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Stoneflies (Plecoptera, Insecta) from Sharr Mountain: A review

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Abstract

This work summarizes both literature review and field observation on the fauna of Plecoptera (Insecta) of the Sharr Mountain, Macedonia. So far, ninety-three species of Plecoptera are known to occur in Macedonia. The recorded stoneflies belong to 18 genera and 7 families. Of them 38 species are known for the Sharr mountain from previous research. In addition, during the last field trip (July 2014 - December 2015) 15 species that belonging to 5 families were identified (Leuctridae, Chloroperlidae, Nemouridae, Perlidae and Perlodidae). The family Leuctridae is represented by 4 species, the family Chloroperlidae 2 species, the Nemouridae 5 species, the Perlidae 2 species and Perlodidae with 2 species. From a zoogeographical point of distribution, 3 species from the Plecoptera, recorded in Sharr Mountain are Balkan endemics: *Leuctra hirsuta, Protonemura matthey* and *Siphonoperla graeca.* The order of stoneflies as a whole is endangered and according to IUCN criteria three species of stoneflies: *Siphonoperla neglecta*, *Dinocras megacephala* and *Leuctra hirsuta* were classified as Vulnerable and are important for conservation status.

Keywords:Plecoptera, diversity, conservation status, Sharr Mountain, Macedonia

1. Introduction

Stoneflies are a small order of hemimetabole insects with more than 3497 species distributed worldwide, and this order is divided in two suborders Arctoperlaria and Antarctoperlaria, which includes 16 families from those 12, are arctoperlarian and 4 are antarctoperlarian while the total number of genera is 286. (Fochetti, Tierno de Figueroa, 2008) The order name Plecoptera comes from the Greek "pleco" that meaning folded and "ptera" wing, and this corresponds to the position of the adult insect when it is in silence where the hind wings are plaited under the front wings. Stoneflies are found on all continents, except Antarctica, and the diversity of species is higher in soft and high altitude regions, while their diversity falls rapidly from Asian breadth (where there are nine families) to tropical (where there are four or fewer families) and also most of them are stenotermal and the water temperature plays an important role in the distribution, the hatching of the eggs as well as in the appearance of the adults (Sivec I., 2004)Plecoptera is characterized by a complex life cycle that includes aquatic larval stage and terrestrial adult stage which is characterized with short lifetime from several days to several weeks and the majority of them feeding with plant material. Distinctive features of the order are: two pairs of membranous wings with complex venation, two long caudal filaments or cerci, long multi-segmented antennae and two claws in each tarsus of the legs.

The first researches with the group of plecoptera in the Western Macedonia are related to Czech Entomologists J. Komárek and J. Štorkan in 1928 and three years later Prof.dr. S. Stanković and Dr. J. Šamal have assembled stoneflies in the mountains of Western Macedonia such as: Sharr Mountain, Korab, Pelister, Jakupica and in 1935 the entomologist Dr. J. Šamal with the material of these two collections has confirmed 25 species of plecoptera.

In Macedonia are known 93 species of plecoptera based on the researches of Petar Ikonomov for two decades (Ikonomov P. , 1972) (Ikonomov. P. , 1980) (Ikonomov P. , 1986) and these stoneflies belong to 18 genera and 7 families and in 2011 was described a new species of stoneflies *(Siphonoperla korab sp.n .)*. (Graf, W. Popijac, A.Previsic, A. Gamboa, M. Kucinic, M., 2012) Comparing the diversity of Macedonia's stoneflies with neighboring

countries of Balkan Pennisula Macedonia is in third position, the highest number of species was recorded in Bulgaria (108 species), Slovenia 100 and under Macedonia are Serbia with 90 species, followed by Bosnia and Herzegovina with 73 taxa and with lowest diversity is Montenegro with 57 stonefly species. (Ana Petrovic, Vladica Simic, Djuradj Milosevic, Momir Paunovic, Ignac Sivec, 2014) The world's first catalog of stoneflies was ranked by (Claasen, 1940) with 1355 species and later J. Illies, 1966 has described 1484 species of Plecoptera and Fochetti&Tierno de Figueroa (2008) has described 3497 species.

Stoneflies are an important insect order because they are more sensitive than other insect species and can not tolerate high degree of pollution in biotopes so they are real indicators of the state of a biotope and this work summarizes both literature review and field observation on the fauna of plecoptera in the Sharr Mountain, Macedonia.

2. Material and Methods

The first section of this work includes literature review and observation of material from stoneflies collection at the **Macedonian Museum of Natural History in Skopje,** where I had the opportunity to observe all the Macedonian species with special interest those of Sharr Mountain.

During the field trip aquatic larvae and terrestrial adults of stoneflies were collected (from July 2014 - December 2015) with relevant techniques including the entomological net for collecting adult forms and Surber's net for collecting larvae forms approximately two hours at each location. For this field observation were needed these tools:

- Entomological special nets
- Laboratory bottles with screw caps
- Entomological forceps
- Graphite pencil and labels containing data about locations, dates of field trips and environmental characteristics
- GPS and altimeter for measuring the geographic coordinates (latitude and longitude) and the sea level altitude
- Camera for photographing localities and material.

The collected material was placed in laboratory bottles with screw caps filled with 4.5% formalin for larvae and filled with 75 % EtOH for adult forms. The identification of larval and adult forms of the Plectopera we have realized in the laboratory of the Faculty of Natural Sciences and Mathematics with stereomicroscope National model No 407 TBL using illustrations in different keys for stoneflies determination such as: *Freshwater Invertebrates of the Malaysian Region* (Sivec I., 2004)*,A monograph of the plecoptera or stoneflies of America North of Mexico* (Claassen, 1925), Russian key for larvae forms (Telsenko, 2009)and publications of P. Ikonomov. (Ikonomov. P. , 1978) (Ikonomov. P. , 1980) (Ikonomov. P. , 1983)

3. Results

During this field trip from July 2014 - December 2015 were identified 15 species that belonging to 5 families (Leuctridae, Chloroperlidae, Nemouridae, Perlidae and Perlodidae). The family Leuctridae is represented by 4 species (*Leuctra hirsuta* Bogoescu&Tabacaru,1960, *Leuctra mortoni* Kempny, 1899, *Leuctra braueri* Kempny, 1898, *Leuctra prima* Kempny, 1899) the family Chloroperlidae 2 species (*Siphonoperla neglecta* (Rostock 1881), *Siphonoperla graeca*(Aubert, 1956), the Nemouridae 5 species (*Protonemura hrabei* Rauser, 1956, *Protonemura nitida* (Pictet 1935), *Protonemura Montana* Kimminis 1941, *Protonemura mattheyi* (Aubert, 1956), *Nemoura cinerea (*Retzius,1783) , the Perlidae 2 species (*Perla marginata* (Panzer 1799),*Dinocras megacephala* (Klapalek, 1907) and Perlodidae with 2 species (*Perlodes jurassica* Aubert, 1946, *Isoperla tripartita* Illies 1954).

The distribution of stoneflies species in 13 localities in Sharr Mountain is presented in Table 2 and in Table 1 is presented the date of field trip and the geographic coordinates and the sea level altitude of localities and examples of “hot keys” are photographed in Figure 1.

Table 1. Localities and geographic coordinates during the period of field trip (July 2014-December 2015)

Locality		Date of field trip	Latitude	Longitude	Altitude
1.	Aerodrom, Lisec Sharr Mountain	23.07.2014	N 42° 00' 257"	E 20° 53' 184"	1713 m
2.	Uliverica	23.07.2014	N 41° 59' 50"	E 20° 52' 48"	1690 m
3.	Popova Sapka, above Hotel Bora	17.08.2014 15.03.2015 20.09.2015	N 42° 00' 09,80"	E 20° 52' 60,80"	1812 m
4.	Popova Sapka	17.08.2014 15.03.2015 26.04.2015 20.09.2015	N 42° 01' 03,61"	E 20° 52' 49,61"	1761 m
5.	Stream Popova Sapka Lisec	24.08.2014	N 42° 01' 04,98"	E 20° 52' 15,19"	1950 m
6.	Girl Meadow	24.08.2014	N 41° 59' 17,09"	E 20° 51' 05,96"	1966 m
7.	Bara Vakof - The water supply of Tetova	24.08.2014	N 41° 58' 44,30"	E 20° 50' 58,27"	1958 m
8.	Kara Bunar	24.08.2014	N 41° 58' 16,56"	E 20° 50' 57,50"	1945 m
9.	Urvic	24.08.2014	N 41° 58' 17,87"	E 20° 51' 14,40"	1916 m
10.	Uliverica	24.08.2014	N 41° 59' 34,40"	E 20° 51' 45,34"	1752 m
11.	Water source above the village Duf	23.11.2014	N 41° 44' 06,36"	E 20° 47' 20,24"	1261 m
12.	Popova Sapka	20.09.2015	N 42° 0' 46.4868"	E 20° 52' 53.0688"	1703 m
13.	Water source near village Novoselo	05.12.2015	N 41° 56' 43,11"	E 20° 53' 13,27"	1142m

Table 2. Plecoptera species identified during field trip and their distribution in 13 localities in Sharr Mountain

Families and species of plecoptera	Localities												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Leuctridae ***Leuctra hirsuta*** **Bogoescu&Tabacaru 1960**	+	-	+	-	-	-	+	+	+	+	-	+	+
Leuctra prima **Kempny, 1899**	-	-	-	+	-	-	-	-	-	-	-	-	-
Leuctra mortoni **Kempny, 1899**	-	-	-	+	-	-	-	-	-	-	-	+	-
Leuctra braueri **Kempny, 1898**	-	-	-	-	-	-	-	-	-	-	-	+	-

Chloroperlidae ***Siphonoperla neglecta* (Rostock 1881)**	-	+	-	-	-	+	-	-	+	-	-	-	-
***Siphonoperla graeca* (Aubert, 1956)**	-	-	-	+	-	-	-	-	-	-	-	-	-
Perlodidae ***Perlodes jurassica* Aubert, 1946**	-	-	+	+	-	-	-	-	-	-	-	-	-
***Isoperla tripartita* Illies 1954**	-	-	-	+	-	-	-	-	-	-	-	+	-
Nemouridae ***Protonemura hrabei* Rauser, 1956**	-	-	+	-	-	-	-	-	-	-	-	-	-
***Protonemura nitida* (Pictet 1935)**	-	-	+	-	-	-	-	-	-	-	-	-	-
***Protonemura Montana* Kimminis 1941**	-	-	+	-	-	-	-	-	-	-	-	-	-
***Protonemura mattheyi* (Aubert, 1956)**	-	-	+	-	-	-	-	-	-	-	-	-	-
***Nemoura cinerea (*Retzius,1783)**	-	-	-	+	-	-	-	-	-	-	-	-	-
Perlidae ***Perla marginata* (Panzer 1799)**	-	-	-	+	+	-	-	-	+	+	+	-	+
***Dinocras megacephala* (Klapalek, 1907)**	-	-	-	+	-	-	-	-	-	-	-	-	-

a) b)

c) d)

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Fig. 1. General keys for identification *Nemoura cinerea* (a, b) and *Siphonoperla graeca* (c, d)

a) 2nd tarsal segments of hind legs are shorter than 1st and 3rd segments
b) Long setae stretched over femur of hind legs
c) 1st and 2nd tarsal segments much shorter than the 3rd segments
d) The last segment of the maxillary palp reduced and this is the main characteristic of the genus Siphonoperla.

4. Conclusions

Compared to other Balkan countries, Macedonia is characterized by a large number of species, immediately after Bulgaria (108 taxa) and Slovenia (with 100 species). Serbia comes after Macedonia, with 90 species (Ana Petrovic, Vladica Simic, Djuradj Milosevic, Momir Paunovic, Ignac Sivec, 2014), Bosnia 73 taxa, Montenegro with 57 and in Croatia the number of species is 50. Based on literature data for Sharr Mountain are recorded 38 species of stoneflies approximately 40.86% of the total number of Macedonian stoneflies, as a result of this we conclude that Sharr Mountain has a high diversity and should be given importance to conservation status in the future because this insect order is an important ecological and numerical component in aquatic ecosystems.

Stoneflies in general are endangered order in Europe and has been researched that at least 324 taxa (62.79%) can be included in one or more categories of vulnerability to climate change and also of these, 43 taxa would be included in three or more vulnerability categories, representing the most threatened taxa. (J. M. Tierno de Figueroa, 2010) and in accordance with the criteria of the *International Union for Conservation of Nature* (IUCN) three species have been classified as vulnerable and important for conservation status (*Siphonoperla neglecta, Dinocras megacephala* and *Leuctra hirsuta*) meaning they are likely to become endangered in the near future if the causative factors continue to operate. This order of insects has a moderate level of endemism (V. Tyufekchieva., V. Evtimova., L. Kenderov, 2016) and from a zoogeographical point of distribution, 3 species of Plecoptera, identified on Sharr Mountain, are Balkan endemics: *Leuctra hirsuta, Protonemura matthey* and *Siphonoperla graeca.*

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