Revision of stoneflies (*insecta: plecoptera*) fauna in Uzbekistan

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Abstract. This article presents data on the study of the fauna of *Plecoptera* watercourses in Uzbekistan. On the basis of original collections of larvae/nymphs and adults of stoneflies and data from literary sources, a revision of the fauna of stoneflies of Uzbekistan was carried out, which currently numbers 48 species belonging to 19 genera and 7 families. Among them, endemic species were identified, first identified for Central Asia and for Uzbekistan.

1 Introduction

Despite the implementation of multilateral studies of the biodiversity of Uzbekistan's ecosystems, in particular, water, the available information in the literature is very scarce and insufficient to solve the environmental problems of our time, and additional scientific work is required [1]. The lack of information on aquatic organisms is especially acute, among which amphibiotic insects - stoneflies of the order *Plecoptera* - are considered one of the important components of indicators of the ecological state and water quality of surface sources [1, 2].

Hydrobiological studies in the territory of Uzbekistan were carried out mainly on large rivers and lake-river systems, while the study of water bodies of small rivers and water bodies of the republic is insignificant and remains poorly studied [2, 3]. The fauna of the stoneflies of Uzbekistan also remains insufficiently studied, since the stoneflies were studied mainly as an integral part of the zoobenthos [3, 12].

The fauna of stoneflies of Central Asia, in particular Uzbekistan, is extremely poorly studied. In the first literary reports, mostly foreign [1, 2], there are only a few scattered descriptions of the species, which make it possible to judge the presence of representatives of 5 families of this order in flowing water bodies of mainly mountainous regions of Central Asia [3].

The first list of stoneflies of Central Asia, consisting of 20 species, is given by LA Zhiltsova in 1969, indicating that 3 species (*Protonemurameyeri* Pict, *Amphinemurastandfussi* Ris, *Nemouraavicularis* Mort) are clearly identified erroneously and 4 are identified as *Nemourasp*, *Leuctrasp*, *Capniasp*, and *Isogenussp* [4-8]. Of the 9 represented species of the Nemouridae family, only 5 species are reliably indicated, of

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which 3 species of the genus *Amphinemura* (*A. crinata* Kop, *A. maracandica* McL, *A. tragula* Kimm) and 2 species of the genus *Nemoura* (*N. cinerea* Retz, *N. ornate* McL). The family Capniidae was especially poorly collected and studied earlier. From this family, 1 genus and 1 species are reliably indicated (*Capnia turkestanica* Kimmins, 1950) [6-8].

The second species, *Capnianigra* Pict, was clearly identified in error, as can be judged from the remark of Kimmins, who described the species *Capnia turkestanica* and indicated that he describes this species from the specimens identified earlier by McLachlan [1875] as *Capnianigra* Pict [12, 14].

In 1969 L.A. Zhiltsova published a description of 5 new Central Asian species: 4 from the genus *Capnia* (*C. bimaculata* Zhiltz, *C. hamifera* Zhiltz, *C. longicauda* Zhiltz, *C. prolongata* Zhiltz); 1 genus and 1 species new to Central Asia - *Isocapnia* (*I. aptera* Zhiltz), and *Capnia* species are close to the Tibetan and Himalayan species; complements the descriptions of *Capnia turkestanica* Kimmins, 1950 and 1 genus new to the fauna of the CIS - *Eucapnopsis* (*E. stigmatica transversa* Aubert) [4].

In 1970 L.A. Zhiltsova carried out a revision of the Central Asian species of stoneflies of the genus *Mesoperlina* Klap from the family Perlodidae. The genus includes 5 species: *M. ochracea*, *M. muricata*, *M. pecirkai*, *M. capnoptera* and a new species described from the Turkestan and Gissar ridges [5, 6].

In 1971 L.A. Zhiltsova supplements the list of Central Asian species of stoneflies of the family Nemouridae: 4 species of the genus *Amphinemura* - *Nemoura* (*Amphinemura*) *tragula* Kimm., *Nemoura* (*Amphinemura*) *maracandica* McL., *Nemoura* (*Amphinemura*) *gritsayae* Zhiltzova, sp. n., *Nemoura* (*Amphinemura*) *zimmermanni* Joost.; 4 species of the genus *Nemoura* - *Nemoura* (*Nemoura*) *hamulata* Zhiltzova, sp. n., *Nemoura* (*Nemoura*) *alabeli* Zhiltzova, sp. n., *Nemoura* (*Nemoura*) *lepnevae* Zhiltzova, sp. n., *Nemoura* (*Nemoura*) *ornate* McLachlan and 2 species of the genus *Protonemura* - *Nemoura* (*Protonemura*) *vaillanti* (Navas), *Nemoura* (*Protonemura*) *tianshanica* Zhiltzova, sp. n. It was reported that the early indication of the presence of *Amphinemurastandfussi* in the fauna of Central Asia is erroneous and gives a description of 5 species new to science: *Nemoura* (*Amphinemura*) *gritsayae* Zhiltzova, sp. n., *Nemoura* (*Nemoura*) *hamulata* Zhiltzova, sp. n., *Nemoura* (*Nemoura*) *alabeli* Zhiltzova, sp. n., *Nemoura* (*Nemoura*) *lepnevae* Zhiltzova, sp. n., and *Nemoura* (*Protonemura*) *tianshanica* Zhiltzova, sp. N [4-8].

A brief overview of the insect fauna of Uzbekistan (25 species from 9 genera and 6 families) covering the territory of the neighboring republics of Central Asia reports the identification of 52 species from 10 genera and 6 families of stoneflies, of which about 80% are endemic [8]. Noting at the same time that the fauna of stoneflies of Central Asia is very peculiar and its main features are: pronounced impoverishment, a high degree of endemism at the species level, a connection with the Central Asian fauna, and the absence of widespread Palearctic species are noted. A number of genera and even one family, richly represented in other regions of the Palearctic, are absent here. The impoverishment of the fauna is manifested in a general decrease in the number of species, while the percentage (80%) of endemic species is high, only some of them go beyond Central Asia [13, 15].

Thus, the main purpose of this work was to revise the fauna of stoneflies in watercourses in Uzbekistan and study the modern species composition.

2 Materials and methods

Monitoring of the breeding sites of stoneflies, subject to varying degrees of anthropogenic impact, was carried out from May to November 2017-2019 by route surveys of flowing freshwater reservoirs of different types (rivers, sais, springs, irrigation collectors, irrigation ditches) and visual inspection of stones immersed in their water and vegetation in 5 regions of Uzbekistan: northeastern (Tashkent, Tashkent province), eastern (Namangan, Fergana

provinces), central (Bukhara, Jizzakh, Navoi, Samarkand provinces), southern (Kashkadarya, Surkhandarya provinces) and southwestern (Republic Karakalpakstan) [12, 18].

The collection of larvae/nymphs of stoneflies from water bodies was carried out manually or with tweezers during visual inspection of stones and submerged vegetation near the coast and on rifts, as well as taking a sample of macrozoobenthos from the water body [13, 16].

The larvae/nymphs of stoneflies collected during visual inspection of stones and flooded objects were selected manually or with tweezers, immediately placed in a separate container and fixed with a 70° ethanol solution, which was labeled with the date and place of collection, coordinates, and the name of the collector.

To collect macrozoobenthos in a watercourse, depending on the depth and speed of water flow, they washed off stones and other flooded objects into a hydrobiological net (ø 20 cm from gas) or dug up pebbles and stones with our feet in front of a net placed against the stream so that insects would fall into the net [9-11].

Thus collected in a net, the biomass was immediately carefully washed under running water and then transferred to a container with tweezers, fixing with a 70 ° ethanol solution and providing a label indicating the date and place of collection, coordinates, and the name of the collector.

Later, in the laboratory of Entomology of the Institute of Zoology of the Academy of Sciences of the Republic of Uzbekistan, they analyzed the washings of macrozoobenthos according to systematic groups to the levels of type, class or order according to F. Mayer's method, carrying out qualitative and quantitative accounting of the collected biomass [12, 18]. Microscopic examination of insects was carried out using *MEIJITECHNO* stereoscopic and biological microscopes.

The collection of adults of stoneflies found on plants, stones, or other objects near water bodies and at the surface of the water was carried out manually or with tweezers. Flying insects were caught with an entomological net (ø 20 cm made of dense fabric or gas) by the “mowing” method over vegetation (100 sweeps of 1 m in one direction and back). Then the collected insects were placed in a separate container, fixed with a 70° ethanol solution, or, having killed, on a cotton mattress. Samples were labeled accordingly, indicating the date and place of collection, coordinates, and the name of the collector.

The identification of stoneflies was carried out mainly according to the larval stages of development (2493 larvae/nymphs, 375 adults) using the corresponding identification tables [8-11, 17].

The collected material is kept in the funds of the Entomological collection of the Institute of Zoology of the Academy of Sciences of the Republic of Uzbekistan.

3 Results and discussion

The monitoring of the places of breeding trees, carried out by us in the watercourses of 5 regions of Uzbekistan (northeastern, eastern, central, southern and southwestern regions), made it possible to obtain data on their uneven, sometimes even local, settlement across the territory of the republic. The survey covered 129 watercourses in 32 regions of the republic (Tashkent city, 9 provinces and the Republic of Karakalpakstan) and collected 663 samples of macrozoobenthos.

The index of occurrence of stoneflies in the republic in samples of zoobenthos was 37.1%, in regions - 28.1%. Most often, stoneflies were found in the mountain-foothill watercourses of the northeastern and southern (33.3%), central (22.2%) and eastern (11.1%) regions. No freckles were found in samples from the southwestern region (steppe, desert) of the republic (Republic of Karakalpakstan). Based on original collections of larvae/nymphs

of stoneflies in watercourses of the republic and adults around them [17, 18], as well as data from literary sources, we revised the fauna of the stoneflies of Uzbekistan, taking into account the synonymous names, which made it possible to clarify the composition of the fauna of the stoneflies of Uzbekistan (Table 1).

Table 1. Species composition of stoneflies (Plecoptera) in water sources in Uzbekistan.

Family	Genus	Type
Systellognatha Enderlein Group, 1969 : Zwick, 2000		
Perlodidae Klapálek, 1912	<i>Isoperla</i> Banks, 1906	<i>Isoperla difformis</i> Klapálek, 1909 (= <i>Chloroperla difformis</i> Klapálek, 1909)
		<i>Isoperlas</i> p.
	<i>Mesoperlina</i> Klapálek, 1921	<i>Mesoperlina capnoptera</i> (McLachlan, 1886) (= <i>Chloroperla capnoptera</i> McLachlan, 1886 – cem. Chloroperlidae)*
		<i>Mesoperlina ochracea</i> Klapálek, 1921
		<i>Mesoperlina pecirkai</i> Klapálek, 1921*
		<i>Mesoperlina</i> sp.
	<i>Arcynopteryx</i> Klapálek, 1904	<i>Arcynopteryx compacta</i> McLachlan, 1892
	<i>Diura</i> Billberg, 1820	<i>Diura knowltoni</i> Frison, 1937**, ***
		<i>Diura</i> sp.
	<i>Filchneria</i> Klapálek, 1908	<i>Filchneria mesasiatica</i> Zhiltzova, 1971*, ***
		<i>Filchneriamongolica</i> (Klapálek, 1901)
		<i>Filchneria olgae</i> McLachlan, 1875 (= <i>Dictyopteryx olgae</i> McLachlan, 1875; <i>Skobeleva olgae</i> (McLachlan, 1875)*
		<i>Filchneria</i> sp.
Perlidae Latreille, 1802	<i>Agnatina</i> Klapálek, 1907 (= <i>Perla</i> Geoffroy, 1761)	<i>Agnatina cocandica</i> (McLachlan, 1875) (= <i>Kamimuriacostulata</i> Navás, 1923; <i>Perlacocandica</i> McLachlan, 1875; <i>Phasganophora undata</i> Klapálek, 1921)
		<i>Agnatina immersa</i> (McLachlan, 1875) (= <i>Perlaimmersa</i> McLachlan, 1875)*
		<i>Agnatina pedata</i> (Koponen, 1949) (= <i>Phasganophora pedata</i> Koponen, 1949)*
		<i>Agnatina</i> sp. (= <i>Phasganophora</i> sp.).
	<i>Dinocras</i> Klapálek, 1907 : Claassen, 1940	<i>Dinocras cephalotes</i> (Curtis, 1827) (= <i>Perlabaetica</i> Rambur, 1842; <i>Perlancephalotes</i> Curtis, 1827)
Chloroperlidae Okamoto, 1912 : Illies, 1966	<i>Chloroperla</i> Newman, 1836 (= <i>Isopteryx</i> Pictet, 1841)	<i>Chloroperlatripunctata</i> (Scopoli, 1763) (= <i>Isopteryx tripunctata</i> Scopoli, 1763)
	<i>Siphonoperla</i> Zwick, 1967	<i>Siphonoperla montana</i> Pictet, F.J., 1841 : Zwick, P. 1972 (= <i>Perla</i> (<i>Isopteryx</i>) <i>montana</i> Pictet, F.J., 1841; <i>Chloroperla</i> <i>montana</i> Pictet, F.J., 1841)
	<i>Xanthoperla</i> Zwick, 1967	<i>Xanthoperla curta</i> McLachlan, 1875 (= <i>Chloroperla curta</i> McLachlan, 1875)*
		<i>Xanthoperla</i> sp.
Euholognatha Zwick Group, 1973 : Zwick, 1969		
Taeniopterygidae Klapálek, 1905	<i>Mesyatsia</i> Ricker et Ross, 1975	<i>Mesyatsianshanica</i> (Zhiltzova, 1972) (= <i>Rhabdiopteryxianshanica</i> Zhiltzova, 1972)*

Nemouridae Newman, 1853	<i>Amphinemura</i> Ris, 1902	<i>Amphinemura crenata</i> Koponen, 1949 (= <i>Nemoura crenata</i> Koponen, 1949)*
		<i>Amphinemura maracandica</i> (McLachlan, 1875) (= <i>Taeniopteryx maracandica</i> McLachlan, 1875; <i>Nemoura maracandica</i> McLachlan, 1875)*
		<i>Amphinemura mirabilis</i> (Martynov, 1928)
		<i>Amphinemura mirabilis turkestanica</i> Zhiltzova, 1978*
		<i>Amphinemurasp. (sulcicollis</i> Stephens)
		<i>Amphinemura sulcicollis</i> (Stephens, 1836)
		<i>Amphinemura trialetica</i> Zhiltzova, 1957***
		<i>Amphinemura zimmermanni</i> Joost, 1970*
	<i>Mesonemoura</i> Baumann, 1975 (1971 – larvae, 1973 – imago)	<i>Mesonemoura tianshanica</i> (Zhiltzova, 1971) (= <i>Nemoura tianshanica</i> Zhiltzova, 1971; <i>Protonemura tianshanica</i> Zhiltzova, 1971)*
		<i>Mesonemoura vaillanti</i> (Navás, 1922)***
		<i>Mesonemourasp.</i>
	<i>Illiesonemoura</i> Baumann, 1975	<i>Illiesonemoura ornata</i> (McLachlan, 1875) (= <i>Nemoura ornata</i> McLachlan, 1875)*
	<i>Nemoura</i> Latreille, 1796	<i>Nemoura cinerea</i> (Retzius, 1783) (= <i>Nemoura variegata</i> Olivier, 1811; <i>Perlacineria</i> Retzius, 1783)
		<i>Nemoura flexuosa</i> Aubert, 1949
		<i>Nemoura lepnevae</i> Zhiltzova, 1971*
Capniidae Banks, 1900 : Klapálek, 1905	<i>Capnia</i> Pictet, 1841	<i>Capnia nigra</i> (Pictet, F.J., 1833) (= <i>apicalis</i> Navás, 1930; <i>conica</i> Klapálek, 1909; <i>maynari</i> Navás, 1917; <i>Perlanigra</i> Pictet, F.J., 1833)
		<i>Capnia prolongata</i> Zhiltzova, 1969*
		<i>Capniaturkestanica</i> Kimmins, 1950*
		<i>Capnia</i> sp.
	<i>Eucapnopsis</i> Okamoto, 1922	<i>Eucapnopsis</i> sp. (<i>stigmatica</i> Aubert?)
		<i>Eucapnopsis stigmatica</i> Okamoto, 1922
		<i>Eucapnopsis stigmatica transversa</i> Aubert, 1959
		<i>Eucapnopsis</i> sp.
	<i>Mesocapnia</i> Raušer, 1968	<i>Mesocapnia altaica</i> (Zapekina-Dulkeit, 1955) (= <i>Capnia altaica</i> Zapekina-Dulkeit, 1955*, ***)
Leuctridae Klapálek, 1905	<i>Leuctra</i> Stephens, 1835	<i>Leuctradigitata</i> Kempny, 1899
Total: family - 7		Types - 48

Note: * - endemics of the mountains of Central Asia and Kazakhstan, ** - identified for the first time for Central Asia, *** - identified for the first time for Uzbekistan.

From the data in the table it can be seen that the fauna of stoneflies (Plecoptera) of Uzbekistan includes 48 species from 19 genera and 7 families, of which 2 species are established before the subspecies and 9 - before the genus.

The *Systellognatha* group is represented by 22 species from 10 genera and 3 families: *Perlodidae* - 13 species from 5 genera, *Perlidae* - 5 species from 2 genera, and *Chloroperlidae* - 4 species from 3 genera. Of these, 7 species are endemics of the

mountains of Central Asia and Kazakhstan, 1 species was detected for the first time in Central Asia and 2 species - for Uzbekistan.

More than half of the fauna of the Systelognatha group consists of species of the *Perlodidae* family (13 species or 59.1%) belonging to 5 genera: *Mesoperlina* and *Filchneria* - 4 species each, *Diura* and *Isoperla* - 2 species each, *Arcynopteryx* - 1 species, then species of the *Perlidae* family (5 species or 22.7%) belonging to 2 genera: *Agnatina* - 4 species, *Dinocras* - 1 species and the family *Chloroperlidae* (4 species or 18.2%) - 3 genera: *Xanthoperla* - 2 species, *Chloroperla* and *Siphonoperla* - 1 species each.

Of the modern collections, the following are widespread and numerous: *Mesoperlina pecirkai* Klapálek, 1921 (northeastern, eastern and southern regions) and *Diura knowltoni* Frison, 1937 (northeastern, central and southern regions), less widely - *Xanthoperla curta* McLachlan, 1875 (north - eastern and central regions) and locally: *Mesoperlina ochracea* Klapálek, 1921 (eastern region), *Filchneria mesasiatica* Zhiltzova, 1971 and *Agnatina immersa* (McLachlan, 1875) (northeastern region).

The *Eucholognatha* group is represented by 26 species from 9 genera of 4 families: *Taeniopterygidae* - 1 species from 1 genus, *Nemouridae* - 15 species from 4 genera, *Capniidae* - 9 species from 3 genera, *Leuctridae* - 1 species from 1 genus. Of these, 11 species are endemic to the mountains of Central Asia and Kazakhstan, 3 species have been identified for the first time in Uzbekistan.

More than half of the fauna of the *Eucholognatha* group are species of the *Nemouridae* family (15 species or 57.7%) belonging to 4 genera: *Amphinemura* - 8 species, *Nemoura* and *Mesonemoura* - 3 species each and *Illiesonemoura* - 1 species, then species of the *Capniidae* family (9 species or 34, 6%) belonging to 3 genera: *Capnia* and *Eucapnopsis* - 4 species each and *Mesocapnia* - 1 species and then 2 families (1 species each or 3.8%): *Taeniopterugidae*: genus *Mesyatsia* - 1 species and *Leuctridae*: genus *Leuctra* - 1 view.

Among modern collections, the following are widespread and numerous: *Amphinemura trialetica* Zhiltzova, 1957, *Mesonemoura tianshanica* (Zhiltzova, 1971) and *Mesonemoura vaillanti* (Navás, 1922) (northeastern, eastern, and southern regions) and locally: *Amphinemura mirabilis turkestova* and *Mesocapnia altaica* (Zapekina-Dulkeit, 1955) (northeastern region).

4 Conclusions

Stoneflies monitoring carried out in 129 watercourses of 5 regions (32 districts) of the republic: northeastern (Tashkent, Tashkent province), eastern (Namangan, Fergana provinces), central (Bukhara, Jizzakh, Navoi, Samarkand provinces), southern (Kashkadarya, Surkhandarya provinces) and southwestern (Republic of Karakalpakstan), made it possible to obtain data on their uneven, sometimes even local, settlement.

The index of occurrence of stoneflies in the republic in samples of macrozoobenthos was 37.1%, in regions - 28.1%. Most often, stoneflies were found in the mountain-foothill watercourses of the northeastern and southern (33.3%), central (22.2%) and eastern (11.1%) regions. No freckles were found in samples from the southwestern region (steppe, desert) of the republic (Republic of Karakalpakstan).

After analyzing the literature data and own collections, the fauna of Plecoptera in Uzbekistan began to total 48 species from 19 genera and 7 families, of which 2 species were established to subspecies and 9 to genus, 18 species of stoneflies are endemics of the mountains of Central Asia and Kazakhstan, 1 species was first identified for the fauna of Central Asia (*Diura knowltoni* Frison, 1937) and 5 species - for Uzbekistan (*Diura knowltoni* Frison, 1937; *Filchneria mesasiatica* Zhiltzova, 1971; *Amphinemura trialetica* Zhiltzova, 1957; *Mesonemoura vaillanti*, 1922; *Navásnia altaica* (Zapekina-Dulkeit, 1955) Species superiority (54.2% of the total number of species) is shifted towards the group of

phyto- and detritivores - *Eucholognatha*, instead of 45.8% of the group of predators - Systellognatha.

The revealed species composition of the order Plecoptera of Uzbekistan cannot be considered complete yet. This can be judged by comparing the species composition of the Plecoptera fauna of the countries of Central Asia adjacent to Uzbekistan (Kyrgyzstan, Tajikistan, Turkmenistan) and Kazakhstan. It can be assumed that further studies (new piedmont-mountain streams, collections in the autumn-winter and early spring periods, molecular genetic studies) will be able not only to clarify the species composition, but to replenish the list of species given in this message and expand the understanding of the biology of the vesnyanokpredgorno -mountain watercourses of Uzbekistan.

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