Contribution to the knowledge of the caddisfly fauna of Montenegro –
New data and records from the karstic springs of Lake Skadar basin

IOANNIS KARAOUZAS1*, ANDRZEJ ZAWAL2, GRZEGORZ MICHOŃSKI2 & VLADIMIR PEŠIĆ3

1 Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research, 46.7 km Athens-Sounio Av., Anavyssos 19013, Greece.
2 Department of Invertebrate Zoology and Limnology, University of Szczecin, Szczecin, Poland
3 Department of Biology, University of Montenegro, Cetinjski put b.b., 81000 Podgorica, Montenegro
*Corresponding author: E-mail: ikarz@hcmr.gr

Received 12 June 2019  |  Accepted by V. Pešić: 4 July 2019  |  Published online 6 July 2019.

Abstract
Caddisfly larvae were collected in 11 karstic springs located in Lake Skadar drainage basin in the Mediterranean part of Montenegro on May and June 2018. Three species are new records for the caddisfly fauna of Montenegro: Brachycentrus subnubilus, Lepidostoma hirtum, Triaenodes ochreellus lefkas. One is a confirmed record of a previously thought absent species Thremma anomalum. Future caddisfly surveys in the region will contribute significantly to the partially known Trichoptera fauna of Montenegro.

Key words: Balkans; biodiversity; Trichoptera; distribution; species.

Introduction
The Balkan Peninsula is an important biodiversity hot-spot of the West Palaearctic, characterized by a rich and diverse freshwater fauna. Despite its high fauna diversity, data and information on the Balkan Trichoptera, especially from Montenegro is still limited. The first caddisfly study was carried out by Radovanovic (1935, 1953) in northwestern Montenegro at Durmitor Mt. who recorded 19 species. The next study followed much later by Marinković-Gospodnetić; (1981) who recorded 48 caddisfly species from the Morača and the Plavnica River drainages. Krusnik (1987) recorded 95 species again from Durmitor Mt., 67 being new for the fauna of Montenegro. Few other studies were published during the last years with the discovery of new species, such as Agapetus kampos Oláh, 2013 and Drusus gombos Oláh, 2013 (Oláh, 2010; Oláh & Kovács, 2013). Recently Ibrahimi et al. (2019) recorded six species new for the fauna of Montenegro. Despite the recent surveys, there are still poorly investigated areas in Montenegro, mostly from springs and streams. Compared with the northern part of Montenegro, the Trichoptera fauna of the Lake Skadar drainage basin has only been partially studied (Pešić et al. 2018). In the present study, 11 karstic springs located in Lake Skadar basin in the Mediterranean part of Montenegro were investigated for its caddisfly fauna. The aim of this work is to contribute to the inventory of the caddisfly fauna of Montenegro.
and to expand the knowledge about the composition of the caddisfly fauna of the springs of Skadar Lake river basin.

**Materials and methods**

**Study area**

Caddisfly larvae were collected from 11 springs situated in the drainage basin of Lake Skadar in Montenegro (Fig. 1, Table 1). In each spring two samples were taken: (1) in the spring source (eucrenal, “A”), and (2) at some distance (2–19 m) from the source (springbrook - hypocrenal, “B”) (see Pešić et al. 2019 for additional information).

Besides usage of the springs as drinking water supplies for humans and livestock, no other types of anthropogenic impact were observed. The basin consists mainly of carbonate rocks and limestones. The climate in the main part of Lake Skadar basin is Mediterranean-Adriatic, typically with hot and dry summers and an average air temperature of the warmest month > 20 °C, whereas in the winter the average air temperature varies from 6 to 9 °C (Kostianoy et al. 2018). The average yearly precipitation in the entire basin ranges from 1800 to 2200 l m−2 with the maximum in November (Kostianoy et al. 2018).

![Map of the study area. The numbers correspond to spring identification numbers in Table 1.](image)

**Figure 1.** Map of the study area. The numbers correspond to spring identification numbers in Table 1.
Table 1. Localities of the sampling sites of Lake Skadar drainage basin.

| Site ID | Zonation | Date      | Latitude  | Longitude | Altitude (m) | Locality                      |
|---------|----------|-----------|-----------|-----------|--------------|--------------------------------|
| KIA 04A | eucrenal | 29/5/2018 | 42.504798 | 19.221773 | 38           | spring near Pričelje           |
| KIA 05A | eucrenal | 29/5/2018 | 42.483141 | 19.243211 | 42           | spring at Zeta River near Pričelje |
| KIA 06A | eucrenal | 29/5/2018 | 42.483390 | 19.242912 | 42           | second spring at Zeta River near Pričelje |
| KIA 07A | hypocrenal | 30/5/2018 | 42.4806591 | 19.1467613 | 34           | spring „Vriješko Vrelo“ in Bandići |
| KIA 07B | hypocrenal | 30/5/2018 | 42.4806591 | 19.1467613 | 34           | spring „Vriješko Vrelo“ in Bandići |
| KIA 09A | eucrenal | 30/5/2018 | 42.624025  | 19.019479 | 55           | Spring „Dobrik“                  |
| KIA 09B | hypocrenal | 30/5/2018 | 42.624025  | 19.019479 | 55           | Spring „Dobrik“                  |
| KIA 11A | eucrenal | 31/5/2018 | 42.325399  | 19.362963 | 30           | Spring „Vitoja“                  |
| KIA 11B | hypocrenal | 31/5/2018 | 42.325399  | 19.362963 | 10           | Spring „Vitoja“                  |
| KIA 12B | hypocrenal | 31/5/2018 | 42.486111  | 19.173611 | 38           | Spring „Kraljičino Oko“            |
| KIA 13A | eucrenal | 31/5/2018 | 42.540279  | 19.228056 | 444          | Spring „Studenec“                |
| KIA 14A | eucrenal | 1/6/2018   | 42.630280  | 19.033056 | 47           | Spring „Pećina“ (cave)          |
| KIA 14B | hypocrenal | 1/6/2018   | 42.630280  | 19.033056 | 42           | Spring „Pećina“ (cave)          |
| KIA 18A | eucrenal | 4/6/2018   | 42.857815  | 18.941944 | 661          | Spring „Vukovo Vrelo“, Vidrovan, |
| KIA 18B | hypocrenal | 4/6/2018   | 42.857815  | 18.941944 | 661          | Spring „Vukovo Vrelo“, Vidrovan, |
| KIA 20A | eucrenal | 4/6/2018   | 42.554169  | 19.105633 | 43           | spring at Zeta River in Danilovgrad |
| KIA 20B | hypocrenal | 4/6/2018   | 42.554170  | 19.105634 | 43           | spring at Zeta River in Danilovgrad |

Results & Discussion

Family Polycentropodidae

*Polycentropus flavomaculatus* (Pictet, 1834)

KIA 13(A), Studenac Spring: 31.V.2018, 2 fifth instar larvae.

*Plectrocnemia conspersa* (Curtis, 1834)

KIA 18(B), spring “Vukovo Vrelo” in Vidrovan: 04.VI.2018, 16 various instar larvae.

Family Brachycentridae

*Brachycentrus subnubilus* Curtis, 1834

KIA 20(B), spring at Zeta River in Danilovgrad: 04.VI.2018, 3 fifth instar larvae. **First record for Montenegro.** *B. subnubilus* is distributed in Northern and Western Europe, spreading from Scandinavia, to East- and North-Russia, Western Europe including the British Islands, the Iberian Peninsula, Central Europe, Italy and the northern Balkan (Croatia, Slovakia, Slovenia, and Bulgaria). Larvae of *B. subnubilus* usually occur in large rivers and streams in lower river sections and can even be found in brackish water (Waringer & Graf, 2011; Wallace *et al.* 2003).

Family Limnephilidae

*Halesus digitatus* (Schrank, 1781)
KIA 04(A), spring near Pričelje, 29.V.2018, 1 fifth instar larva; KIA 05(A), spring at Zeta River near Pričelje, 29.V.2018, 1 fifth instar larva; KIA 07(B), spring “Vriješko Vrelo” in Bandići, 30.V.2018, 1 fifth instar larva; KIA 09(B), Spring “Dobrik”, 30.V.2018, 1 fifth instar larva; KIA 14(A), Spring “Pećina” (cave), 01.VI.2018, 1 fifth instar larva; KIA 18(B), spring “Vukovo Vrelo” in Vidrovan: 04.VI.2018, 8 fifth instar larvae.

Potamophylax latipennis/luctuosus (larvae not separable).
KIA 18(A), spring “Vukovo Vrelo” in Vidrovan, 04.VI.2018, 1 fifth instar larva.

Limnephilus subcentralis Brauer, 1857 (most possible; needs confirmation with adults). If confirmed, then this is the first record for Montenegro. Due to the several unknown larvae of the tribe Limnephilini, it can not be confirmed with confidence based only on larval material. So far recorded from Britain, Central and Northern Europe, Scandinavia, Bulgaria, Croatia, Romania and Slovakia.

KIA 11 (A), Spring “Vitoja”: 31.V.2018, 2 larvae; KIA 11 (B), Spring “Vitoja”: 31.V.2018, 2 larvae.

Family Lepidostomatidae

Lepidostoma hirtum (Fabricius, 1775)
KIA 06(A), second spring at Zeta River near Pričelje, 29.V.2018, 1 ♂ pupa. First record for Montenegro. Lepidostoma hirtum is widespread throughout Europe and European Russia. From the Balkan Peninsula, it is present in Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece and Slovenia. Its presence in Montenegro fills the gap between its Balkan northernmost record (Croatia) and its southernmost (Greece). Larvae inhabit rivulets, small streams and rivers, the lake littoral and can even be found in brackish water (Tobias & Tobias, 1981; Waringer & Graf 2011; Wallace et al. 2003). They are often found among roots or debris of Alnus spp.

Family Leptoceridae

Athripsodes bilineatus (Linnaeus, 1758)
KIA 20(A), spring at Zeta River in Danilovgrad, 04.VI.2018, 2 fifth instar larva; KIA 20(B), spring at Zeta River in Danilovgrad, 04.VI.2018, 2 fifth instar larva.

Leptocerus interruptus (Fabricius, 1775)
KIA 06(A), second spring at Zeta River near Pričelje, 29.V.2018, 1 fifth instar larva; KIA 20(A), spring at Zeta River in Danilovgrad, 04.VI.2018, 1 fifth instar larva; KIA 20(B), spring at Zeta River in Danilovgrad, 04.VI.2018, 13 various instar larvae.

Mystacides azurea (Linnaeus, 1761)
KIA 06(A), second spring at Zeta River near Pričelje, 29.V.2018, 2 fifth instar larva.

Triaenodes ochreellus lefkas Malicky, 1974
KIA 06(A), second spring at Zeta River near Pričelje, 29.V.2018, 2 fifth instar larva. First record for Montenegro. Until recently, Triaenodes ochreellus was known from Plavnica (Marinković-Gospodnetić, 1981) but recent taxonomic works confirm that T. ochreellus ochrellus is so far only found in ecoregions 1, 2, 8 and 13 (Iberic-Macaronesian, Pyrenees, Western Highlands, Western Plains, respectively) and T. ochreellus lefkas in ecoregions 3, 5 and 6 (Italy, Corsica and Malta, Dinaric Western Balkan, Hellenic Western Balkan, respectively) (Graf et al. 2008; de Jong et al. 2014).

Family Sericostomatidae

Ecologica Montenegrina, 22, 2019, 34-39
Sericostoma personatum/schneideri (larvae not separable)
KIA 07(A), spring “Vriješko Vrelo” in Bandići, 30.V.2018, 3 fifth instar larvae; KIA 09(B), Spring “Dobrik”, 30.V.2018, 3 fifth instar larvae; KIA 12(B) Spring “Kraljičino Oko”, 31.V.2018, 2 fifth instar larvae; KIA 14(B), Spring “Pećina” (cave), 01.VI.2018, 1 fifth instar larva; KIA 18(B), spring “Vukovo Vrelo” in Vidrovan,: 04.VI.2018, 2 fifth instar larvae.

Based on current records, Sericostoma personatum Kirby & Spence, 1826 has not been recorded from most of the Balkans; thus it is probable that the species present in the drainage basin of Lake Skadar is Sericostoma scheideri Schneider, 1845. However, it must be noted that molecular analysis carried out by Leese (2004) revealed that the division of the Central European Sericostoma ‘species’ into S. personatum and S. schneideri seems to be questionable. Considering the current state of knowledge, the species status of Sericostoma species may change in the future.

Family Odontoceridae

Odontocerus albicorne (Scopoli, 1763)
KIA 09(A), Spring “Dobrik”, 30.V.2018, 4 fifth instar larvae; KIA 09(B), Spring “Dobrik”, 30.V.2018, 9 fifth instar larvae.

Family Uenoidae

Thremma anomalum McLachlan, 1876
KIA 18(B), spring “Vukovo Vrelo” in Vidrovan: 04.VI.2018, 4 fifth instar larvae. Confirmed record for Montenegro where it was considered absent. Recent research in western Serbia and northern Montenegro has shown no trace of this species, in spite of its previous presence and that its area boundary in Serbia has moved from the Drina river (as the western boundary) to the Lisinski Brook - Grza River line, i.e. about 100 km eastwards (Ţivić et al. 2013). Macrozoobenthos research within Serbian watercourses between 1989 and 2010 suggested a shift of the western boundary of its distribution. In Bosnia and Herzegovina, the species was found in only one of ten former localities, implying that the species might entirely vanish from zoographic region 5 in the near future (Ţivić et al. 2013). The finding of T. anomalum in this study confirms its presence in Montenegro; however more research is needed in the region to confirm the findings of Ţivić et al. (2013).

Faunistic surveys and records based on larvae are not frequently used or recommended, due to inability and uncertainty of identification to the species level in some cases (Waringer & Graf, 2011). However, we considered the current data as an important contribution to the knowledge of caddisfly fauna of Montenegro and it was proven that in some cases faunistic data based on larvae can be useful (e.g. Previšić et al. 2013). Nevertheless, future caddisfly surveys in the region, preferably based on adult material, will contribute significantly to the Trichoptera fauna of Montenegro. In addition, molecular analysis (DNA barcoding) will increase the knowledge of the species present in the area, where the caddisfly fauna is partially known. During this investigation, fourteen Trichoptera species were found; three being new records for Montenegro (Brachycentrus subnubilus, Lepidostoma hirtum, Triaenodes ochreellus lefkas) and one being a confirmed record of a previously thought lost species (Thremma anomalum). This investigation with several first records is a result of a few days collecting effort in Montenegro and shows that the country is still under-investigated.

Acknowledgements

Many thanks to Prof. Johann Waringer for verifying identification for some larva specimens, to Dr. Halil Ibrahimi for providing literature and information on Montenegrin Trichoptera, and to an anonymous reviewer for his/hers comments. We are grateful to Dr. Edyta Buczyńska for reviewing the manuscript and for her constructive comments and suggestions.
References

de Jong, Y. et al. (2014) Fauna Europaea - all European animal species on the web. Biodiversity Data Journal 2: e4034. https://doi.org/10.3897/BDJ.2.e4034

Graf, W., Murphy, J., Dahl, J., Zamora-Muñoz, C. & López Rodríguez, M.J. (2008) Trichoptera. In: Schmidt-Kloiber, A. & Hering, D. (Eds.), Distribution and ecological preferences of European freshwater organisms. Vol. 1. Pensoft, Sofia, 388 pp.

Ibrahimí, H., Pali, E., Bilalli, A., & Musliu, M. (2019) New records for the Caddisfly (Insecta: Trichoptera) fauna of Montenegro. Journal of the Entomological Research Society, (in press).

Kostianoy, A.G., Serykh, I.V. & Kostianaia, E.A. (2018) Climate change in the lake Skadar/Shkodra Region. The Handbook of Environmental Chemistry, vol. 80. Springer, Cham, pp. 63–88.

Krušnik, C. (1987) Trichoptera (Insecta). In: Fauna of Mt. Durmitor, Book 2. Montenegrin Academy of Science and Arts, Special edition, Book 21, Department of Natural Sciences, vol. 13, pp. 201–224. [in Serbian]

Leese, F. (2004). Molecular genetic, chemotaxonomic, and autecological investigations of European Sericostomatidae (Insecta: Trichoptera). Diploma Thesis, Ruhr-Universität, Bochum, 137 pp.

Marinković-Gospodnetić, M. (1981) Trichoptera of the Morača and Plavnica river drainages. In: Beeton, A.M., Karaman, G.S. (eds) The biota and limnology of Lake Skadar. University Veljko Vlahović, Institute of Biological and Medicine Research Titograd, Montenegro, pp. 307–309.

Oláh, J. (2011) New species and species records of Balkan Trichoptera. Folia Historico Naturalia Musei Matraensis, 35, 111–121.

Oláh, J. & Kovacs, T. (2013) New species and records of Balkan Trichoptera II. Folia Historico Naturalia Musei Matraensis, 37, 109–121.

Pešić, V., Savić, A., Jablonska, A., Mičoški, G., Grabawski, M., Baňkowska, A. & Zawal, A. (2019) Environmental factors affecting water mite assemblages along eucrenon-hypocrenon gradients in Mediterranean karstic springs. Experimental and Applied Acarology, 77 (4), 471–486.

Previšić, A., Brigić, A., Sedlar, Z. & Soštarić, R. (2013) First data on caddisfly (Insecta, Trichoptera) fauna of peatlands in Croatia. Natura Croatica, 22(2), 235–242.

Radovanović, M. (1935) Trihoptere Jugoslavije. Glasnik Zemaljskog Muzeja u Bosni i Hercegovini, 47, 73–84.

Radovanovic, M. (1953) Prilog poznavanju Trichoptera Balkanskog poluostrva, prvenstveno u peæinama i planinskim jezerima. Glas SAN, Odeljenje prirodno-matematièkih nauka, 7, 11–38.

Tobias, W. & Tobias, D. (1981) Trichoptera germanica: Bestimmungstafeln für die deutschen Käferläuse. Senckenbergische Naturforschende Gesellschaft.

Živić, I., Bjelanović, K., Sinić, V., Živić, M., Žikić, V. & Marković, Z. (2013) New Records of Thremma anomala (Trichoptera: Uenoidae) from Southeastern Europe with Notes on its Ecology. Entomological news, 123(3), 206–220. https://doi.org/10.3157/021.123.0307

Wallace, I.D., Wallace, B. & Philipson, G.N. (2003) A key to the case-bearing caddis larvae of Britain and Ireland. Freshwater Biological Association Scientific Publication, 61, 1–259 pp.

Waringer, J. & Graf, W. (2011) Atlas of Central European Trichoptera Larvae. Erik Mauch Publishers, Verlag, Dinkelscherben, 468 pp.