

The caddisfly fauna (Insecta: Trichoptera) of Shar Planina mountain (Republic of North Macedonia)

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Abstract



Shar Planina mountain, spanning through North Macedonia and Kosovo, are a significant biodiversity hotspot in the Western Balkans. Despite their ecological importance, data on the region's caddisfly (Trichoptera) diversity remain scarce and fragmented. This study compiles a comprehensive review of all published records alongside findings from a seven-year field investigation across various habitats in North Macedonia's part of Shar Planina mountain. As a result, the first checklist of Trichoptera species for the region is presented. According to literature and our new faunistic data, a total of 63 species are currently known from Shar Planina mountain. Notably, ten species are newly reported for the mountain and one is newly recorded for North Macedonia. The study highlights the conservation significance of these species and identifies ecologically sensitive areas based on caddisfly distribution. These findings enhance our understanding of freshwater biodiversity in a region recognized for its rich natural heritage.

Key words: caddisflies, rare species, distribution, Balkan Peninsula

Introduction

Shar Planina mountain belongs to the Dinaric range and extends across the border between Republic of North Macedonia and Kosovo. With a total area of 830 km² and main ridge stretching up to 80 km in length, Shar Planina presents one of the largest mountain ranges in North Macedonia (Melovski et al. 2013). Despite possessing significant landscape visual quality (Jovanovska et al. 2020), Shar Planina mountain are also considered treasured biodiversity hotspot in the Western Balkans (Miho et al. 2023). The outstanding diversity of habitats and remarkably high species

richness was emphasized many times (Melovski et al. 2010; UNEP 2020). However, the published literature data dedicated on check lists for specific taxonomic groups is considerably scarce or outdated. Although some data on the stonefly diversity of Shar Planina mountain exist (Ikonov, 1970, 1972), published records of investigations that summarize the diversity of other groups of aquatic insects are completely lacking. This especially applies to caddisflies, bearing in mind that Shar Planina mountain in Kosovo holds significant importance in terms of caddisfly fauna as it is inhabited by great number of rare caddisfly species (Ibrahimović et al. 2016a, 2016b; Ibrahimović & Vehapić 2017; Ibrahimović et

Submitted: 18.05.2025

Accepted: 28.05.2025

al. 2019, 2023). Unfortunately, within the Macedonian part of this mountain, the Trichoptera fauna remains insufficiently known. Namely, trichopterological research on the Macedonian part of Shar Planina mountain has been inconsistent, with significant gaps between studies (Radovanović 1953; Kumanski 1997; Kovachev et al. 1999; Mementi & Janeva 1999; Oláh & Kovác 2013, 2014; Oláh et al. 2017, 2022a, 2022b; Hinić - Jordanovska et al. 2024, 2025). These studies were only partial, with some being segments of broader research conducted across the Balkan Peninsula (Kumanski, 1997; Oláh & Kovác 2013, 2014; Oláh et al. 2017, 2022a, 2022b). As a result, the caddisfly diversity of Shar Planina mountain has never been the primary focus of scientific investigation.

This study compiles the findings from a thorough literature review of all published records on the caddisfly diversity of Shar Planina mountain (North Macedonia) combined with results from a seven-year investigation conducted across various aquatic and mire habitats in the region. Therefore, it provides the first checklist of Trichoptera species of Shar Planina mountain. The study offers insights into the conservation significance of caddisfly species and identifies ecologically sensitive areas in this region based on caddisflies. Finally, this study contributes to the ongoing efforts towards ecological connectivity within the transboundary regions, especially freshwater connectivity (Melovski et al. 2022).

Materials and Methods

Study area

All selected sampling localities were located on Shar Planina mountain region in the north-western part of the country (Table 1). This mountain massif spans from southern Kosovo to northwestern North Macedonia. The areas within Kosovo and North Macedonia are designated national parks. According to Jovanovska et al. (2020) these mountains are characterized by rugged terrain and sparse vegetation and are ranked among the highest in the Balkans, with 30 peaks exceeding 2,500 meters.

The entomological investigations on the caddisfly fauna on Shar Mountain were conducted in duration of seven years time on a total number of 28 sampling sites that included mountainous streams, springs, rivers, wetlands and glacial lakes on different altitudes situated within and above the forest zone of the mountain. This selection of sampling sites helped uncover the caddisfly diversity of this mountain in North Macedonia, considering that various habitat types were studied. All localities belong to the 6th ecoregion (Hellenic Western Balkan) according the classification made by Illies (1978). Detailed information about the sampling localities of the collected adult specimens are presented in Table 1.

Data reviewing, sampling and processing

The comprehensive literature review included all published records on the caddisfly fauna of the Shar Planina mountain, beginning with the earliest report by Radovanović (1953) and extending to the most recent findings by Hinić-Jordanovska et al. (2025).

Adult caddisfly specimens were collected with entomological nets during the day, as well as with ultraviolet (UV) pyramid light traps during the night. UV light traps were placed right next to each water body after dusk and operated for app. 60 minutes. Samplings were conducted during the period of August 2016 to September 2023. The collected material was preserved in 96% ethanol. Adult specimens were identified using a Nikon SMZ745 stereomicroscope with identification keys (Kumanski 1985, 1988; Malicky 2004). All collected specimens are deposited in the Macedonian National Collection of Invertebrates (MNCI) Skopje and at the Laboratory of Zoology of the Faculty of Natural and Mathematical Sciences, University of Prishtina, Kosovo. Systematic presentation follows Morse (2025). Conservation value assessment was completed based on the published literature data, web datasets (GBIF) and personal records on the species distribution area over the region as well as within the country. Once endemic and rare species were identified, their distribution on Shar Planina mountain was used in preparation of Map of ecologically sensitive areas in terms of caddisfly fauna (Figure 1).

Results

Based on the detailed literature review which included twelve research papers published from 1953 to 2025, a total of 52 caddisfly species classified into 14 families are reported from Shar Planina mountain (Table 2). The highest number of species were registered in the families Limnephilidae (17 species) and Rhyacophilidae (12 species), while Bereidae, Brachycentridae, Glossosomatidae, Goeridae, Leptoceridae, Lepidostomatidae, Polycentropodidae, Psychomyiidae and Uenoidae are the least diverse families (1 species). According to the results from the literature review presented in Table 2, six species are considered Balkan endemics, and two subendemic species, while the distribution of *Drusus sharrensis* Ibrahim, Previsic & Vitecek, 2016 *Limnephilus petri* Marinković Gospodnetić, 1966 and *Notidobia vaillanti* Oláh, Vinçon & Ibrahim, 2022 is restricted only to Shar Planina mountain making these three species stenoendemics.

During the seven-year field investigation, a total number of 47 species were recorded on Shar Planina mountain, belonging to eleven families: Bereidae, Glossosomatidae, Hydropsychidae, Lepidostomatidae, Limnephilidae, Philopotamidae, Psychomyiidae,

Table 1. Sampling sites from Shar Planina mountain (North Macedonia) visited within the period 2016 - 2023.

Code	Name of the locality	Waterbody	Longitude	Latitude	Altitude
T1	Stream on r. Pena (v. Brodec)	Stream	42°3'35.21"N	20°53'2.34"E	998 m
T2	Stream before v. Veshala	Stream	42°3'52.26"N	20°50'53.48"E	1194 m
T3	Stream above v. Bozovce	Stream	42°2'51.28"N	20°49'13.93"E	1257 m
T4	Wetland under Leshnica	Wetland	42°2'30.92"N	20°48'27.0"E	1352 m
T5	Wetland under Leshnica (stream)	Stream	42°02'29.7"N	20°48'23.5"E	1364 m
T6	Waterfall near v. Gajre	Stream	42°0'14.02"N	20°56'10.62"E	893 m
T7	Uliverica	Spring	41°59'38.78"N	20°51'49.36"E	1745 m
T8	Stream above the intake (v. Gjurgevishte)	Stream	41°54'20.67"N	20°49'47.66"E	1329 m
T9	Forrest stream on the road to r. Mazdraca	Stream	41°54'27.32"N	20°49'8.18"E	1295 m
T10	Stream above v. Novo Selo	Stream	41°56'54.83"N	20°51'43.04"E	1344 m
T11	Small stream on the road to r. Mazdraca	Stream	41°54'11.2"N	20°49'22.4"E	1130 m
T12	Flat mountain stream on the road to r. Mazdraca	Stream	41°54'11.9"N	20°49'40.0"E	1238 m
T13	Stream above Scardus (Popova Sapka)	Stream	42°01'01.2"N	20°52'51.0"E	1779 m
T14	Streams Leshnica	Stream	42°0'57.47"N	20°46'37.35"E	1548 m
T15	Small brooks after v. Bozovce	Stream	42°02'58.6"N	20°49'18.8"E	1238 m
T16	Stream after v. Lisec	Stream	41°59'58.4"N	20°55'14.7"E	1158 m
T17	Lukovo Pole	Spring	41°50'57.8"N	20°37'30.3"E	1661 m
T18	Springs above H. Bora (Popova Sapka)	Spring	42°00'51.9"N	20°52'10.3"E	1933 m
T19	Streams near cable cars (Popova Sapka)	Stream	42°00'50.0"N	20°52'38.5"E	1768 m
T20	Turchinski meadows – Krivoshijsko Lake, Hanoj (below peak Titov Vrv)	Spring	41°58'42.0"N	20°48'42.0"E	2202 m
T21	Turchinski meadows – Krivoshijsko Lake, Hanoj mountain stream (with moss)	Stream	41°58'43.0"N	20°48'38.0"E	2190 m
T22	Turchinski meadows – Krivoshijsko Lake, Mountain stream below Mal Turchin	Stream	41°58'39.0"N	20°47'29.0"E	2251 m
T23	Krivoshijsko Lake	Glacial lake	41°59'09.7"N	20°47'00.9"E	2237 m
T24	Meadow with mountain streams (Popova Shapka)	Stream	42°01'37.9"N	20°53'14.2"E	1802 m
T25	Stream Tiha voda	Stream	41°53'23.3"N	20°47'09.7"E	1317 m
T26	Jelovjanska reka river (upstream)	River	41°48'42.8"N	20°46'07.7"E	1306 m
T27	Kadi (Leshnica)	River	42°00'55.3"N	20°46'38.3"E	1581 m
T28	Streams near Karanikolicko Lake	Stream	42°04'34.6"N	20°48'29.0"E	1920 m

Table 2. List of caddisfly species reported for Shar Planina mountain in North Macedonia based on literature data.

Taxon	Literature data											Endemism	
	Radovanović, 1953	Kumanski, 1997	Kovacev et al. 1999	Memeti & Janeva, 1999	Oláh & Kováč, 2013	Oláh & Kováč, 2014	Waringer et al. 2015	Oláh et al. 2017	Oláh et al. 2022a	Oláh et al. 2022b	Himić - Jordanovska et al. 2024	Himić - Jordanovska et al. 2025	
Fam Bereidae													
Fam. Beraeidae													
<i>Beraea maurus</i> (Curtis, 1834)						+							
Fam Brachycentridae													
<i>Micrasena minimum</i> McLachlan, 1876		+	+		+	+							
Fam. Glossomatidae													
<i>Agapetus iridipennis</i> (McLachlan, 1879)					+								
Fam. Goeridae													
<i>Goera pilosa</i> (Fabricius, 1775)		+											
Fam. Hydropsychidae													
<i>Hydropsyche fulvipes</i> Curtis, 1834		+											
<i>Hydropsyche guttata</i> Pictet, 1834			+										
<i>Hydropsyche instabilis</i> (Curtis, 1834)		+	+										
<i>Hydropsyche mostarensis</i> Klapalek, 1898		+											
<i>Hydropsyche pellicidula</i> (Curtis, 1834)			+										
<i>Hydropsyche tabacarui</i> Botosaneanu, 1960			+			+							
Fam. Lepidostomatidae													
<i>Crunoecia bosniaca</i> Marinkovic-Gospodnetic, 1970						+						+	
Fam. Leptoceridae													
<i>Adicella filicornis</i> (Pictet, 1834)		+				+							
Fam. Limnephilidae													
<i>Allogamus auricollis</i> (Pictet, 1834)			+		+								
<i>Allogamus brauerii</i> (Kolenati, 1859)													+
<i>Drusus biguttatus</i> (Pictet, 1834)		+											
													Balkan endemic (Macedonia, Bosnia and Herzegovina and Kosovo)

Taxon	Literature data											Endemism	
	Radovanović, 1953	Kumanski, 1997	Kovacev et al. 1999	Memeti & Janeva, 1999	Olah & Kováč, 2013	Olah & Kováč, 2014	Waringer et al. 2015	Olah et al. 2017	Olah et al. 2022a	Olah et al. 2022b	Hinić - Jordanovska et al. 2024	Hinić - Jordanovska et al. 2025	
<i>Drusus botosaneanui</i> Kumanski, 1968							+						Balkan endemic (Macedonia, Serbia, Montenegro, Bulgaria, Greece)
<i>Drusus discolor</i> (Rambur, 1842)		+	+	+									
<i>Drusus sharrensis</i> Ibrahim, Previsic & Vitecek, 2016											+		Stenoendemic
<i>Ecdisopteryx keroveci</i> Previsic, Graf & Vitecek 2014								+					Balkan endemic (Macedonia, Kosovo, Montenegro, Bosnia and Herzegovina, Croatia)
<i>Limnephilus affinis</i> Curtis, 1834						+							
<i>Limnephilus bipunctatus</i> Curtis, 1834	+		+			+							
<i>Limnephilus sparsus</i> Curtis, 1834						+							
<i>Limnephilus petri</i> Marinković Gospodnetić, 1966												+	Stenoendemic
<i>Micropterna caesareica</i> Schmid, 1959		+											
<i>Micropterna nycterobia</i> McLachlan, 1875		+			+								
<i>Parachiona picicornis</i> (Pictet, 1834)					+								
<i>Potamophylax cingulatus</i> (Stephens, 1837)		+	+										
<i>Stenophylax meridionalis</i> Malicky, 1982			+		+								
<i>Stenophylax sequax</i> (McLachlan, 1875)					+								
Fam Philopotamidae													
<i>Philopotamus montanus</i> (Donovan, 1813)		+	+		+								
<i>Philopotamus variegatus</i> (Scopoli, 1763)		+											
<i>Wormaldia subterranea</i> Radovanović, 1932		+											
<i>Wormaldia pulla</i> (McLachlan, 1878)		+											
Fam Polycentropodidae													
<i>Polycentropus excisus</i> Klapalek, 1894		+											
Fam Psychomyiidae													
<i>Tinodes rostocki</i> McLachlan, 1878		+			+							+	
<i>Tinodes kimminsi</i> Sykora, 1962													

Taxon	Literature data											Endemism	
	Radovanović, 1953	Kumanski, 1997	Kovacev et al. 1999	Memeti & Janeva, 1999	Oláh & Kováč, 2013	Oláh & Kováč, 2014	Waringer et al. 2015	Oláh et al. 2017	Oláh et al. 2022a	Oláh et al. 2022b	Himić - Jordanovska et al. 2024	Himić - Jordanovska et al. 2025	
Fam Rhyacophilidae													
<i>Rhyacophila armeniaca</i> Guérin-Ménéville, 1843		+	+							+			Subendemic (Balkan, Caucasus and Asia Minor)
<i>Rhyacophila balcanica</i> Radovanovic, 1953					+								Balkan endemic (Macedonia, Albania, Kosovo, Bosnia and Herzegovina)
<i>Rhyacophila fasciata</i> Hagen, 1859			+										Balkan endemic (Macedonia, Greece, Bulgaria, Albania, Serbia, Kosovo, Montenegro, Bosnia and Herzegovina)
<i>Rhyacophila loxias</i> Schmid, 1970		+	+										
<i>Rhyacophila mocsaryi</i> Klapalek, 1898			+			+							
<i>Rhyacophila nubila</i> Zetterstedt, 1840			+										
<i>Rhyacophila oblitterata</i> McLachlan, 1863			+										
<i>Rhyacophila palmeni</i> McLachlan, 1879			+										
<i>Rhyacophila polonica</i> McLachlan, 1879			+										
<i>Rhyacophila tristis</i> Pictet, 1834			+										
<i>Rhyacophila vulgaris</i> Pictet, 1834			+	+		+							
<i>Rhyacophila sarplana</i> Oláh, 2022										+			Balkan endemic (Macedonia and Albania)
Fam. Sericostomatidae													
<i>Notidobia nekibe</i> Klapalek, 1903													
<i>Notidobia vaillanti</i> Oláh, Vinçon & Ibrahim, 2022						+				+			Stenoendemic
<i>Sericostoma flavicorne</i> Schneider, 1845		+	+										
Fam. Uenoidae													
<i>Threnna anomalum</i> McLachlan, 1876		+			+								Subendemic (Balkan and Caucasus)

Rhyacophilidae, Odontoceridae, Sericostomatidae and Uenoidae. Among the families, the highest number of species was recorded within the family Limnephilidae (21 species) and Rhyacophilidae (7 species), while Hydropsychidae (4) and Psychomyiidae (3) were less diverse families. All of the other caddisfly families were represented with only one or two species. Of all registered species, 10 are registered on Shar Planina mountain for the first time, while one species (*Limnephilus hirsutus* (Pictet, 1834)) is new for the fauna of the Republic of North Macedonia.

Systematic list of caddisflies collected at 28 sampling localities on Shar Planina mountain (North Macedonia):

- Family: BERAEDIAE Wallengren, 1891**
Genus: Beraea Stephens, 1836
1. *Beraea pullata* (Curtis, 1834)
Material examined:
T1. 15.7.2021. 5 ♂; T15. 1.6.2023. 4 ♂, 1 ♀; T24. 18.6.2017. 2 ♂.
Note: new for Shar Planina mountain (North Macedonia)
- Genus: Ernodes Wallengren, 1891**
2. *Ernodes articularis* (Pictet, 1834)
Material examined:
T1. 15.7.2021. 1 ♂.
Note: new for Shar Planina mountain (North Macedonia)
- Family: GLOSSOSOMATIDAE Wallengren, 1891**
Genus: Glossosoma Curtis, 1834
3. *Glossosoma discophorum* Klapálek, 1902
Material examined:
T1. 17.6.2021. 1 ♂, 1 ♀; T10. 17.6.2021. 1 ♂.
Note: new for Shar Planina mountain (North Macedonia)
- Genus: Synagapetus McLachlan, 1879**
4. *Synagapetus iridipennis* McLachlan, 1879
Material examined:
T15. 1.6.2023. 1 ♂.
- Family: Hydropsychidae Wallengren, 1891**
Genus: Hydropsyche Curtis, 1835
5. *Hydropsyche incognita* Pitsch, 1993
Material examined:
T1. 15.7.2021. 1 ♂, 38 ♀; T6. 17.6.2021. 3 ♂, 2 ♀, 15.7.2021. 10 ♂, 7 ♀, 1.9.2021. 7 ♂, 4 ♀.
Note: new for Shar Planina mountain (North Macedonia)
 6. *Hydropsyche instabilis* (Curtis, 1834)
Material examined:
T8. 17.6.2021. 7 ♀; T9. 17.6.2021. 4 ♂, 2 ♀.
 7. *Hydropsyche pellucidula* (Curtis, 1834)
Material examined:
T7. 15.7.2021. 2 ♂.
 8. *Hydropsyche tabacari* Botosaneanu, 1960
Material examined:
T1. 1.9.2021. 5 ♂, 11 ♀, 1.6.2023. 5 ♀; T10. 17.6.2021. 4 ♂; T2. 15.7.2021. 2 ♀, 17.6.2021. 1 ♂, 1 ♀.
- Family: LEPIDOSTOMATIDAE Ulmer, 1903**
Genus: Crunoecia McLachlan, 1876
9. *Crunoecia bosniaca* Marinkovic-Gospodnetic, 1970
Material examined:
T10. 17.6.2021. 1 ♂.
- Family: LIMNEPHILIDAE Kolenati, 1848**
Genus: Allogamus Schmid, 1955
10. *Allogamus uncatus* (Brauer, 1857)
Material examined:
T18. 20.11.2023. 2 ♂.
- Genus: Annitella Klapalek, 1907**
11. *Annitella triloba* Marinkovic-Gospodnetic, 1957
Material examined:
T7. 25.11.2023. 1 ♀.
- Genus: Chaetopteryx Stephens, 1829**
12. *Chaetopteryx stankovici* Marinkovic-Gospodnetic, 1966
Material examined:
T7. 25.11.2023. 1 ♂ 1 ♀.
- Genus: Drusus Stephens, 1833**
13. *Drusus botosaneanui* Kumanski, 1968
Material examined:
T6. 1.9.2021. 2 ♂ 1 ♀; T9. 17.9.2021. 6 ♂ 1 ♀; T19. 17.9.2021. 6 ♂.
 14. *Drusus biguttatus* (Pictet, 1834)
Material examined:
T20. 22.7.2017. 3 ♂ 2 ♀; T21. 22.7.2017. 3 ♂ 3 ♀; T22. 22.7.2017. 4 ♂; T23. 22.7.2017. 8 ♂ 2 ♀.
 15. *Drusus discolor* (Rambur, 1842)
Material examined:
T27. 15.8.2017. 2 ♀.
 16. *Drusus sharrensis* Ibrahim, Previsic & Vitecek, 2016
Material examined:
T7. 1.6.2023. 1 ♂ 1 ♀; T14. 1.6.2023. 1 ♀; T18. 12.9.2023. 1 ♂.
- Genus: Ecclisopteryx Kolenati, 1848**
17. *Ecclisopteryx keroveci* Previsic, Graf & Vitecek 2014
Material examined:
T1. 15.7.2021. 2 ♂ 2 ♀.
- Genus: Limnephilus Leach, 1815**
18. *Limnephilus auricula* Curtis, 1834
Material examined:
T3. 17.6.2021. 1 ♂ 1 ♀; T4. 17.6.2021. 7 ♂ 4 ♀; T19. 17.9.2022. 1 ♂.
Note: new for Shar Planina mountain (North Macedonia)
 19. *Limnephilus bipunctatus* Curtis, 1834
Material examined:
T4. 17.6.2021. 3 ♂; T5. 17.6.2021. 1 ♂; T18. 12.9.2023. 1 ♂; T19. 17.9.2022. 2 ♂.
 20. *Limnephilus hirsutus* (Pictet, 1834)
Material examined:
T24. 18.6.2017. 2 ♂.
Note: new for North Macedonia
 21. *Limnephilus sparsus* Curtis, 1834
Material examined:
T3. 17.6.2021. 1 ♂, 1.9.2021. 1 ♂ 1 ♀, 17.9.2022. 1 ♂; T7. 17.9.2022. 2 ♂ 1 ♀; T8. 17.6.2021. 1 ♀; T17. 1.6.2023. 2 ♂.
 22. *Limnephilus petri* Marinković Gospodnetić, 1966
Material examined:
T28. 1.8.2016. 1 ♂.
- Genus: Micropterna Stein, 1873**
23. *Micropterna caesareica* Schmid, 1959
Material examined:
T4. 17.6.2021. 1 ♂; T7. 15.7.2021. 3 ♂.
 24. *Micropterna nycterobia* McLachlan, 1875

- Material examined:
T3. 17.9.2022. 1 ♂ 1 ♀.
25. *Micropterna sequax* McLachlan, 1875
Material examined:
T3. 17.6.2021. 1 ♂ 1 ♀, 17.9.2022. 2 ♂ 1 ♀; T6. 17.6.2021. 1 ♀; T7. 17.9.2022. 1 ♂ 4 ♀; T9. 17.6.2021. 6 ♂ 3 ♀; T10. 17.6.2021. 1 ♂.
- Genus: *Potamophylax* Wallengren, 1891**
26. *Potamophylax latipennis* (Curtis, 1834)
Material examined:
T1. 1.9.2021. 1 ♂ 3 ♀, 17.9.2022. 1 ♀; T2. 17.9.2022. 2 ♂ 3 ♀; T3. 17.9.2022. 1 ♂ 2 ♀; T6. 1.9.2021. 1 ♂; T18. 12.9.2023. 2 ♀.
27. *Potamophylax luctuosus* (Piller & Mitterpacher, 1783)
Material examined:
T1. 17.6.2021. 1 ♂; T9. 1.9.2021. 1 ♂; T17. 1.6.2023. 1 ♂ 1 ♀.
28. *Potamophylax pallidus* (Klapalek, 1899)
Material examined:
T3. 17.9.2022. 1 ♂ 1 ♀; T7. 1.9.2021. 1 ♀, 17.9.2022. 21 ♂ 3 ♀; T13. 1.9.2021. 2 ♂.
- Genus: *Psilopteryx* Stein, 1874**
29. *Psilopteryx montanus* Kumanski 1968
Material examined:
T7. 24.11.2023. 1 ♂ 1 ♀.
- Genus: *Stenophylax* Kolenati, 1848**
30. *Stenophylax meridiorientalis* Malicky, 1982
Material examined:
T1. 17.9.2022. 1 ♂; T4. 17.6.2021. 2 ♀; T7. 1.9.2021. 3 ♀, 17.9.2022. 1 ♀; T8. 17.6.2021. 1 ♂; T10. 17.6.2021. 1 ♂; T13. 1.9.2021. 2 ♂ 1 ♀.
- Family: ODONTOCERIDAE Wallengren, 1891**
Genus: *Odontocerum* Leach, 1815
31. *Odontocerum hellenicum* Malicky, 1972
Material examined:
T1. 1.9.2021. 2 ♂, 15.7.2021. 9 ♂, 1 ♀.
Note: new for Shar Planina mountain (North Macedonia)
- Family: PHILOPOTAMIDAE Stephens, 1829**
Genus: *Philopotamus* Stephens, 1829
32. *Philopotamus montanus* (Donovan, 1813)
Material examined:
T1. 8.5.2021. 1 ♀, 17.6.2021. 11 ♂, 5 ♀, 15.7.2021. 14 ♂, 4 ♀, 17.9.2022. 2 ♂, 1.6.2023. 4 ♂; T2. 15.7.2021. 1 ♂, 1 ♀, 1.6.2023. 1 ♂; T3. 17.6.2021. 1 ♂, 15.7.2021. 1 ♂, 1 ♀; T6. 17.6.2021. 13 ♂, 8 ♀; T7. 18.6.2021. 4 ♂, 1 ♀, 15.7.2021. 1 ♂ 1 ♀, 1.9.2021. 1 ♂, 1.6.2023. 3 ♂; T8. 8.5.2021. 1 ♂, 17.6.2021. 6 ♂, 2 ♀, 15.7.2021. 6 ♂, 1.9.2021. 4 ♂; T9. 17.6.2021. 5 ♂, 2 ♀, 15.7.2021. 2 ♂, 1 ♀; T10. 17.6.2021. 5 ♂, 15 ♀; T12. 17.6.2021. 1 ♂, 1 ♀; T13. 1.6.2023. 3 ♂, 1 ♀; T14. 1.6.2023. 1 ♂; T15. 1.6.2023. 3 ♂; T16. 1.6.2023. 2 ♂; T17. 1.6.2023. 2 ♀; T19. 17.9.2022. 2 ♂; T25. 4.6.2017. 3 ♂; T26. 3.6.2017. 3 ♂.
- Genus: *Wormaldia* McLachlan, 1865**
33. *Wormaldia subterranea* Radovanovic, 1932
Material examined:
T1. 17.9.2022. 1 ♂; T3. 17.9.2022. 1 ♂.
- Family: PSYCHOMYIIDAE Walker, 1852**
Genus: *Tinodes* Leach, 1815
34. *Tinodes unidentatus* Klapalek, 1894
Material examined:
T1. 15.7.2021. 1 ♂, 1.6.2023. 1 ♀; T7. 15.7.2021. 1 ♂; T9. 15.7.2021. 1 ♂ 1 ♀.
- Note: new for Shar Planina mountain (North Macedonia)
35. *Tinodes rostocki* McLachlan, 1878
Material examined:
T1. 15.7.2021. 1 ♂ 1 ♀; T9. 17.6.2021. 2 ♂ 1 ♀.
36. *Tinodes kimminsi* Sykora, 1962
Material examined:
T1. 17.6.2021. 2 ♂.
- Genus: *Lype* McLachlan, 1878**
37. *Lype reducta* (Hagen, 1868)
Material examined:
T1. 15.7.2021. 2 ♂.
Note: new for Shar Planina mountain (North Macedonia)
- Family: RHYACOPHILIDAE Stephens, 1836**
Genus: *Rhyacophila* Pictet, 1834
38. *Rhyacophila balcanica* Radovanovic, 1953
Material examined:
T2. 17.9.2022. 2 ♂; T3. 17.6.2021. 3 ♂, 17.9.2022. 5 ♂; T9. 1.9.2021. 1 ♂.
39. *Rhyacophila fasciata* Hagen, 1859
Material examined:
T6. 1.9.2021. 3 ♂ 1 ♀; T9. 1.9.2021. 1 ♂.
40. *Rhyacophila fischeri* Botosaneanu, 1957
Material examined:
T1. 17.6.2021. 2 ♂.
Note: new for Shar Planina mountain (North Macedonia)
41. *Rhyacophila loxias* Schmid, 1970
Material examined:
T1. 15.7.2021. 22 ♂ 2 ♀, 1.9.2021. 2 ♂, 17.9.2022. 1 ♂; T2. 17.9.2022. 6 ♂ 1 ♀; T3. 17.9.2022. 3 ♂; T6. 17.6.2021. 11 ♂ 1 ♀, 1.9.2021. 7 ♂ 2 ♀.
42. *Rhyacophila mocsaryi* Klapalek, 1898
Material examined:
T1. 17.6.2021. 6 ♂; T2. 15.7.2021. 1 ♂ 1 ♀.
43. *Rhyacophila polonica* McLachlan, 1879
Material examined:
T7. 1.9.2021. 2 ♂, 17.9.2022. 5 ♂ 4 ♀; T13. 1.9.2021. 2 ♂.
44. *Rhyacophila tristis* Pictet, 1834
Material examined:
T1. 17.6.2021. 5 ♂ 1 ♀; T2. 17.6.2021. 2 ♂ 1 ♀, 15.7.2021. 2 ♀, 1.9.2021. 3 ♂; T8. 17.6.2021. 2 ♂ 1 ♀, T9. 17.6.2021. 9 ♂ 13 ♀, T10. 17.6.2021. 5 ♂ 7 ♀, T17. 1.6.2023. 10 ♂ 2 ♀.
- Family: SERICOSTOMATIDAE Stephens, 1836**
Genus: *Notidobia* Stephens, 1829
45. *Notidobia nekibe* Klapalek, 1903
Material examined:
T15. 1.6.2023. 2 ♂ 1 ♀.
46. *Oecismus monedula* (Hagen, 1859)
Material examined:
T9. 15.7.2021. 2 ♂.
Note: new for Shar Planina mountain (North Macedonia)
- Family: UENOIDAE Iwata, 1927**
Genus: *Thremma* McLachlan, 1876
47. *Thremma anomalum* McLachlan, 1876
Material examined:
T1. 8.5.2021. 2 ♂ 1 ♀; T3. 17.9.2022. 2 ♂; T9. 17.9.2022. 1 ♀.

The diversity assessment of the caddisfly fauna of Shar planina mountain in North Macedonia resulted with identification of 24 species of high conservational value (Table 3). Their distribution pattern revealed areas with high sensitivity for caddisfly fauna on Shar Planina (Figure 1).

The produced map of areas with high ecological sensitivity (Figure 1) indicates that the stream on river Pena in v. Brodec, the mountain stream above v. Novo Selo and above v. Bozovce, as well as the wetland below Leshnica and the vicinity of Krivoshisko and Karanikolicko lakes present localities that hold the most suitable conditions for obtaining populations of conservationally important caddisfly species, making them sensitive areas of Shar Planina mountain in terms of caddisfly fauna.

Discussion

The first data about the caddisflies on the Macedonian territory of Shar planina mountain was

published by Radovanović (1953) when *Limnephilus bipunctatus* Curtis, 1834 was reported from Livadichko Lake (Table 2). More than four decades later, only few studies (Kumanski 1997; Kovachev et al. 1999; Mementi & Janeva 1999) included localities within the mountain and provided information on the caddisfly diversity, estimating total number of 35 species. Later, some investigations at Popova Shapka, village Brodec, village Bozovce (Oláh & Kovác 2013, 2014) and Tetovska River (Oláh et al. 2017) contributed to the knowledge about these insects on Shar Planina mountain increasing the number to 45 species. After a five-year break, new data on the occurrence of caddisfly species on Shar Planina mountain occurred when *Allogamus brauerii* (Kolenati, 1859) was noted in a rocky stream at v. Veshala (Oláh et al. 2022a). Right afterwards, during their investigation in the Balkan Peninsula Oláh et al. (2022b) described two new species from Shar Planina mountain: *Rhyacophila sarplana* Oláh, 2022 and *Notidobia vaillanti* Oláh, Vinçon & Ibrahimi, 2022. Although the latter was previously listed as *Notidobia salihli* Malicky & Sipahiler, 1993 by Oláh & Kovác (2014) it was considered

Table 3. Caddisfly species of conservational value on Shar Planina mountain (North Macedonia).

Species	Conservation value
Fam. Beraeidae	
<i>Beraea pullata</i> (Curtis, 1834)	Rare species in North Macedonia
<i>Ernodes articularis</i> (Pictet, 1834)	Rare species in North Macedonia
Fam. Lepidostomatidae	
<i>Crunoecia bosniaca</i> Marinkovic-Gospodnetic, 1970	Balkan endemic; Rare species in North Macedonia
Fam. Limnephilidae	
<i>Allogamus brauerii</i> (Kolenati, 1859)	Rare species in North Macedonia
<i>Drusus biguttatus</i> (Pictet, 1834)	Rare species in North Macedonia
<i>Drusus botosaneanui</i> Kumanski, 1968	Balkan endemic
<i>Drusus sharrensis</i> Ibrahimi, Previsic & Vitecek, 2016	Stenoendemic
<i>Ecclisopteryx keroveci</i> Previsic, Graf & Vitecek 2014	Balkan endemic; Rare species in North Macedonia
<i>Limnephilus auricula</i> Curtis, 1834	Rare species in North Macedonia
<i>Limnephilus bipunctatus</i> Curtis, 1834	Rare species in North Macedonia
<i>Limnephilus hirsutus</i> (Pictet, 1834)	Rare species in North Macedonia
<i>Limnephilus petri</i> Marinković Gospodnetić, 1966	Stenoendemic
<i>Micropterna caesareica</i> Schmid, 1959	Rare species in North Macedonia
<i>Micropterna sequax</i> McLachlan, 1875	Rare species in North Macedonia
<i>Psilopteryx montanus</i> Kumanski, 1968	Rare species in North Macedonia
<i>Stenophylax meridiorientalis</i> Malicky, 1982	Rare species in North Macedonia
Fam. Rhyacophilidae	
<i>Rhyacophila armeniaca</i> Guérin-Méneville, 1843	Subendemic
<i>Rhyacophila balcanica</i> Radovanovic, 1953	Balkan endemic
<i>Rhyacophila fischeri</i> Botosaneanu, 1957	Rare species in North Macedonia
<i>Rhyacophila loxias</i> Schmid, 1970	Balkan endemic
<i>Rhyacophila sarplana</i> Oláh, 2022	Balkan endemic; Rare species in North Macedonia
Fam. Psychomyiidae	
<i>Tinodes kimminsi</i> Sykora, 1962	Rare species in North Macedonia
Fam. Sericostomatidae	
<i>Notidobia vaillanti</i> Oláh, Vinçon & Ibrahimi, 2022	Stenoendemic
Fam. Uenoidae	
<i>Thremma anomalum</i> McLachlan, 1876	Subendemic

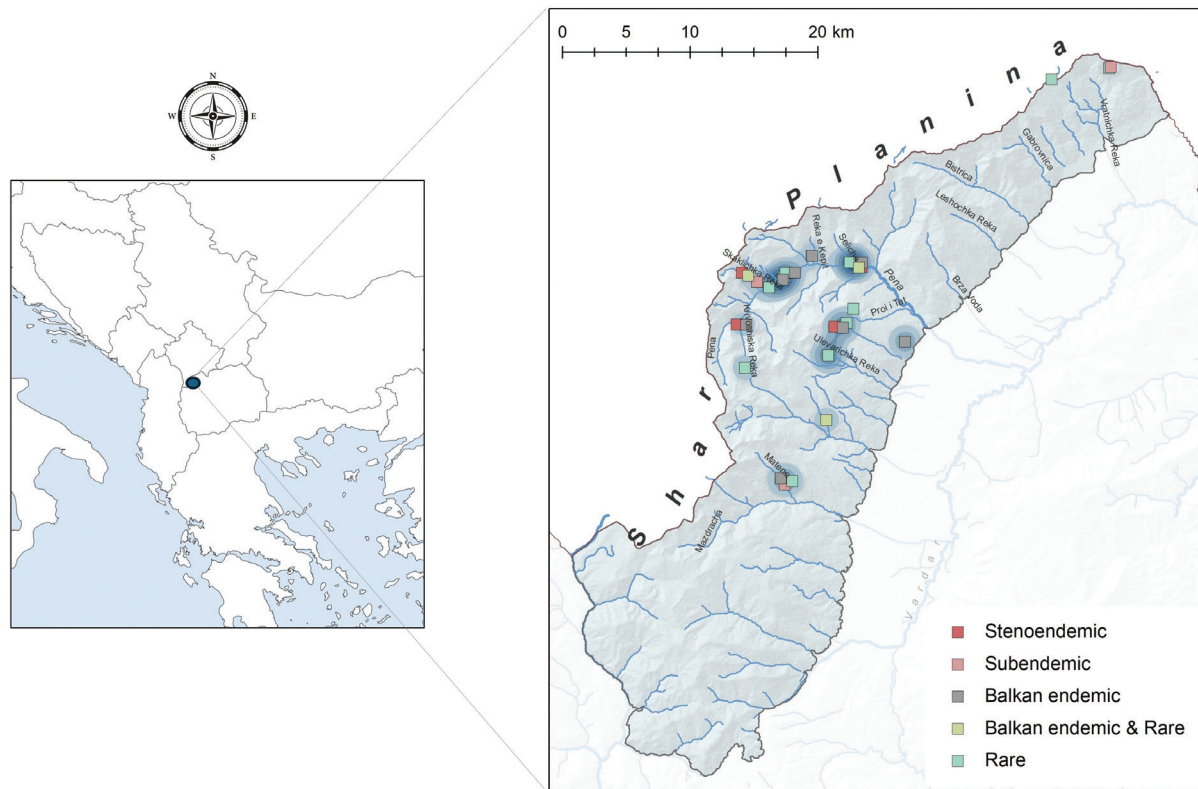


Figure 1. Map of areas with high ecological sensitivity on Shar Planina mountain (North Macedonia) in terms of caddisfly fauna.

as misidentification (Oláh et al. 2022b) and therefore it is not included in the species list. Recently, significant progress in terms of the knowledge of caddisfly diversity on Shar Planina mountain has been made when three new rare species *Crunoecia bosniaca*, *Drusus sharrensis* and *Tinodes kimminsi* were reported for the first time (Hinić-Jordanovska et al. 2024). The records of *C. bosniaca* and *D. sharrensis* along with the newly redescribed Balkan endemic *Limnephilus petri* (Hinić - Jordanovska et al. 2025) present new records not only for Shar Planina mountain, but also for North Macedonia.

The literature review of published records for Shar Planina mountain revealed a total of 52 caddisfly species. Although this number may seem significant, it is apparent that up until now there have not been any comprehensive investigations that included different habitats on Shar Planina mountain, thus leaving many caddisflies species yet undiscovered.

The most recent field investigations presented in this study showed 47 recorded species, out of which *Beraea pullata*, *Ernodes articularis*, *Glossosoma discophorum*, *Odontocerum hellenicum*, *Hydropsyche incognita*, *Tinodes unidentatus*, *Lype reducta*, *Rhyacophila fischeri*, *Limnephilus auricula* and *Oecismus monedula* are reported from Shar Planina mountain in North Macedonia for the first time. Additionally, *Limnephilus hirsutus* (Pictet, 1834) collected at Popova Shapka meadows with mountain streams (T24) is recorded for the first time and thus presents a new species for

the fauna of North Macedonia. Although it is recorded across Europe, it appears to be relatively uncommon on the Balkan Peninsula (Ibrahimi & Vehapi 2017). Namely, the only place where its populations were previously recorded is v. Brod on Shar Planina mountain in Kosovo (Ibrahimi & Vehapi 2017).

This study substantially enhances the existing inventory of caddisfly fauna in the Shar Planina Mountain, increasing the known species count to 63 with the addition of eleven newly recorded taxa.

Despite registering new species, the notation of *Limnephilus bipunctatus* from the mountain wetland below Leshnica (T4), mountain spring at Popova Shapka near Bora (T18) and near the cable cars (T19) present the first rediscovery of this species on Shar Planina mountain after a long period (Radovanović 1953). Having in mind that this species is considered to be very rare in North Macedonia and inhabits only Shar Planina (Radovanović 1953) and Bistra mountains (Oláh & Kovács 2013), discovering new populations can contribute to valuable insights for developing conservation approaches. When it comes to species with narrow distribution range, the results of our investigation revealed the presence of a considerable number of rare species on Shar Planina mountain which are new for the fauna of North Macedonia or currently known only from one or few: *Beraea pullata*, *Ernodes articularis*, *Tinodes kimminsi*, *Drusus biggutatus*, *Limnephilus bipunctatus*, *Limnephilus hirsutus*, *Limnephilus auricula*,

Stenophylax meridionalis Micropterna caesareica, Micropterna sequax, Psilopteryx montanus, Rhyacophila balcanica, and Rhyacophila fischeri.

Considering the rarity and the endemism aspects of the caddisfly fauna of Shar Planina mountain in North Macedonia, out of the total number of 63 species, 24 are considered species with high conservation values. Namely, the distribution range of *Drusus sharrensis*, *Limnephilus petri* and *Notidobia vaillanti* is restricted to Shar Planina mountain so these species present stenoendemic species, while *Crunoecia bosniaca*, *Drusus botosaneanui*, *Ecclisopteryx keroveci*, *Rhyacophila balcanica*, *Rhyacophila loxias* and *Rhyacophila sarplana* have a little wider distribution yet limited to the Balkan Peninsula. Despite stenoendemic and Balkan endemic species, the presence of two subendemic and 13 rare caddisfly species gives considerable value to Shar Planina mountain fauna. The detailed knowledge on their distribution over the studied region (Figure 1) can serve during the development of conservation and management schemes for the protection of biodiversity hotspots such as Shar Planina mountain National Park and safeguard this crucial species existence. Given their rarity and vulnerability to environmental changes and disturbances, they are highly susceptible to anthropogenic impacts, including climate change. Fortunately, in North Macedonia there are ongoing activities for reviewing National lists for strictly protected and protected wild species where inclusion of the Balkan endemic *C. bosniaca* and stenoendemics *D. sharrensis* and *L. petri* is proposed.

Conclusion

This study advances our understanding of caddisfly diversity in the Shar Planina mountain in North Macedonia, bringing us closer to uncovering the lesser-known components of the country's fauna. The findings underscore the importance of aquatic biodiversity and highlight the need to prioritize areas of very high conservation value regarding caddisfly fauna. By expanding the faunal inventory of the mountain, especially within biodiversity hotspots such as Shar Planina, our results provide a valuable foundation for future efforts aimed at sustainable management of freshwater and wetland ecosystems.

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