers. In: Research Update on Ephemeroptera & Plecoptera. p. 299–203.

FREYHOFF, J., 2012: Threatened freshwater fishes and molluscs of the Balkan, potential impact of hydropower projects, unpublished report, ECA Watch Austria and EuroNatur. p. 1–81.
GRiffiths, H. I., KrySTufek, B. & Reed, J. M., 2004: Balkan Biodiversity. Pattern and Process in the European hotspot. Kluwer Academic Publishers, Dordrecht. p. 1–191.

HarDJia, I. & PrimC, P., 1987: Biocenotical Classification of the Lithoreophilous Communities in the Karst Running Waters According to the Macro Benthic fauna. Acta hydrochimica et hydrobiologica 15 (5), 495–503.

HarDJia, I., PRimC-HarDJia, B. & Belinic, I., 1994: Functional Community Organization of macroinvertebrates in Lotic Habitats of the Plitvice lakes. Acta hydrochimica et hydrobiologica 22 (2), 85–92.

HarDJia, I., PRimC-HarDJia, B., Matoničkin, R., Kučinić, M., Radanović, I., Milša, M. & Mihaljević, Z., 2004: Current velocity and food supply as factors affecting the composition of macroinvertebrates in bryophyte habitats in karst running water. Biologija 59 (5), 577–593.

Havbach, A. & Malzacher, P., 2003: Verzeichnis der Eintagsfliegen (Ephemeroptera) Deutschlands. Entomofauna Germanica 6, 33–46.

Havbach, A., 1998: Die Eintagsfliegen (Insecta: Ephemeroptera) von Rheinland-Pfalz – Zoogeographie, Faunistik, Ökologie, Taxonomie und Nomenklatur – Unter besonderer Berücksichtigung der Familie Heptageniidae und unter Einbeziehung der übrigen aus Deutschland bekannten Arten.- 417 SS. + 129 S. Anhang. Dissertation Universität Mainz.

Havbach, A., 2006: Ein Schlüssel für die Weibchen der Gattung Electrogena Zurwerra & Tomka, 1985 in Deutschland (Insecta: Ephemeroptera), nebst einem Gattungsschlüssel für die Weibchen der Familie Heptageniidae. Mainzer naturwissenschaftliches Archiv 43, 39–44.

Illies, J., 1978: Limnofauna Europaea. Gustav Fischer Verlag, Stuttgart and New York. p. 1–532.

Ivković, M. & plant, a., 2015: Aquatic insects in the Dinarides: identifying hotspots of endemism and species richness shaped by geological and hydrological history using Empididae (Diptera). Insect Conservation and Diversity. http://dx.doi.org/10.1111/icad.12113.

Kail, J., Arle, J. & Jähnig, S. C., 2012: Limiting factors and thresholds for macroinvertebrate assemblages in European rivers: empirical evidence from three datasets on water quality, catchment urbanization, and river restoration. Ecological Indicators 18, 63–72.

Matoničkin, I., 1987: Građa za limnofaunu krških voda tekućica Hrvatske. Biosistematika 13(1), 25–35. (In Croatian).

Matoničkin, I. & Pavletic, Z., 1967: Hidrologija potočnog Sistema Plitvičkih jezera i njegove ekološko-biocenološke značajke. Krš Jugoslovije, JAZU, Zagreb 5, 83–126. (In Croatian).

Mihaljević, Z., Kerovec, M., Tavčar, V. & Bukvić, I., 1998: Macroinvertebrate community on an artificial substrate in the Sava river: Long-term changes in the community structure and water quality. Biologia 53, 611–620.

Müller-Liebenau, I., 1969: Revision der europäischen Arten der Gattung Baetis Leach, 1815. (Insecta, Ephemeroptera). Gewässer und Abwasser 66/67, 95–101

Orendt, C., Schöpfelder, J. & Langner, D., 2019: Revised overview of the mayflies (Ephemeroptera) in Brandenburg state (Germany, Central European Lowlands) after 11 years of running water monitoring–Checklist, revised Red List and distribution data. Lauterbornia 86, 61–77.

Petrović, A., MiLOSEVIĆ, D., PAUNOVIĆ, M., SIMIĆ, S., DORJEVIĆ, N., Stokković, M. & SIMIĆ, V., 2015: New data on the distribution and ecology of the mayfly larvae (Insecta: Ephemeroptera) of Serbia (central part of the Balkan Peninsula). Turkish Journal of Zoology 39, 195–209.

Previšić, A., Rožman, M., Mor, J.-R., Acună, V., Serra-Compte, A., Petrović, M. & Sabater, S., 2020: Aquatic macroinvertebrates under stress: Bioaccumulation of emerging contaminants and metabolomics implications. Science of The Total Environment 704, 135333, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2019.135333.
Rimcheska, B., 2020: A check list of the mayfly fauna (Insecta; Ephemeroptera) of the Republic of North Macedonia with a short literature review. Acta Musei Macedonici Scientiarum Naturalium 23, 51–60.

Sartori, M. & Landolt, P., 1999: Atlas de distribution des Ephémères de Suisse (Insecta, Ephemeroptera). Fauna helvetica 3. SEG-CSCF ed., Neuchâtel. p. 1–214.

Schwarz, U., 2012: Balkan Rivers – The Blue Heart of Europe, Hydromorphological Status and Dam Projects, Report. Vienna, Austria. p. 1-151.

Šegota, T. & Filipčić, A. 2003: Köppenova podjela klima i hrvatsko nazivlje. Geoadria 8(1), 17–23. (In Croatian).

Vidinova, Y. 2003: Contribution to the study of mayfly fauna (Ephemeroptera) in Bulgaria. In: Gaino, E., editor. Research Update on Ephemeroptera and Plecoptera. Perugia, Italy: University of Perugia p. 159–163.

Vilenica M, Gattollat J-L, Mihaljević Z, & Sartori M (2015) Croatian mayflies (Insecta, Ephemeroptera): species diversity and distribution patterns. ZooKeys 523, 99–127. DOI: 10.3897/zook.eys.523.6100.

Vilenica, M., Brigić, A., Kerovec, M., Gottstein, S. & Ternjej, I., 2016: Spatial distribution and seasonal changes of mayflies (Insecta, Ephemeroptera) in a Western Balkan peat bog. ZooKeys 637, 135–149.

Vilenica, M., Mičetić Stanković, V., Sartori, M., Kučinić, M., & Mihaljević, Z., 2017: Environmental factors affecting mayfly assemblages in tufa-depositing habitats of the Dinaric Karst. Knowledge and Management of Aquatic Ecosystems 418(14), 1–12.

Vilenica, M., Ergović, V., & Mihaljević, Z., 2018a: Mayfly (Ephemeroptera) assemblages of a Pannonian lowland mountain, with first records of the parasite Symbiocladius rhithrogenae (Zavrel, 1924) (Diptera: Chironomidae). Annales de Limnologie – International Journal of Limnology 54(31), 1–10.

Vilenica, M., Brigić, A., Sartori, M. & Mihaljević, Z., 2018b: Microhabitat selection and distribution of functional feeding groups of mayfly larvae (Ephemeroptera) in lotic karst habitats. Knowledge and Management of Aquatic Ecosystems 419(17), 1–12.

Vilenica, M., Vučković, N., & Mihaljević, Z., 2019: Littoral mayfly assemblages in South-East European man-made lakes. Journal of limnology 70(1), 1–13.

Vilenica, M., Kerovec, M., Pozojević, I. & Mihaljević, Z., 2020: Mayfly response to different stress types in small and mid-sized lowland rivers. Zooclines 980, 57–77.

Zabrig, D. & Sartori, M., 1997: First contribution to the mayfly fauna from Slovenia (Ephemeroptera). In: Landolt, P., Sartori, M. (eds.), Ephemeroptera and Plecoptera, Biology-Ecology-Systematics. Fribourg, Switzerland: MTL. p. 147–151.

Zaninović, K., Gajić-Čapka, M., Perčec Tadić, M., Vučetić, M., Milkojić, J., Bajić, A., Čindrić, K., Cvitan, L., Katusin, Z., Kučinić, D., Likso, T., Lončar, E., Lončar, Ž., Mihaljević, D., Pandžić, K., Patarčić, M., Srnc, L., Vučetić, V., 2008: Klimatski atlas Hrvatske / Climate atlas of Croatia 1961–1990., 1971–2000. Državni hidrometeorološki zavod, Zagreb. p. 1–200. (In Croatian).