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A CONTRIBUTION TO THE KNOWLEDGE OF CADDISFLIES (INSECTA, TRICHOPTERA) OF SPRINGS IN THE DINARIC KARST OF CROATIA

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In this research 55 species of caddisflies belonging to 33 genera and 13 families were identified in 23 springs in the Dinaric area of Croatia. The Dinaric karst region is recognized as an area of exceptional biodiversity and endemism. The species *Crunoecia irrorata* (Curtis, 1834) was found in the spring in Kamensko, in the area of Lička Plješevica, and that is the first finding of this species in Croatia. The largest number of species was determined at the spring Keljevac (14 species) and the spring in Rudanovac village (14 species). The species *Drusus croaticus* Marinkovic-Gospodnetic, 1971 was found in most of the locations.

Keywords: South-east Europe, aquatic habitats, aquatic insects, *Crunoecia irrorata*

Žalac, S. & Kučinić, M.**: Doprinos poznavanju tulara (Insecta, Trichoptera) izvora u dinarskom kršu Hrvatske. Nat. Croat., Vol. 31, No. 2, 303-324, 2022, Zagreb.**

U sklopu ovog istraživanja tulara na području Dinarskog krša Hrvatske u 23 izvora utvrđeno je 55 vrsta iz 33 roda i 13 porodica. Regija Dinarskog krša prepoznata je kao područje iznimne bioraznolikosti i endemizma. Na izvoru na Kamenskom, na području Ličke Plješevice, utvrđena je vrsta *Crunoecia irrorata* (Curtis, 1834), što je prvi nalaz ove vrste za područje Hrvatske. Najveći broj vrsta utvrđen je na izvorima Keljevac (14 vrsta) i izvoru u mjestu Rudanovac (14 vrsta). Vrsta *Drusus croaticus* Marinkovic-Gospodnetic, 1971 utvrđena je na najviše lokaliteta (8).

Ključne riječi: jugoistočna Europa, vodena staništa, vodeni kukci, *Crunoecia irrorata*

INTRODUCTION

The Balkan peninsula, the south-eastern part of Europe, has very great biological diversity (Ivković & Plant, 2015; Kryštufek *et al*., 2007; Sket, 2002; Sket *et al*., 2001), not only because of the particular characteristics of its climate, geology and geomorphology, but also because of the geological processes that occurred in the past (Bilandžija *et al*., 20132013; Previšić et al., 2014b). Within the Balkan peninsula, a particularly interesting part is the 650 km-long area of Dinaric karst, which extends from Slovenia in the north-west to Albania in the south-east (Bilandžija *et al*., 2013) (Fig. 1). In the last two decades, a considerable number of scientific studies have been published on the fauna, the distribution, taxonomy, phylogeny and phylogeography of the aquatic insects of this area (Gligorović *et al*., 2010; Ivković & Plant, 2015; Malicky, 2005; Vilenica *et al*., 2015; Živić *et al*., 2009), including Trichoptera (Malicky, 2005, 2014; Ma-

rinković-Gospodnetić, 1970, 1971, 1976, 1978, 1979; Oláh, 2010, 2011; Previšić *et al*., 2014a, 2014b; Valladolid *et al*., 2021).

Caddisflies are one of the most abundant insect orders in terrestrial aquatic biotopes. They are found in almost all types of freshwater habitats, although their biodiversity is the greatest in streams and small rivers (Wallace *et al*., 1996). As compared with other groups of aquatic insects, they demonstrate great biodiversity and numbers of species, which is a consequence of their ability to adapt to various life conditions in aquatic habitats and to adjust to various types of diet (Solem & Gullerfors, 1996). They are also one of the key bioindicator groups of organisms, along with Plecoptera and Ephemeroptera, in the assessment of the ecological condition of diverse freshwater habitats, including springs (Hlebec et al., 2021; Vilenica *et al*., 2015).

Investigations of the Trichoptera of the Dinaric part of the karst of Croatia have included, to a certain extent, the springs, making a considerable contribution to the knowledge of Trichopteran fauna (e.g. Cerjanec *et al.,* 2020; Kučinić *et al.,* 2017; Malicky *et al.,* 2007; Previšić *et al*., 2007, 2009, 2014a; Vučković *et al.,* 2021; Waringer *et al.,* 2009). Springs are unique freshwater habitats in which communities with a specific composition and structure develop, often rich in endemic and relict species (Hlebec *et al.,* 2021; Ibrahimi *et al.,* 2015, 2016; Ivković *et al.,* 2013, 2015; Marinković-Gospodnetić 1970, 1971, 1979). Certain species are adapted only to the ecological conditions characteristic of spring habitats, such as constant water temperature in all seasons.

There are various possibilities of categorising springs, for example, into the limnocrene and the rheocrene (Habdija & Primc, 2019) or perennial and intermittent (Stubbington et al., 2017). Unlike perennial springs, at intermittent springs, a small number of species is recorded, which is consistent with the characteristics of communities of aquatic insects in lasting and occasional springs (Stubbington *et al.,* 2017). In intermittent springs, an insect community is usually composed of tolerant, widely distributed species, and species with a life cycle adapted to a specific hydrological regime (Stubbington *et al.,* 2017). Research into the aquatic insects in limnocrene and rheocrene springs (Ivković *et al.,* 2018; Kučinić *et al*., 2017) shows various faunal compositions conditioned by various ecological factors (velocity of flow for instance).

The aim of the current study is to: 1) make a contribution to the knowledge of Trichopteran fauna in the 23 studied springs, 2) draw particular attention to the species most interesting from a faunistic point of view, 3) draw attention to certain aspects of the threats to springs and their fauna.

MATERIAL AND METHODS

Study area

The Dinaric karst is geographically and geologically a part of the Dinarides range, which extends over about 60,000 square kilometres, forming the biggest uninterrupted karstic continuity in Europe (Mihevc *et al.,* 2010). It lies between the Pannonian basin in the north-east and the Adriatic Sea in the south-west, covering an area over 650 km long and 200 km wide (Mihevc *et al*., 2010) (Fig. 1), from Slovenia in the north east to Albania in the south west (Fig. 1).

In Croatia the Dinaric karst occupy the mountain regions of Istria, Gorski Kotar, Lika, Hrvatsko primorje [littoral] and Dalmatia, with the island chain from the Kvarner Gulf

to the Dubrovnik littoral (Bonacci, 2015). The karstic area comprises 49% of the total area of Croatia, with its 27,683 square kilometres (Bonacci, 2015). In addition to those areas in which the karst is geographically and morphologically integral in Croatia, it also occupies smaller stretches in the land between the Sava and the Drava (Bonacci, 2015). In the area of the Dinaric karst, rivers and streams, because of the porous nature of the rock, in their flow along the surface, often disappear into the underground or actually remain in underground spaces, creating reservoirs of water or flow through the underground, ultimately reappearing on the surface in the form of karstic springs (Božičević, 1992). In its passage through the underground and on the surface, it will dissolve the rock, creating the typical karstic relief (Božičević, 1992).

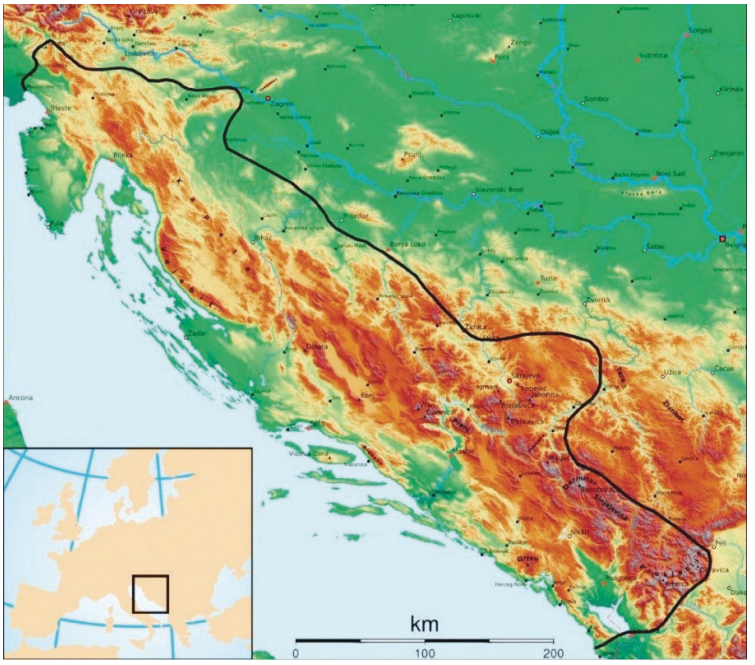

Fig. 1. Approximate borders of Dinaric karst (after Hajna, 2019).

Field and laboratory work

During the period 2015-2020 caddisflies adults were sampled at 23 springs (Figs. 2–3, A–F, Tab. 1). Fifteen springs belong to the Black Sea basin and 8 to the Adriatic basin (Tab. 1). Eight springs are limnocrene, 13 are rheocrene, one of the springs belongs to the helocrene type, and one is a fountain type of spring (Tab. 1). The collecting of samples was done at all localities with portable 12V UV lamps and in 4 localities (spring of Drakulić river, Crna rijeka spring, spring of the Sušanj stream and Stipinovac spring) also with emergence pyramid-traps (see about this in Kučinić, 2002; Previšić *et al*., 2007). Sampling with UV lamps was done at 23 locations, one hour at each location, three times a year. Collecting the material from emergence pyramid-traps was done monthly, in the first few days of the month. Caddisflies were also collected in all of the 23 locations from the surrounding vegetation with an entomological net. Sampling with UV light traps and entomological net was done in the warmer part of the year

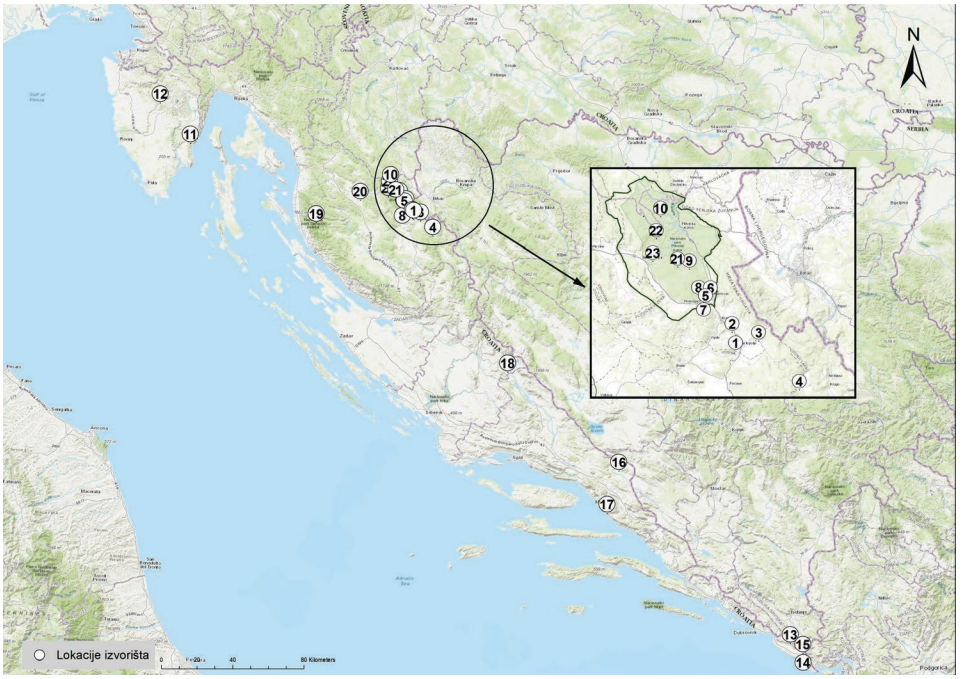

Fig. 2. Studied springs: 1. Keljevac spring, 2. spring in Jasikovac village, 3. Crkva Ružica spring, 4. on Kamensko spring, 5. Vrelo Koreničko spring, 6. spring in Rudanovac village, 7. Stipinovac spring, 8. spring of the Drakulić river, 9. Napojište spring, 10. source of Plitvica stream, 11. Špilja spring, 12. Čerišnjevica spring, 13. spring of the Ljuta river, 14. Marija spring, 15. spring in Vodovađa village, 16. spring of the Vrljika river, 17. Vrutak spring, 18. Nela spring, 19. Štirovača fountain spring, 20. Majerovo vrilo spring, 21. spring of the Crna Rijeka river, 22. spring of Sušanj stream, 23. spring of the Bijela Rijeka river.

when caddisflies are more active (Kučinić, 2002), in the period from April to September. The collected material was preserved in 80% and 96% alcohol for laboratory analysis.

The collected material is part of two collections: the "NiP Trichoptera collection" deposited in the Croatian Natural History Museum in Zagreb and the first author´s research collection - „Trichoptera Žalac".

Determination of all species was done according to Malicky (2004). Systematics followed Neu *et al.* (2018) and Morse (2022). Undeterminate females in genera *Wormaldia*, *Philopotamus*, *Plectronemia*, *Hydropsyche* & *Diplectrona*, *Limnephilus*, *Potamophylax* and *Athripsodes* were not included in the analysis of the total number of species and genera. The photo of the species *Crunoecia irrorata* was taken in the laboratory of the Croatian agency for Agriculture and Food by Maja Pintar.

Tab. 1. Springs where sampling was done, with some of characteristics (coordinates, elevation, spring type, basin and anthropogenic influence).

Locations	Coordinates	Elevation	Spring type	Basin	Anthropogenic influence
Keljevac spring	439602,6671; 4953724,062	666 m	Limnocrene	Black Sea	Yes
spring in Jasikovac village	439009,6134; 4954281,044	652 m	Limnocrene	Black Sea	Yes
Crkva Ružica spring	443535,9269; 4952794,79	616 m	Rheocrene	Black Sea	Yes
Kamensko spring	450442,1482; 4944445,133	932 m	Rheocrene	Black Sea	No
Vrelo Koreničko spring	434462,1863; 4959078,196	695 m	Limnocrene	Black Sea	Yes
spring in Rudanovac village	435329,1213; 4960372,82	687 m	Limnocrene	Black Sea	No
Stipinovac spring	434151,9134; 4959344,739	694 m	Limnocrene	Black Sea	Yes
spring of the Drakulić river	433310,3603; 4960453,61	701 m	Rheocrene	Black Sea	No
Napojište spring	430141,1792; 4965578,276	675 m	Rheocrene	Black Sea	No
Bijela rijeka spring	425479,506; 4966364,385	714 m	Rheocrene	Black Sea	Yes
Crna rijeka spring	429944,911; 4965832,915	667 m	Rheocrene	Black Sea	No
Sušanj stream spring	426105,785; 4970187,194	705 m	Helocrene	Black Sea	No
Plitvica stream spring	426816,0645; 4973946,074	610 m	Rheocrene	Black Sea	Yes
Špilja spring	314390,625; 4996502,006	54 m	Rheocrene	Adriatic	No
Čerišnjevica spring	297620,8007; 5019176,267	264 m	Rheocrene	Adriatic	No
Ljuta river spring	654322,501; 4712626,427	100 m	Rheocrene	Adriatic	Yes
Marija spring	658123,9944; 4709729,27	227 m	Rheocrene	Adriatic	Yes
Vodovađa village spring	657941,4213; 4710454,339	305 m	Rheocrene	Adriatic	Yes
Vrljika river spring	554766,9153; 4812621,466	268 m	Limnocrene	Adriatic	No
Vrutak spring (Gornja Podgora)	548155,4791; 4788940,189	260 m	Rheocrene	Adriatic	No
Nela spring	492430,8589; 4868167,262	388 m	Limnocrene	Adriatic	Yes
Štirovača fountain spring	385078,936; 4951917,787	1109 m	Fountain	Black Sea	Yes
Majerovo vrilo spring	409746,3489; 4964508,136	462 m	Limnocrene	Black Sea	Yes

Fig. 3. A – F: A) Marija spring, B) Nela spring, C) Vrelo Koreničko spring, D) Špilja spring, E) Čerišnjevica spring, F) Štirovača fountain spring.

RESULTS

During this study and investigation at the 23 springs (Fig. 2, Tab. 1) a total of 687 adult Trichoptera were collected. Fifty-five species were established, belonging to 33 genera and 13 families (Tab. 2). The species *Drusus croaticus* was registered at 8 springs, the greatest number of any Trichoptera species recorded in this study. In contrast to *D. croaticus*, 24 species were found at a single spring. The greatest numbers of species, 14 were recorded at Keljevac spring and the spring in the Rudanovac village, in four springs only two species were registered, and in one spring just one species was established (Tab. 2). In different types of springs a different number of species were collected: limnocrene

springs – 36 species, rheocrene springs – 50 species, helocrene spring – 9 species and in the fountain spring – 4 species. In springs that form part of the Black Sea basin 36 species were collected, and in the springs belonging to the Adriatic basin 32 species were collected. Faunistically interesting species established in this study were: *Rhyacophila delici*, *Agapetus kampos*, *Crunoecia kempnyi*, *Drusus croaticus*, *Chaetopteryx gonospina*, *Potamophylax pallidus*, *Ernodes vicinus*, but the most interesting is the species *Crunoecia irrorata* (Curtis, 1834), found for the first time in Croatia (Fig. 4).

Forty-eight species were collected with the UV-lamps (633 individuals), 7 with entomological nets (27 individuals) and 6 species (27 individuals) in emergence pyramid-traps. The highest number of species was registered in June, August and September (Tab. 3).

Regarding seasonal dynamics the largest number of species and specimens was established during the summer months, while in the winter months, in the period from December to March, adults were not collected (Tab. 3).

Systematic presentation of caddisflies collected in this research with data of collection, collection date and number of collected female and male specimens, and sampling methods (UV – UV light traps, P – emergency pyramid-traps, EN – entomological net).

Family Rhyacophilidae

Rhyacophila delici Kucinic & Valladolid, 2020

Bijela rijeka spring: 13.08.2018, 3 ♂♂ (UV), 18.09.2018, 3 ♂♂ (UV), Crna rijeka spring: 13.09.2018, 1 ♂ (UV), 11.10.2018, 2 ♂♂, 1 ♀ (UV), spring of the Drakulić river: 22.08.2017, 1 ♂ (UV), 06.05.2018, 1 ♀ (P), 14.08.2018, 1 ♂ (UV), 31.10.2018, 4 ♀♀ (P), 19.10.2018, 8 ♂♂, 1 ♀ (UV), 29.10.2019, 1 ♂ (UV), Napojište spring: 14.10.2017, 1 ♂ (UV), spring of the Plitvica stream: 07.07.2017, 20 ♂♂, 3 ♀♀ (UV), 24.08.2017, 4 ♂♂, 10 ♀♀ (UV), spring in the Rudanovac village: 16.09.2016, 1 ♀ (UV), Vrelo Koreničko spring: 04.06.2016, 5 ♂♂ (UV), 26.07.2016, 3 ♀♀ (UV), 12.09.2016, 1 ♂ (UV).

Rhyacophila schmidinarica Urbanic, Krusnik & Malicky, 2000

Napojište spring: 29.05.2017, 1 ♂ (UV), 23.08.2017, 2 ♂♂, 1 ♀ (UV).

Rhyacophila tristis Pictet, 1834

Spring of the Ljuta river: 20.06.2020, 1 ♀ (UV), Marija spring: 30.10.2015, 2 ♂♂ (UV).

Family Glossosomatidae

Agapetus kampos Oláh, 2013

Spring of the Ljuta river: 02.04.2015, 5 ♂♂, 1 ♀ (UV), 13 ♂♂, 1 ♀ (EN), 21.07.2015, 4 ♂♂ (EN), 17.08.2016, 2 ♂♂, 1 ♀ (UV).

Agapetus ochripes Curtis, 1834

Spring in the Rudanovac village: 08.06.2016, 1 ♂ (UV), Vrelo Koreničko spring: 26.07.2016, 1 ♂ (UV).

Glossosoma discophorum Klapálek, 1902

Spring of the Plitvica stream: 07.07.2017, 1 ♂ (UV), 24.08.2017, 1 ♂ (UV).

Family Philopotamidae

Wormaldia occipitalis (Pictet, 1834)

Spring of the Drakulić river: 14.08.2018, 1 ♂ (UV), Napojište spring: 23.08.2017, 9 ♂♂, 3 ♀♀ (UV), spring in Rudanovac village: 02.08.2016, 1 ♂ (UV).

Wormaldia subnigra McLachlan, 1865

Čerišnjevica spring: 23.06.2017, 7 ♂♂, 14 ♀♀ (UV).

Wormaldia sp.

Spring in Rudanovac village: 06.06.2016, 1 ♀ (UV), 02.08.2016, 1 ♀ (UV), Vrelo Koreničko spring: 06.06.2016, 1 ♀ (UV).

Philopotamus sp.

Spring of the Sušanj stream: 02.08.2018, 1 ♀ (P).

Family Polycentropodidae

Cyrnus trimaculatus (Curtis, 1834)

Čerišnjevica spring: 23.06.2017, 1 ♂(UV).

Polycentropus excisus Klapálek, 1894

Spring of the Ljuta river: 21.07.2015, 1 ♂ (UV).

Plectronemia conspersa (Curtis, 1834)

Spring of the Drakulić river: 22.08.2017, 1 ♀ (UV), spring of the Plitvica stream: 07.07.2017, 6 ♂♂ (UV), spring of the Sušanj stream: 17.07.2018, 1 ♂, 3 ♀♀ (UV), 02.08.2018, 2♀ (P), 13.08.2018, 1 ♂ (UV), 31.08.2018, 1 ♂ (P), 10.09.2018, 1 ♂, 2 ♀♀ (P).

Plectronemia sp.

Spring in Jasikovac village: 17.07.2016, 1 ♀ (UV), Napojište spring: 23.08.2017, 1 ♀ (UV).

Family Psychomyiidae

Lype reducta (Hagen, 1868)

Spring Čerišnjevica: 23.06.2017, 1 ♂ (UV).

Tinodes braueri McLachlan, 1878

Spring of the Ljuta river: 01.11.2015, 2 ♂♂ (UV), 1 ♂ (EN).

Tinodes unicolor Pictet, 1834

Čerišnjevica spring: 23.06.2017, 7 ♂♂, 31 ♀♀ (UV), Špilja spring: 20.06.2017, 2 ♂ ♂ (UV), 13.09.2017, 1 ♂ (UV).

Tinodes sp.

Crna rijeka spring: 02.08.2018, 1 ♀ (P), Čerišnjevica spring: 14.09.2017, 1 ♀ (UV), Špilja spring: 13.09.2017, 4 ♀♀ (UV), spring of the Vrljika river: 05.04.2015, 2 ♀♀ (UV).

Family Hydropsychidae

Diplectrona cf. *atra* McLachlan, 1878

Spring of the Ljuta river: 21.07.2015, 6 ♂♂, 4 ♀♀ (UV), spring in Vodovađa village: 22.07.2015, 3 ♂♂, 1 ♀ (UV), 1 ♂ (EN).

Diplectrona sp. & *Hydropsyche* sp.

Spring of the Ljuta river: 17.08.2016, 1 ♀ (UV), spring in Vodovađa village: 21.07.2015, 1 ♀ (UV), 16.08.2016, 4 ♀♀ (UV).

Hydropsyche bulgaroromanorum Malicky, 1977

Majerovo vrilo spring: 18.08.2017, 1 ♂ (UV).

Hydropsyche instabilis (Curtis, 1834)

Spring of the Ljuta river: 01.11.2015, 1 ♂ (UV), 17.08.2016, 1 ♂ (UV), Marija spring: 22.07.2015, 1 ♂ (UV), spring of the Plitvica stream: 07.07.2017, 3♂♂, 3 ♀♀(UV), 24.08.2017, 1 ♂ (UV), spring of the Sušanj stream: 13.08.2018, 2 ♂♂ (UV), spring in Vodovađa village: 21.07.2015, 1 ♂ (UV), spring of the Vrljika river: 20.06.2015, 1 ♂ (UV), 20.06.2015, 1 ♂ (EN).

Hydropsyche saxonica McLachlan, 1884

Čerišnjevica spring: 14.09.2017, 4 ♂♂ (UV).

Hydropsyche sp.

Čerišnjevica spring: 23.06.2017, 2 ♂♂, 1 ♀ (UV), spring in Jasikovac village: 17.7.2016, 1 ♀ (UV), Keljevac spring: 03.07.2015, 1 ♀ (UV), 01.08.2016, 1 ♀ (UV), spring of the Ljuta river: 21.07.2015, 2 ♀♀ (UV), 1 ♀ (EN), 01.11.2015, 2 ♀♀ (UV), spring in Rudanovac village: 02.08.2016, 1 ♀ (UV), spring of the Sušanj stream: 13.08.2018, 1 ♀ (UV), Štirovača spring: 29.05.2015, 1♀ (UV).

Family Phrygaenidae

Agrypnia varia Fabricius, 1793

Spring in Rudanovac village: 02.08.2016, 1 ♂ (UV).

Trichostegia minor (Curtis, 1834)

Majerovo vrilo spring: 18.08.2017, 1 ♂ (UV).

Family Goeridae

Silo nigricornis (Pictet, 1834)

Marija spring: 02.04.2015, 1 ♂ (UV), 1 ♂ (EN).

Family Lepidostomatidae

Lepidostoma hirtum (Fabricius, 1775)

Čerišnjevica spring: 23.06.2017, 3 ♂♂ (UV), spring in Rudanovac village: 17.08.2017, 6 ♀♀ (UV).

Crunoecia irrorata

Spring on Kamensko: 13.09.2016, 1 ♂ (UV).

Crunoecia kempnyi Morton, 1901

Napojište spring: 23.08.2017, 1 ♂ (UV).

Family Limnephilidae

Drusus croaticus Marinkovic-Gospodnetic, 1971

Fig. 4. *Crunoecia irrorata* (Curtis, 1834). Male genitalia, lateral, left side (Kamensko spring, 13.09.2016, leg. S. Žalac), collection „Trichoptera Žalac" (photo M. Pintar & M. Kučinić).

Bijela rijeka spring: 13.08.2018, 1 ♂ (UV), Crna rijeka spring: 02.08.2018, 1 ♀ (P), 13.08.2018, 1 ♂ (UV), 13.09.2018, 6 ♂♂, 14 ♀♀ (UV), 11.10.2018, 2 ♂♂, 1 ♀ (UV), spring of the Drakulić river: 01.06.2018, 2 ♀♀ (P), 14.08.2018, 1 ♂, 3♀♀ (UV), 03.10.2018, 1 ♀ (P), 19.10.2018, 2 ♂♂, 1 ♀ (UV), 31.10.2018, 6 ♀♀ (P), 04.06.2019, 1 ♀ (P), 29.10.2019, 1 ♂, 1 ♀ (UV), Keljevac spring: 11.09.2016, 1 ♂ (UV), 09.10.2016, 1 ♀ (UV), Majerovo vrilo spring: 20.04.2016 2 ♂♂ (UV), 21.07.2016, 1 ♂, 2 ♀♀ (UV), spring of the Plitvica stream: 24.08.2017, 3♂♂, 8♀♀ (UV), Stipinovac spring: 17.10.2019, 1 ♂, 1 ♀ (P), Vrelo Koreničko spring: 26.07.2016 3 ♂♂ (UV), 12.09.2016, 4 ♂♂, 1 ♀ (UV).

Glyphotaelius pellucidus (Reitzius, 1783)

Crkva Ružica spring: 19.05.2017, 1 ♂ (UV), spring in Jasikovac village: 17.07.2016, 1 ♂ (UV), 11.09.2016, 4 ♂♂, 1 ♀ (UV), Kamensko spring: 16.06.2016, 4 ♂♂, 1♀ (UV), Keljevac spring: 09.10.2016, 1 ♂ (UV), Napojište spring: 23.08.2017, 1 ♂ (UV), Nela spring: 17.06.2015, 1 ♂ (UV), spring in Rudanovac village: 16.09.2016, 3 ♀♀ (UV).

Grammotaelius nigropunctatus (Retzius, 1783)

Spring in Jasikovac village: 11.09.2016, 1 ♀ (UV), Kamensko spring: 16.06.2016, 1 ♂, 1 ♀ (UV), Keljevac spring: 11.09.2016, 2 ♂♂ (UV).

Limnephilus auricula Curtis, 1834

Bijela rijeka spring: 18.09.2018, 1 ♂ (UV), Crna rijeka spring: 13.09.2018, 1 ♂ (UV).

Limnephilus extricatus McLachlan, 1865

Napojište spring: 29.05.2017, 1 ♀ (UV), Vrelo Koreničko spring: 04.06.2016, 3 ♀♀ (UV), 26.07.2016, 1 ♀ (UV), 12.09.2016, 2 ♂♂ (UV).

Limnephilus flavicornis (Fabricius, 1787)

Bijela rijeka spring: 13.08.2018, 1 ♂ (UV), Majerovo vrilo spring: 18.08.2017, 1 ♂ (UV), spring of the Plitvica stream: 24.08.2017, 1 ♂ (UV), spring of the Sušanj stream: 13.08.2018, 1 ♂ (UV).

Limnephilus cf. *hirsutus* (Pictet, 1834)

Spring of the Drakulić river: 14.08.2018, 1 ♂, 1 ♀ (UV), spring in Jasikovac village: 17.07.2016, 2 ♂♂, 3♀♀ (UV), 11.09.2016, 2 ♂♂, 1 ♀ (UV), Keljevac spring: 01.08.2016, 1 ♂ (UV), 11.09.2016, 1 ♂ (UV), 19.09.2016, 1 ♀ (UV), spring in Rudanovac village: 02.08.2016, 3 ♂♂ (UV).

Limnephilus ignavus McLachlan, 1865

Spring of the Drakulić river: 22.08.2017, 1 ♀ (UV), spring in Jasikovac village: 17.07.2016, 1 ♂, 3 ♀♀ (UV), 11.09.2016, 2 ♂♂, 1 ♀ (UV), Keljevac spring: 04.10.2017, 1 ♀ (UV), 09.10.2016, 1 ♂ (UV), 13.10.2016, 1 ♂ (UV), spring in Rudanovac village: 16.09.2016, 2 ♀♀ (UV).

Limnephilus lunatus Curtis, 1934

Spring in Jasikovac village: 17.07.2016, 1 ♀ (UV), Keljevac spring: 13.10.2015, 1 ♂ (UV), 27.10.2016, 2 ♂♂ (UV), spring of the Ljuta river: 01.11.2015, 1 ♂, 1 ♀ (UV), 1 ♀ (EM), Majerovo vrilo spring: 18.08.2017, 1 ♂, 1 ♀ (UV), Marija spring: 30.10.2015, 1 ♂ (UV), spring of the Plitvica stream: 24.08.2017, 1 ♂(UV), spring in Vodovađa village: 31.10.2015, 1 ♂ (UV), spring of the Vrljika river: 20.06.2015, 3 ♀♀ (UV), 03.09.2015, 1 ♂ (UV), 1 ♀ (EN).

Limnephilus rhombicus (Linnaeus, 1758)

Keljevac spring: 22.08.2016, 1 ♂ (UV), spring of the Plitvica stream: 24.08.2017, 1 ♂ (UV), Štirovača fountain spring: 21.08.2015, 1 ♂ (UV), spring of the Vrljika river: 20.06.2015, 1 ♂ (UV), 20.07.2015, 1 ♂ (UV).

Limnephilus sparsus Curtis, 1834

Bijela rijeka spring: 18.09.2018, 1 ♀ (UV), spring in Jasikovac village: 11.09.2016, 16 ♂♂, 3 ♀♀ (UV), Kamensko spring: 16.06.2016, 6 ♂♂, 2 ♀♀ (UV), Keljevac spring: 22.08.2016, 1 ♀ (UV), 11.09.2016, 1 ♀ (UV), 19.09.2016, 1 ♂, 1 ♀ (UV), 09.10.2016, 1 ♂ (UV), spring in Rudanovac village: 16.09.2016, 8 ♂♂, 3 ♀♀ (UV), Vrelo Koreničko spring: 12.09.2016, 1 ♂ (UV).

Limnephilus vittatus (Fabricius, 1798)

Keljevac spring: 09.10.2016, 1 ♂ (UV).

Limnephilus sp.

Crkva Ružica spring: 23.07.2017, 1 ♀ (UV), Kamensko spring: 13.09.2016, 1 ♀ (UV), Vrutak spring: 02.04.2015, 1 ♀ (UV).

Chaetopteryx gonospina Marinkovic, 1966

Crna rijeka spring: 13.09.2018, 1 ♂ (UV), 11.10.2018, 8 ♂♂, 1 ♀ (UV), spring of the Drakulić river: 19.10.2018, 1 ♀ (UV),31.10.2019, 1 ♂ (P), Napojište spring: 14.10.2017, 7 ♂♂ (UV), Stipinovac spring: 17.10.2019, 1 ♂ (P), spring of the Sušanj stream: 10.09.2018, 2 ♀♀ (UV), 03.10.2018, 3 ♂♂, 2 ♀♀ (UV), 11.10.2018 2 ♂♂, 1 ♀ (UV).

Halesus digitatus (Schrank, 1781)

Bijela rijeka spring: 18.09.2018, 4 ♂♂, 10 ♀♀ (UV), Crna rijeka spring: 13.09.2018, 2 ♂♂, 10 ♀♀ (UV), 11.10.2018, 3 ♂♂, 11 ♀♀ (UV), spring of the Drakulić river: 19.10.2018, 1 ♀ (UV), Keljevac spring: 09.10.2016, 1 ♂ (UV), spring of the Plitvica stream: 13.10.2017, 2 ♀♀ (UV), spring in Rudanovac village: 11.09.2016, 1 ♀ (UV), spring of the Sušanj stream: 11.10.2018, 1 ♀ (UV).

Mesophylax aspersus (Rambur, 1842)

Špilja spring: 20.06.2017, 1 ♂, 1 ♀ (UV), 13.09.2017, 1 ♀ (UV).

Micropterna lateralis (Stephens, 1834)

Vrelo Koreničko spring: 06.06.2016, 1 ♂ (UV), spring in Rudanovac village: 08.06.2016, 1 ♂, 3 ♀♀ (UV), spring of the Sušanj stream: 17.07.2018, 1 ♂ (UV).

Micropterna nycterobia (McLachlan, 1875)

Keljevac spring: 04.10.2017, 2 ♂♂, 1 ♀ (UV), 09.10.2016, 1 ♂, 2 ♀♀ (UV).

Micropterna sequax (McLachlan, 1875)

Vrutak Spring: 11.10.2014., 1 ♂ (UV), Štirovača spring: 21.08.2015, 1 ♂ (UV), 1 ♂ (EM).

Micropterna testacea (Gmelin, 1790)

Keljevac spring: 04.10.2017, 3 ♂♂ (UV), 09.10.2016, 2 ♂♂, 1 ♀ (UV), Majerovo vrilo spring: 23.06.2016, 1 ♂, 1 ♀ (UV).

Micropterna wageneri Malicky, 1971

Spring of the Ljuta river: 01.11.2015, 1 ♂, 1 ♀ (UV), spring in Vodovađa village: 31.10.2015, 1 ♀ (UV).

Potamophylax latipennis (Curtis, 1834)

Spring in Rudanovac village: 08.06.2016, 1 ♀ (UV), Vrelo Koreničko spring: 04.06.2016, 1 ♂ (UV), spring of the Plitvica stream: 24.08.2017, 2 ♀ (UV).

Potamophylax pallidus (Klapálek, 1899)

Bijela rijeka spring: 18.09.2018, 1 ♂ (UV), Crna rijeka spring: 13.09.2018, 1 ♂, 2 ♀♀ (UV), spring of the Drakulić river: 22.08.2017, 2 ♂♂ (UV), Marija spring: 30.10.2015, 1 ♂ (UV), Napojište spring: 23.08.2017, 5 ♂♂, 2 ♀♀ (UV), 14.10.2017, 1 ♂ (UV), spring of the Sušanj stream: 10.09.2018, 4 ♂♂, 7 ♀♀ (UV).

Potamophylax sp.

Štirovača fountain spring: 24.10.2015, 1 ♀ (UV).

Stenophylax permistus McLachlan, 1895

Spring in Jasikovac village: 11.09.2016, 1 ♂, 1 ♀ (UV), Keljevac spring: 11.09.2016, 1 ♂, 2 ♀♀ (UV), 19.09.2016, 2 ♀♀ (UV), 09.10.2016, 1 ♀ (UV), 04.10.2017, 1 ♂ (UV), spring of the Vrljika river: 03.09.2015, 1 ♂ (UV).

Stenophylax vibex (Curtis, 1834)

Bijela rijeka spring: 18.09.2018, 2 ♀♀ (UV).

Family Sericostomatidae

Sericostoma flavicorne Schneider, 1845

Nela spring: 17.06.2015, 1 ♀ (UV), spring of the Plitvica stream: 07.07.2017, 1 ♀ (UV), spring in Rudanovac village: 08.06.2016, 1 ♂, 1 ♀ (UV), spring in Vodovađa village: 16.08.2016, 1 ♀ (UV).

Family Odontoceridae

Odontocerum albicorne (Scopoli, 1763)

Keljevac spring: 24.06.2017, 2 ♀♀ (UV), Marija spring: 16.08.2016, 1 ♂ (UV), spring in the Rudanovac village: 02.08.2016, 1 ♀ (UV).

Family Beraeidae

Beraea pullata (Curtis, 1834)

Napojište spring: 29.05.2017, 11 ♂♂, 1 ♀ (UV), 23.08.2017, 1 ♂ (UV).

Ernodes vicinus McLachlan, 1879

Vrutak spring: 20.06.2015, 3 ♀♀ (UV).

Family Leptoceridae

Adicella filicornis (Pictet, 1834)

Spring of the Ljuta River: 02.04.2015, 1 ♂ (UV), Marija spring: 20.06.2020., 1 ♂ (UV).

Athripsodes cinereus (Curtis, 1834)

Vrelo Koreničko spring: 26.07.2016, 1 ♂ (UV).

Athripsodes sp.

Spring of the Vrljika River: 05.04.2015, 1 ♀ (UV).

Oecetis notata (Rambur, 1842)

Majerovo vrilo spring: 18.08.2017, 1 ♂ (UV).

Tab. 2. Number of species, genera and families per spring found during the research.

Spring	Number of species	Number of genera	Number of families
Spring of the Drakulić river	9	8	4
Spring of Plitvica stream	11	9	6
Vrelo Koreničko spring	8	7	4
Napojište spring	9	8	5
Spring of the Ljuta river	9	9	7
Marija spring	8	8	7
Spring of the Vrljika river	4	3	3
Spring in Rudanovac village	14	11	8
Čerišnjevica spring	6	6	5
Špilja spring	2	2	2
Vodovađa spring	5	5	3
Majerovo vrilo spring	6	5	3
Keljevac spring	14	9	3
Štirovača spring	2	2	1
Stipinovac spring	2	2	1
Crkva Ružica spring	1	1	1
Spring in Jasikovac village	7	4	1
Kamensko spring	3	3	1
Nela spring	2	2	2
Vrutak spring	2	2	2
Spring of Sušanj stream	7	7	4
Bijela rijeka spring	8	6	2
Crna rijeka spring	6	6	3

Tab. 3. Species and seasonal activity in the investigated area (23 springs).

Species/Months	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Family Rhyacophilidae												
Rhyacophila delici Kucinic & Valladolid, 2020					●	●	●	●	●	●		
Rhyacophila schmidinarica Urbanic, Krusnik & Malicky, 2000					●			●				
Rhyacophila tristis Pictet, 1834						●				●		
Family Glossosomatidae												
Agapetus kampos Olah, 2013				●			●	●				
Agapetus ochripes Curtis, 1834						●	●					
Glossosoma discophorum Klapálek, 1902							●	●				
Family Philopotamidae												
Wormaldia occipitalis (Pictet, 1834)								●				
Wormaldia subnigra McLachlan, 1865						●						
Family Polycentropodidae												
Cyrnus trimaculatus (Curtis, 1834)						●						
Polycentropus excisus Klapálek, 1894							●					
Plectronemia conspersa (Curtis, 1834)							●	●	●			
Family Psychomyiidae												
Lype reducta (Hagen, 1868)						●						
Tinodes braueri McLachlan, 1878											●	
Tinodes unicolor (Pictet, 1834)						●			●			
Family Hydropsychidae												
Diplectrona cf. atra McLachlan, 1878							●					
Hydropsyche bulgaroromanorum Malicky, 1977								●				
Hydropsyche instabilis (Curtis, 1834)						●	●	●	●	●	●	
Hydropsyche saxonica McLachlan, 1884									●			
Family Phryganeidae												
Agripnia varia Fabricius, 1793								●				
Trichostegia minor (Curtis, 1834)								●				
Family Goeridae												
Silo nigricornis (Pictet, 1834)				●								
Family Lepidostomatidae												
Lepidostoma hirtum (Fabricius, 1775)						●		●				
Crunoecia irrorata (Curtis, 1834)									●			
Crunoecia kempnyi Morton, 1901								●				
Family Limnephilidae												
Drusus croaticus Marinkovic-Gospodnetic, 1971				●		●	●	●	●	●		
Glyphotaelius pellucidus (Retzius, 1783)					●	●	●	●	●	●		
Grammotaelius nigropunctatus (Retzius, 1783)						●			●			
Limnephilus auricula Curtis, 1834									●			
Limnephilus extricates McLachlan, 1865					●	●	●		●			
Limnephilus flavicornis (Fabricius, 1787)								●				
Limnephilus hirsutus (Pictet, 1834)							●	●	●			

Tab. 3. Continued

Species/Months	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Limnephilus ignavus McLachlan, 1865							●	●	●	●		
Limnephilus lunatus Curtis, 1834						●		●	●	●	●	
Limnephilus rombicus (Linnaeus, 1758)						●	●	●				
Limnephilus sparsus Curtis, 1834						●		●	●	●		
Limnephilus vittatus (Fabricius, 1798)										●		
Chaetopteryx gonospina Marinkovic-Gospodnetic, 1966									●	●		
Halesus digitatus (Schrank, 1781)									●	●		
Mesophylax aspersus (Rambur, 1842)						●			●			
Micropterna lateralis (Stephens, 1834)						●	●					
Micropterna nycterobia (McLachlan, 1875)										●		
Micropterna sequax (McLachlan, 1875)								●		●		
Micropterna testacea Malicky, 1985						●				●		
Micropterna wageneri Malicky, 1971										●		
Potamophylax latipennis (Curtis, 1834)						●		●				
Potamophylax pallidus (Klapalek, 1899)								●	●	●		
Stenophylax permistus McLachlan, 1895								●	●	●		
Stenophylax vibex (Curtis, 1834)									●			
Family Sericostomatidae												
Sericostoma flavicorne Schneider, 1845						●	●	●				
Family Odontoceridae												
Odontocerum albicorne (Scopoli, 1763)						●		●				
Family Beraeidae												
Beraea pullata (Curtis, 1834)					●			●				
Ernodes vicinus (McLachlan, 1879)						●						
Family Leptoceridae												
Adicella filicornis (Pictet, 1834)				●		●						
Athripsodes cinereus (Curtis, 1834)							●					
Oecetis notata (Rambur, 1842)								●				
Number of species	-	-	-	4	5	24	17	28	21	17	3	-

DISCUSSION

In this investigation a total of 55 species of caddisflies were found (Tab. 3), and that is about 40% of caddisflies fauna established in spring biotopes in Croatia (e.g. Cerjanec *et al*., 2020; Kučinić *et al*., 2017, 2020; Vučković *et al*., 2021; Waringer *et al*., 2009). Several new species of caddisflies have previously been found and described from spring areas in Croatia, e.g. *Rhyacophila cabrekenensis* Malicky, Previšić & Kučinić 2007, *Chaetopteryx bucari* Kučinić, Szivák & Delić, 2013, *Chaetopteryx marinkovicae* Malicky & Krušnik, 1988, *Drusus croaticus* Marinkovic-Gospodnetic, 1971 (Kučinić *et al*., 2017; Malicky & Krušnik, 2008; Malicky *et al*., 2007; Marinković-Gospodnetić, 1971) which also indicate that the springs are faunistically very interesting habitats (e.g. Cerjanec *et al*., 2020; Kučinić *et al*., 2008, 2017).

The highest number of species was found at Keljevac spring and in the spring in Rudanovac village, probably because both of them are heterogeneous in microhabitats, or else on account of greater research effort (there were eight collecting outings), whi-

ch was the case with Keljevac spring, too. The lowest number of species was established for several springs (Tab. 2). In some cases, we found the anthropogenic influence to be the reason, e.g. at Štirovača spring, some localities are very specific, like Špilja spring - the spring in cave, while some springs are very small (Štirovača spring, Vrutak spring etc.). All these factors have influence on biodiversity and the number of species found in these localities. In some springs (e.g. spring Napojište – spring of the Ljuta river – spring of the Drakulić river, the number of species is the same and is determined by some specific characteristics of the springs not considered in this report, such as those related to hydrology, size, geology and geography.

As was expected, the highest number of species was collected with UV-lamps, usual in the collection of Trichoptera; far fewer were caught with pyramidal emergence traps and with an entomological net during the daytime. Collection of Trichoptera with pyramid emergence traps was carried out at four springs, but this method is selective when it is a matter of research into the fauna of aquatic insects, although some very interesting results can be arrived at with it, taxonomic as well as faunistic (Previšić *et al.*, 2007; Kučinić, 2002; Kučinić *et al.*, 2013; 2017). The situation is similar with the collection of Trichoptera during the day with an entomological net, for a certain number of Trichoptera species demonstrate as a rule diurnal activity or else live in vegetation close to aquatic habitats, and so this method often proves to be very interesting in the investigation of aquatic insects, including Trichoptera.

More species have been found in rheocrene springs than in any other type of springs, and more species have been found in springs that belong to the Black Sea basin than in springs of the Adriatic basin. This was expected because there were more springs belonging to the rheocrene type and to the Black Sea basin, than to the limnocrene type and Adriatic basin (Tab. 1).

The most interesting faunistic data of this research concern *Crunoecia irrorata*, because it has been found for the first time in Croatia. In the studies prior to this one, it has been relatively easy to collect some of the unrecorded species of Croatian fauna, which were previously unknown (Kučinić, 2002), but after relatively numerous studies in the last two decades (e.g. Cerjanec *et al.*, 2020; Graf *et al.*, 2008; Previšić *et al.*, 2007; Vučković *et al.*, 2021) and the large number of newly recorded species, the finding of a new one is increasingly rare (e.g. Kučinić *et al.*, 2019, 2021). This is also the case with the species *C. irrorata* (Fig. 4). The European fauna currently has 5 recorded species of the genus *Crunoecia* (Fauna Europaea; Malicky, 2004). Until now *Crunoecia kempnyi* Morton, 1901 was the only species of this genus recorded in Croatia, discovered in the Plitvice Lakes National Park (Kučinić *et al.*, 2017). The larva of *C. irrorata* builds a specific case, first circular in shape from grains of sand, and later it replaces the sand with plant material and the house becomes square in cross-section. It mostly inhabits forest streams. It includes wood remains, shredded fallen leaves in its diet, but it also shows characteristics of a predatory species (Graf *et al.*, 2008; Wallace *et al.*, 1990; http://trichopteraireland.wordpress.com). According to Fauna Europaea (2020), this species is spread over a larger area of central and northern Europe (Gardenfors, 2005; Gullerfors, 2002), including southern areas such as Bosnia and Herzegovina, Sardinia and Sicily.

Apart from *C. irrorata* other very interesting species found during this study were: *Rhyacophila delici*, *Agapetus kampos*, *Crunoecia kempnyi*, *Chaetopteryx gonospina*, *Potamophylax pallidus* and *Ernodes vicinus*.

Rhyacophila delici is a taxon previously described as a subspecies of *R. fasciata delici* (Valladolid *et al.*, 2020) but it was elevated to species level (Valladolid *et al.*, 2022). As Croatian endemic, it is distributed in the north and central part of Pannonian/Peri-Pannonian, in central-mountainous and Mediterranean parts of Croatia (Valladolid *et al.*, 2020).

Agapetus kampos is a species described from Montenegro (Oláh & Kovács, 2013). Apart from the type locality in Montenegro, this Mediterranean species has been recorded in Croatia only in the area of Konavle (Kučinić *et al.*, 2021).

Crunoecia kempnyi is a very interesting species from the Lepidostomatidae family. In previous research it was registered in Croatia only at the spring of the Bijela rijeka river in the Plitvice area (Kučinić *et al.*, 2017) so its finding at the source of the Napojište stream (Plitvice Lakes NP) is the second one for the National Park and for Croatia. According to Fauna Europaea (2022), *C. kempnyi* is most widely distributed in Central Europe, in Austria, Bosnia and Herzegovina , Hungary and Germany.

The autumnal species *Chaetopteryx gonospina* has been found so far in Croatia only in the Banovina region (Kučinić *et al.*, 2010) and from Plitvice Lakes (Kučinić *et al.*, 2017), as was confirmed in the present study. The genus *Chaetopteryx* is characterised by emergence in autumn and winter. In Croatia, 10 species of the genus *Chaetopteryx* have been recorded (Kučinić *et al.*, 2013, 2017; Malicky & Krušnik, 1988; Oláh, 2011; Szivák *et al.*, 2017), some of which have been described from our area, for example *C. bucari* with *locus typicus* in Banovina (Kučinić *et al.*, 2013), *C. marinkovicae* with *locus typicus* in Istria (Malicky & Krušnik, 1988) and *C. uherkovici* with *locus typicus* in Slavonia (Oláh, 2011). In a study published ten years ago seven species new to science from the genus *Chaetopteryx* were described from the area of Central Europe (Oláh *et al.*, 2012), though with very questionable taxonomic statuses, and some species were synonymised (Malicky, 2014).

In this research the species *Potamophylax pallidus* was found for the second time in the Mediterranean part of Croatia, at the Marija Spring in Konavle. In Mediterranean Croatia it has previously been registered only in the Cetina River (Vučković *et al.*, 2021), and it was also noted in the Central-Mountain and Pannonian/Peri-Pannonian area of Croatia (Cerjanec *et al.*, 2020; Previšić *et al.*, 2010). According to Fauna Europaea *P. pallidus* is distributed in parts of central and south east Europe, for example in Albania, Austria, Bulgaria, Bosnia and Herzegovina, Slovenia (Fauna Europaea, 2022).

A particularly interesting find in this study from the faunistic viewpoint is that of the species *Ernodes vicinus* from Biokovo Mt. This species, rare in the fauna of Croatia, was previously recorded only in Plitvice Lakes NP (Kučinić *et al.*, 2017; Previšić *et al.*, 2010) and in Žumberak Mt in the north-east part of the Pannonian/Peri-Pannonian part of Croatia (Previšić *et al.*, 2013). With the find in the area of Mt Biokovo, *E. vicinus* was found for the first time in the Mediterranean part. The determination of the species was confirmed with DNA barcoding (Ćukušić, 2019). *E. vicinus* is distributed in the area of central (Austria, Germany), eastern (Romania), western (France) and southern Europe (Italy) (Fauna Europaea, 2022).

The adults were collected in all months of the year, except in winter period, December to March (Tab. 3). In early investigations in the karst area (Plitvice Lakes National Park) the adults were collected in December and March, too (Kučinić *et al.*, 2017).

In June, August and September the greatest number of species was recorded, which is to be expected because of the biological characteristics of Trichoptera, and has been ascertained in some earlier studies (Cerjanec *et al.*, 2020; Kučinić *et al.*, 2017). The shortcomings of this segment of the results in this study reflect the diverse intensity of research (number of field trips) in different months, but is as such in accordance with the results for the seasonal dynamics of Trichoptera in the area of the Dinaric karst of Croatia (Cerjanec *et al.*, 2020; Kučinić *et al.*, 2011, 2017; Vučković *et al.*, 2021).

CONCLUSION

This study has made a new contribution to the understanding of Trichoptera of the springs of Croatia, which will continue to be the object of scientific research. Caddisfly diversity at springs is determined on the one hand by the biological features of a given species, and on the other by certain abiotic factors, such as the geographic, geological, or hydrological features of certain springs. There is much importance in the actual size of the springs, the type of the spring (limnocrene or rheocrene) and the anthropogenic influence that on the whole always has a negative impact on the biodiversity and structure of the fauna in all aquatic types of habitats, including springs. Springs in the area of the Dinaric karst are highly and negatively anthropogenically impacted, as seen for example in the modification of their hydrological features – capturing the springs, channelling of springs, construction of mini-HEP stations and even in various kinds of contamination (Cerjanec *et al.*, 2020; Vučković *et al.*, 2021) especially if they are in the vicinity of settlements. All these process lead to irreversible changes of the natural environment, in this case of springs and the fauna that inhabit them. Protection of springs, and other types of aquatic habitats, requires high standards for their effective preservation. We have to point out that green policies have to recognise that for example hydro-power is often anything but 'green' and it has to be seen, analysed and treated accordingly. Protection of natural biotopes that includes springs as habitats of great diversity and endemism deserves the engagement of not only scientists but of all segments of the wider social community aimed at the preservation of local areas, both as individual segment and also as a part of the wider global mosaic.

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