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Composition and Zoogeographic Features of the Stonefly Fauna (Insecta: Plecoptera) of Mountainous and semi-mountainous streams in Aegean watershed (7th Ecoregion, Eastern Balkans)

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Abstract. This work summarise 23 species and 4 subspecies stoneflies established during sample periods, Autumn 2017 and Spring 2018 at 38 mountainous and semi-mountainous streams from Bulgaria and North Macedonia. The species are relatively estimated by the dominant analysis. The Plecoptera fauna belongs to 7 zoogeographical categories, grouped into 5 complexes. Moreover, eighteen taxa are European species and three (*Brachyptera beali beali* (Navás, 1923), *Leuctra hirsuta* Bogoescu & Tabacaru, 1960, *Isoperla pesici* Murányi, 2011) are Balkan endemic species. Furthermore, *Amphinemura sulcicolis* (Stephens, 1836) and *Isoperla pesici* Murányi, 2011 were recorded at North Macedonian fauna only. Among the total of 20 stoneflies species that have been recorded in Bulgaria, 6 taxa are classified as Vulnerable (VU) according to the Red Data Lists of Threatened species.

Key words: stoneflies, distribution, dominant analysis, Bulgaria, North Macedonia.

Introduction

Plecoptera presents one of the most important orders of hemimetabolous aquatic insects being found chiefly in mountain river zone (HYNES, 1970; RESH & ROSENBERG, 1984; CUSHING & ALLAN, 2001). Distributed over all continents (except Antarctica) the stoneflies constitute one of the most significant ecological components of running water ecosystems (ZWICK, 1992).

Established survey (FOCHETTI & TIERNO DE FIGUEROA, 2008) confirmed that, of the 383 European Plecoptera species, 252 (or 66%) are mainly found in crenal of mountainous and semi-mountainous rivers, compared to Trichoptera and Ephemeroptera orders which represents only 12% and 1%, respectively.

In Bulgaria and North Macedonia, Plecoptera presents relatively well-known insect group at species and subspecies level. Concerning Bulgaria, the stonefly fauna comprises 103 species and six subspecies belonging to 23 genera and seven families (TYUFEKCHIEVA *et al.*, 2019). On the other hand, North Macedonian stoneflies have been extensively examined by IKONOMOV (1969; 1970; 1971; 1972; 1974a; b; 1975; 1976a; b; 1977; 1978; 1979; 1980a; b; 1982; 1983a; b; c; 1986a; b), where until mid-1980s, 95 species belonging to 22 genera and seven families were known (IKONOMOV, 1978; 1986b; ZWICK, 1984). After few decades gap, few new records of stonefly fauna enriched with new species followed (GRAF *et al.*, 2012; MURÁNYI

et al., 2014). Up to day, the North Macedonian hitherto stonefly fauna comprises 101 species, with so far known few new species that need to be further described (MURÁNYI *et al.*, 2014; 2016).

In the zoogeographical point of view, 64% of the Plecoptera of Bulgaria are determined by Palearctic and European species. The share of endemics is 28.44% (TYUFEKCHIEVA *et al.*, 2019), which determines its local character. North Macedonian stonefly fauna is also determined by Palearctic and European species (49.1%) followed by 34.4% of endemic taxa (IKONOMOV, 1986b).

Nowadays, Plecoptera order is one of the most endangered groups of insects (FOCHETTI & TIERNO DE FIGUEROA, 2006) in Europe. The first data summary of the conservation status of Bulgarian stoneflies, discussed by TYUFEKCHIEVA *et al.* (2019) highlights the vulnerability of the species, while the available information on this topic concerning North Macedonia is still scarce (MURÁNYI *et al.*, 2014; SLAVEVSKA-STAMENKOVIĆ *et al.*, 2016).

Most of the published papers for Bulgarian stoneflies have emphasized more taxonomical aspects (BRAASCH & JOOST, 1971a; b; c; 1972; 1973; 1975; 1976; 1977; GRAF, 2010). Purposeful studies of the composition and zoogeographic features of the stonefly fauna of mountain streams are few in number (KUMANSKI, 1997; 2004; HUBENOV *et al.*, 2000a; b), with important contributions established recently (MURÁNYI, 2007; TYUFEKCHIEVA *et al.*, 2011; 2013; 2016; 2019; VARADINOVA *et al.*, 2013; MURÁNYI *et al.*, 2014; SLAVEVSKA-STAMENKOVIĆ *et al.*, 2016). Nevertheless, data of the precise distribution of stoneflies in mountainous and semi-mountainous streams from Bulgaria and North Macedonia remains incomplete. Moreover, we give a brief contribution presenting part of the results within this paper.

Thus, the aim of the present work is to determine species composition, zoogeographic features, endemic and conservation status, as well as we analysed the frequency of occurrence and dominance of stonefly species in studied mountainous and semi-mountainous stretches of Bulgaria and North Macedonia.

Material and Methods

In total 69 samples of bottom macroinvertebrates were collected in Autumn 2017 (October) and in Spring 2018 (April/May). Twenty-two sites were sampled in the Bulgaria and sixteen sites in North Macedonia (Fig. 1). Data for the altitude and geographical coordinates of each locality, as well as the year(s) of investigation is presented in Table 1. At two sites (marked with „♦" at Table 1) we didn't observe any Plecoptera species.

The multi-habitat approach for zoobenthos samplings was applied following CHESHMEDJIEV *et al.* (2011). The collected material was fixed with 4% formaldehyde in situ. After samples processing in the laboratory, the zoobenthic organisms were sorted by taxonomic groups and stored in 70% ethanol. The stoneflies were identified to the species level. Nomenclature and zoogeographic features for Plecoptera follow MURÁNYI (2008) and DEWALT *et al.* (2018). Stoneflies are classified according the IUCN categories (TYUFEKCHIEVA *et al.*, 2019). The dominant analysis was made after DE VRIES (1937) and KOJOVA (1970).

Results

Species composition

The study comprises 23 species and 4 subspecies (Table 2) belonging to 12 genera and six families from 38 mountainous and semi-mountainous river stretches in Bulgaria and North Macedonia (Table 1). By species numbers, the family Nemouridae dominates. Two species of *A. sulcicolis* and *I. pesici* are known only for the fauna of North Macedonia. Herein, for the first time we give original faunistic data for Plecoptera fauna for 14 Bulgarian rivers as follows: *L. hippopus* from Draglishka and Dvorishka River; *T. schoenemundi* from the rivers Elovitsa, Sushichka, Oshtavska, Eleshnitsa and Sovolyanska Bistritsa; *A.*

triangularis from Dvorishka and Sushichka River; *P. marginata* from the rivers Elovitsa, Bobeshinska and Sovolyanska Bistritsa; *D. megacephala* from Oshtavska, Dragovishtitsa and Eleshnitsa River; *P. intricatus* from Sovolyanska Bistritsa River and *N. flexuosa* from Bobeshinska River. Faunistic data for the stoneflies fauna of the Bachevska, Klinotitsa, Lomishka, Tsaparevska and Elovitsa rivers are reported for the first time (Table 3, 4).

Zoogeographical characteristics

According to their current distribution the established stoneflies can be assigned to 7 zoogeographical categories, grouped into 5 zoogeographical complexes (Table 2; Figure 2, 3).

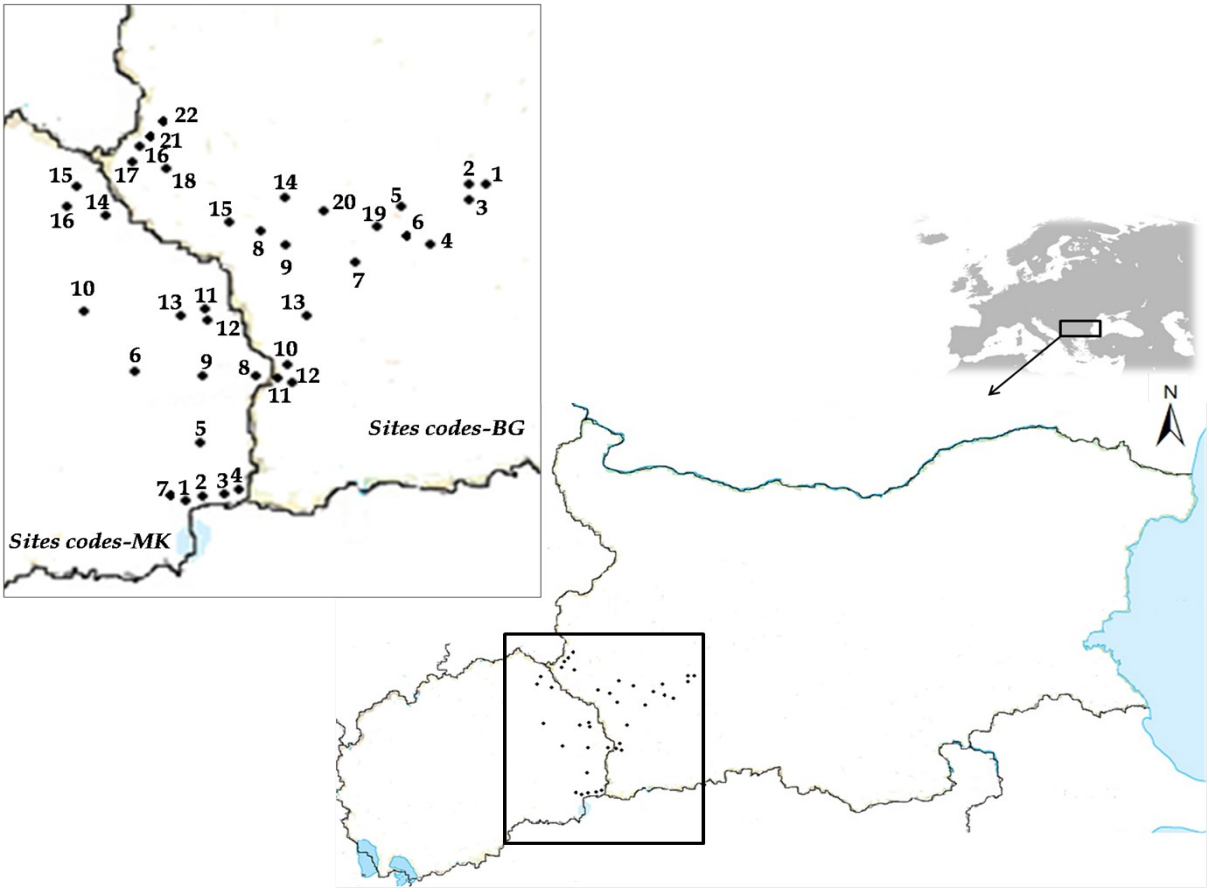

Fig. 1. Map of the studied sites.

Table 1. List of the studied rivers and localities from the mountain and semi-mountain streams in Bulgaria and North Macedonia. *Legend:* *Sites collected only at Autumn 2017; **Sites collected only at Spring 2018; ***HPS-Hydroelectric power station.

№	River/Locality	Altitude, m	N	E	2017	2018
1_BG	Cherna Mesta River, upstream HPS***	1125	42.07875	23.72581	x	x
2_BG*	Small brook, tributary to Cherna Mesta, near site 1_BG	1121	42.07776	23.72564	x	
3_BG	Right tributary to Cherna Mesta	1040	42.06104	23.72682	x	x

№	River/Locality	Altitude, m	N	E	2017	2018
4_BG	River, upstream Cherna Mesta v. Mesta River, downstream Yakoruda town	851	42.00163	23.62883	x	x
5_BG	Klinoshtitsa River, upstream Dobarsko v.	1220	41.98504	23.46597	x	x
6_BG	Draglishka River, at Draglishte v.	831	41.93432	23.51248	x	
7_BG	Elovitsa River, at Prevala	1038	41.89799	23.33618	x	x
8_BG	Sushichka River, upstream Sushitsa v.	873	41.80629	23.02944	x	x
9_BG	Sushichka River, downstream Sushitsa v.	780	41.81839	23.07301	x	x
10_BG	Lebnitsa River, after border with R. North Macedonia	789	41.55756	22.99431	x	x
11_BG	Dvorishka (Cironska) River	814	41.56622	22.98840	x	x
12_BG	Tributary to Lebnitsa River, after Dobri Laki v.	797	41.56890	22.99031	x	
13_BG	Tsaparevska River, upstream Tsaparevo v.	622	41.63227	23.07884	x	x
14_BG	Oshtavska River, before its mouth to Struma River	190	41.75985	23.15539	x	x
15_BG	Eleshnitsa River, at Chetirtsi v.	457	42.24273	22.87364	x	x
16_BG	Sovolyanska Bistritsa River, near Kutugertsi v.	797	42.31128	22.50344	x	x
17_BG	Bobeshinska River, before its mouth to Sovolyanska Bistritsa R.	806	42.31732	22.49856	x	x
18_BG*	Sovolyanska Bistritsa River, upstream Gurlyano v.	1090	42.24026	22.55357	x	
19_BG**	Bachevska River, at Bachevo v.	949	41.9290	23.4480		x
20_BG**	Blagoevgradska Bistritsa River, near "Parangalitsa" Reserve	1528	42.0424	23.3643		x
21_BG**	Lomnishka River, at Lomnitsa v.	824	42.3762	22.5482		x
22_BG**	Dragovishtitsa River, downstream Dolno Ujno v.	594	42.4043	22.594		x
1_MKD	Baba River, downstream Koleshinski Waterfall	435	41.3703	22.8078	x	x
2_MKD	Lomnitza River, downstream Smolarski Waterfall	742	41.3709	22.9003	x	x
3_MKD	Drazevska River upstream Drazevo v.	924	41.3715	22.9185	x	x
4_MKD	Star Dol River upstream Staro Konjarevo v.	464	41.3627	22.9529	x	x
5_MKD	River Shtuka, upstream Stuka v.	379	41.479	22.821	x	x
6_MKD	Dvorishka (Prevedenska, Cironska) River, spring region	1138	41.5719	22.8473	x	x
♦7_MKD*	Barlen River, upstream Gabrovo v.	849	41.3764	22.7816		x

№	River/Locality	Altitude, m	N	E	2017	2018
8_MKD	Dvorishka (Cironska) River, downstream Dvorishte v.	901	41.5848	22.9336		x
9_MKD	Dvorishka (Cironska) River, upstream Dvorishte v.	944	41.5935	22.9004	x	x
10_MKD	River Ratevska, downstream Rusinovo v.	833	41.6952	22.8325	x	x
11_MKD	River Klepalska Reka, upstream HPS***	1165	41.6666	22.9614	x	x
12_MKD	River Ambarska Reka, upstream HPS***	1165	41.6673	22.9622	x	x
13_MKD	River Klepalska Reka, downstream HPS***	1122	41.6744	22.9428	x	x
14_MKD	River Kriva Reka,upstream Uzem v.	864	42.2152	22.4356	x	x
♦15_MKD	River Luchka Reka, downstream Dobrovitza v.	789	42.2566	22.3492	x	x
16_MKD	River Kriva Reka, upstream Kriva Palanka town	670	42.2122	22.3452	x	x

Table 2. Species composition and zoogeographical characteristics of Plecoptera from the studied mountain and semi-mountainous streams from Bulgaria and North Macedonia. Legend: *Species that refer to Vulnerable (VU) category according to the Red Data Lists of Threatened species of Plecoptera in Bulgaria.

Taxa	Abbreviation	Zoogeographical complexes	Zoogeographical categories
⁎*Taeniopteryx shoenemundi* (Mertens, 1923)	Taensho	European	Mid-European
Brachyptera beali beali (Navás, 1923)	Brachbe	Endemic	Balkan
Brachyptera risi (Morton, 1896)	Brachri	European	Pan-European
Brachyptera seticornis (Klapálek, 1902)	Brachse	European	Mid-and South-European
Leuctra fusca fusca (Linnaeus, 1758)	Leucfus	Holarctic	Palearctic
Leuctra hippopus Kempny, 1899	Leuchip	Holarctic	Palearctic
⁎*Leuctra hirsuta* Bogoescu & Tabacaru, 1960	Leuchir	Endemic	Balkan
Leuctra inermis Kempny, 1899	Leucine	European	Pan-European
Leuctra prima Kempny, 1899	Leucpri	European	Mid-and South-European
Leuctra pseudosignifera Aubert, 1954	Leucpsi	European	Mid-and South-European
Amphinemura sulcicolis (Stephens, 1836)	Amphsul	European	Pan-European
Amphinemura standfussi (Ris, 1902)	Amphsta	European	Pan-European
Amphinemura triangularis (Ris, 1902)	Amphtri	European	Mid-and South-European

Taxa	Abbreviation	Zoogeographical complexes	Zoogeographical categories
Protonemura intricata intricata (Ris, 1902)	Protint	European	Mid-European
Protonemura montana Kimmins, 1941	Protmon	European	Pan-European
Protonemura praecox praecox (Morton, 1894)	Protpra	European-Mediterranean	European-Anatolian
Nemoura cinerea cinerea (Retzius, 1783)	Nemocin	Holarctic	Palearctic
⁎*Nemoura flexuosa* Aubert, 1949	Nemofle	European-Mediterranean	European-Anatolian
⁎*Nemoura subtilis* Klapálek, 1895	Nemosub	Mediterranean	Balkan-Anatolian
Nemoura uncinata Despax, 1934	Nemounc	European	Mid-and South-European
Perlodes intricatus (Pictet, 1841)	Perlint	European	Mid-and South-European
Isoperla grammatica (Poda, 1761)	Isopgra	European	Pan-European
Isoperla pesici Murányi, 2011	Isoppes	Endemic	Balkan
⁎*Chloroperla tripunctata* (Scopoli, 1763)	Chlotri	European	Pan-European
⁎*Siphonoperla neglecta* (Rostock, 1881)	Siphneg	European	Mid-European
Perla marginata (Panzer, 1799)	Perlmar	European	Mid-and South-European
Dinocras megacephala (Klapálek, 1907)	Dinmega	European	Mid-and South-European

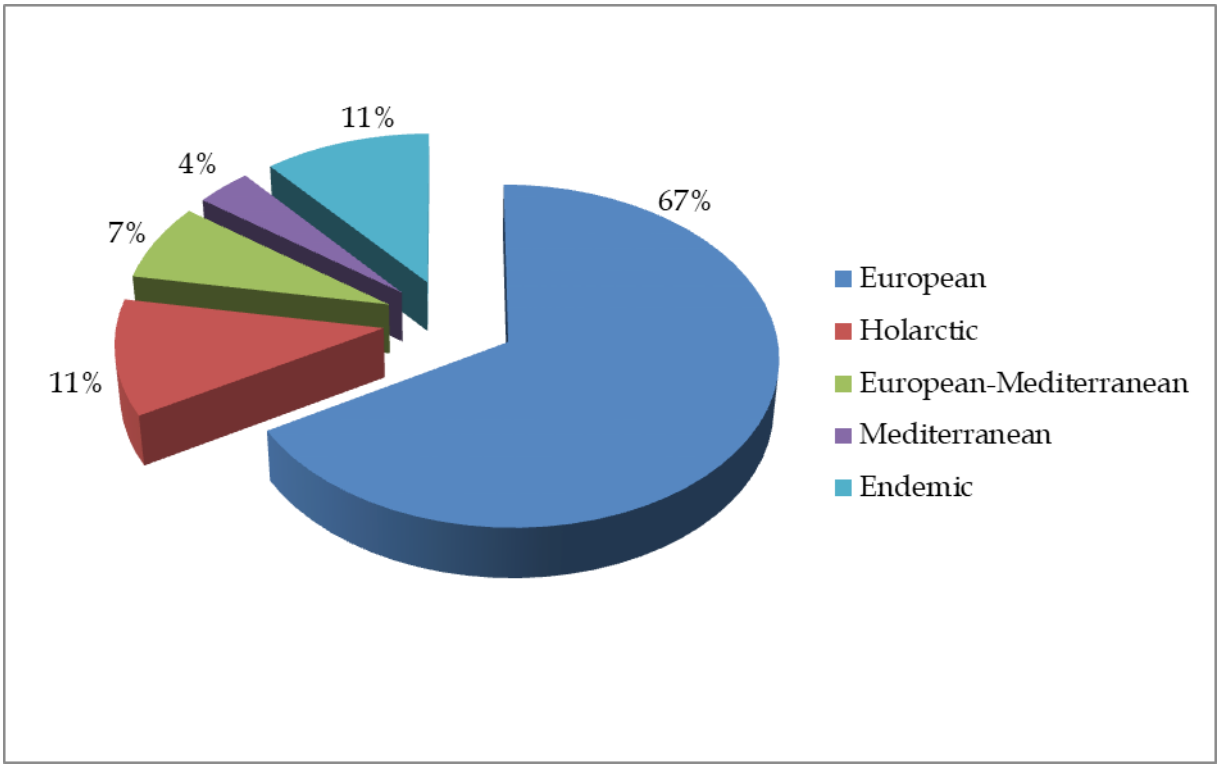

Fig. 2. Distribution of stonefly fauna according to zoogeographical complexes.

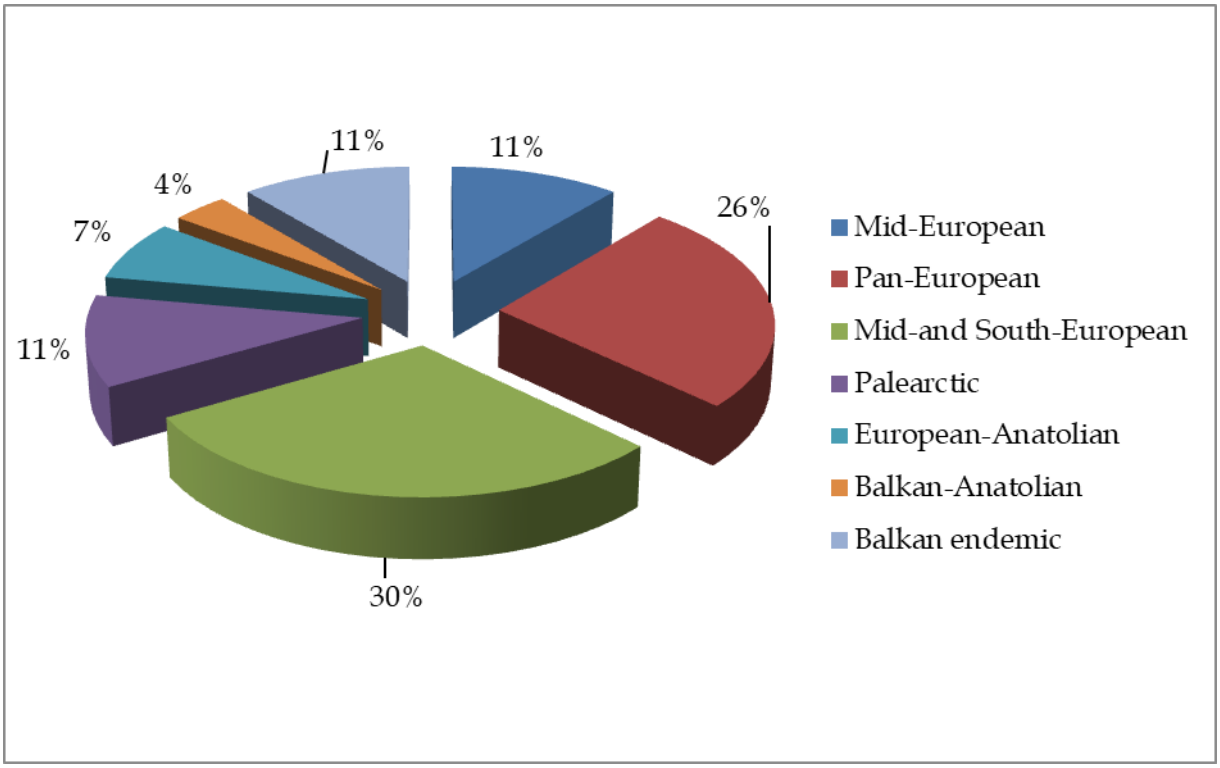

Fig. 3. Distribution of stonefly fauna according to zoogeographical categories.

The Plecoptera order is defined mainly by Palearctic and European species (78%) and locally with endemic species (11%).

Holarctic species complex includes only one zoogeographical category - Palearctic species represented by one species and two subspecies (11%).

European species complex is best represented and comprises 17 species and one subspecies (67%) from three zoogeographical categories. Mid- and South- European species are dominant (8 taxa, 30%), followed by Pan-European (7 taxa, 26%) and Mid-European (3 taxa, 11%). This complex includes especially widespread species in all Europe.

Mediterranean species complex includes one Balkan-Anatolian species (*N. subtilis*).

European-Mediterranean species complex comprises one species and subspecies, classified into European-Anatolian zoogeographical category.

Endemic species complex includes Balkan endemic species *B. beali beali*, *L. hirsuta* and *I. pesici*.

Six species (*T. shoenemundi*, *L. hirsuta*, *N. flexuosa*, *N. subtilis*, *Ch. tripunctata* and *S.neglecta*) refer to Vulnerable (VU) category according to the Red Data Lists of Threatened Species of Plecoptera in Bulgaria (marked with * in Table 2, TYUFEKCHIEVA *et al.*, 2019).

Dominant analysis

Table 3 and 4 give information on the frequency of occurrence (pF%), frequency of dominance (dF%) and the range of dominance (DT) of the stoneflies found during sample periods, Autumn 2017 and Spring 2018. The species with high values of pF and DT (*B. seticornis*, *I. grammatica*, *N. subtilis*, *P. marginata* and *P. intricata intricata*) dominate and quantitatively in the composition of the stoneflies complex (Fig. 4, 5). This shows their fundamental importance for establishment of its qualitative and quantitative composition in river zoocenoses. These taxa are also the most spread stoneflies in the investigated semi-mountainous and mountainous river sections.

With a most substantial quantitative part (DT>50%) are eleven taxa (40.7%). The present data establish stenobiotic character of some species as well. These are representative taxa with high values of the range of dominance and low frequency of occurrence (*L. hippous*, *L. fusca fusca*, *N. cinerea*, *A. standfussi* and *Ch. tripunctata*). Their mass development, expressed through numerical domination in the sample, is possible in relatively narrow living conditions limits only. They do not occur frequently, but once appearing, always dominate in the community. Therefore, apart of the high values of DT, these species could not be specified as dominating. The studied river sections are inhabited by Plecoptera species with different ecological plasticity which is evident from the results of the dominant analysis.

Table 3. Dominant analysis of stoneflies established during sample periods, Autumn 2017.

Localities / Taxa	*Taensho*	*Brachri*	*Leucine*	*Leuchip*	*Leucpsi*	*Leucfus*	*Leucpri*	*Amphtri*	*Protint*	*Protmon*	*Protpra*	*Nemocin*	*Nemofle*	*Nemounc*	*Nemosub*	*Perlint*	*Isopgra*	*Chlotri*	*Dinomeg*	*Perlmar*
pf	**40**	**3.3**	**36.7**	**13.3**	**3.3**	**13.3**	**3.3**	**6.7**	**16.7**	**6.7**	**6.7**	**3.3**	**10**	**13.3**	**60**	**6.7**	**10**	**13.3**	**10.3**	**50**
dF	**20**		**13.3**	**13.3**		**13.3**		**3.3**	**6.7**	**3.3**			**6.7**	**3.3**	**43.3**	**3.3**		**10**		**23.3**
DT	**50**		**36.4**	**100**		**100**		**50**	**40**	**50**			**66.7**	**25**	**72.2**	**50**		**75**		**46.7**
1_BG									+						+			+		+
2_BG			+				+							+	+			+		
3_BG			+						+						+					
4_BG			+												+					
5_BG										+					+	+				
6_BG				+																
7_BG	+		+												+					+
8_BG			+							+					+					+
9_BG	+							+									+			+
10_BG	+				+										+					+
11_BG				+				+												+
12_BG				+																
13_BG															+					
14_BG	+					+													+	
15_BG	+					+													+	+
16_BG	+					+									+	+				+
17_BG													+							+
18_BG	+		+								+				+				+	+
1_MK	+														+					+
2_MK	+		+						+						+					+
3_MK	+		+						+						+					+
4_MK			+						+						+		+			
5_MK	+	+	+											+						
6_MK	+												+		+			+		
9_MK			+	+											+					+
10_MK																		+		
11_MK			+								+			+						
12_MK												+	+	+						
14_MK															+		+			
16_MK						+														+

Table 4. Dominant analysis of stoneflies established during sample periods, Spring 2018.

Localities /Taxa	*Brachbe*	*Brachri*	*Brachse*	*Leuchip*	*Leuchir*	*Leucine*	*Amphsul*	*Amphsta*	*Amphtri*	*Protint*	*Protmon*	*Protpra*	*Nemocin*	*Isopgra*	*Isoppes*	*Siphmeg*	*Chlotri*	*Dinomeg*	*Perlmar*
pf	**3.1**	**15.6**	**50**	**9.4**	**9.4**	**15.6**	**12.5**	**3.1**	**6.25**	**59.4**	**3.1**	**18.8**	**6.3**	**40.6**	**3.1**	**9.4**	**6.3**	**12.5**	**78.1**
dF		**3.1**	**37.5**		**3.1**		**6.3**	**3.1**		**59.4**		**9.4**	**6.3**	**31.3**		**3.1**		**3.1**	**40.6**
DT		**20**	**75**		**33.3**		**50**	**100**		**100**		**50**	**100**	**76.9**		**33.3**		**25**	**52**
1_BG			+	+										+			+		+
3_BG			+	+						+				+					+
4_BG																			+
5_BG			+						+					+					+
7_BG			+		+	+				+				+					+
8_BG						+				+				+					+
9_BG										+				+				+	+
10_BG																			+
11_BG										+									+
13_BG										+		+							+
14_BG										+								+	
15_BG					+									+					+
16_BG																			+
17_BG										+									
19_BG									+	+		+		+					+
20_BG			+							+		+		+					
21_BG					+						+								+
22_BG																		+	+
1_MK										+									+
2_MK			+				+			+									+
3_MK		+	+							+								+	+
4_MK		+	+				+			+									+
5_MK		+	+							+									+
6_MK		+	+							+						+	+		+
8_MK													+						
9_MK	+	+	+			+	+					+	+	+					+
10_MK	+	+	+				+					+	+	+					
11_MK			+			+		+		+		+			+	+			+
12_MK			+			+		+				+			+	+			
13_MK			+	+		+				+				+					
14_MK		+	+											+					+
16_MK																			+

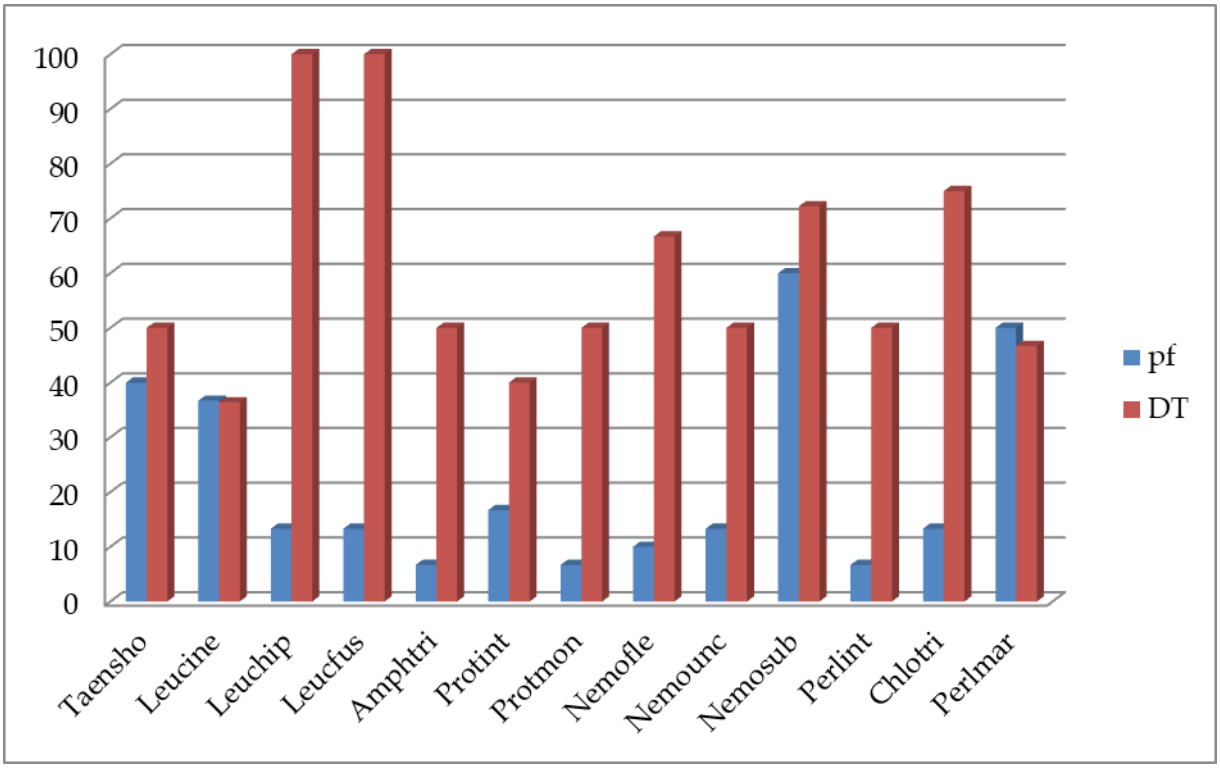

Fig. 3. The frequency of occurrence (pF%) and the range of dominance (DT) of the stoneflies found during sample period, Autumn 2017.

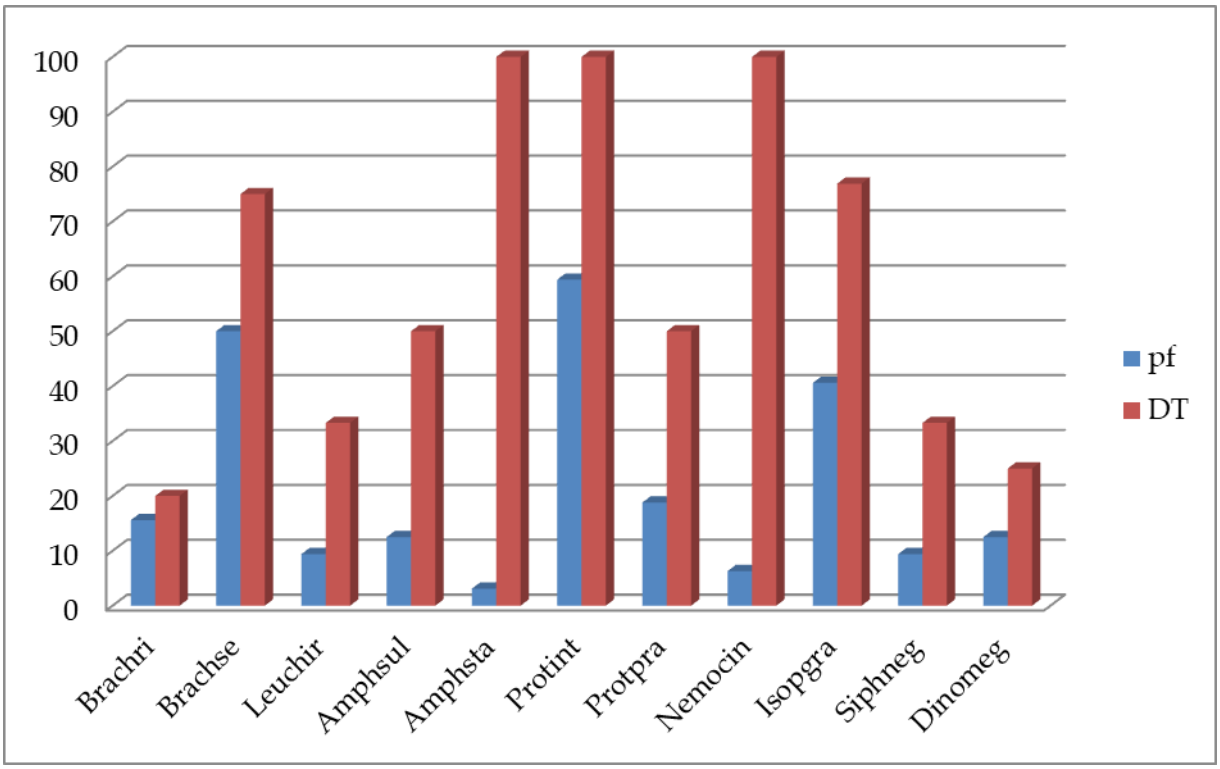

Fig. 4. The frequency of occurrence (pF%) and the range of dominance (DT) of the stoneflies found during sample period, Spring 2018.

Discussion

Available information about the strict requirements of stoneflies to the specific hydromorphological, physical and hydrochemical characteristics of the environment, which they inhabit (ZWICK, 1982; 1992; ZAMORA-MUNOZ *et al.*, 1993) explain the dynamic of the Plecoptera complex in the river coenosis.

AUBERT (1965) and RAVVIZA & RAVVIZA DEMATTEIS (1991) report that the maximum stoneflies species diversity for the Alps is in the lower part of the mountain (circa 1200 m a.s.l.), while for the Pyrenees, BERTHELÉMY (1966) finds this maximum at 900m a.s.l. According KRNO (2003a; b) the maximum species richness is at high-mountain rivers and streams of Slovakia. KAMLER (1965); WARD (1986); SOLDÁN *et al.* (1998); BULANKOVA *et al.* (2001) and MAVRI *et al.* (2003) found that in semi-mountainous river stretches occur species *Perlodes microcephalus* (Pictet, 1933), *Leuctra albida* Kempny 1899, *L. fusca fusca* and *L. hippopus*. According RAVIZZA & GERECKE (1992), RAVIZZA & RAVIZZA DEMATTEIS (1993), KOVÁCS & MURÁNYI (2008) and BOJKOVA *et al.* (2011) the species *B. seticornis*, *I. grammatica, P. marginata* and *P. intricata intricata* are widely distributed in whole Europe. These taxa are also the most spread stoneflies in the investigated semi-mountainous and mountainous river sections in North Macedonia and Bulgaria.

Forty one species from the Bulgarian mountain stoneflies fauna are common with the mountain Plecoptera-fauna of Montenegro, 19-with that of Croatia and 26-with the mountain zones of Pyrenean Peninsula (VINÇON & PARDO, 2004; MURÁNYI, 2008; POPIJAČ & SIVEC, 2009).

ZWICK (2000) indicates that Plecoptera fauna is result of the paleogeographic and paleoclimatic changes and global distribution patterns suggest that evolution of the extant suborders started with the breakup of Pangaea. We established six stoneflies taxa (*B. seticornis, N. cinerea cinerea, N. flexuosa, L. hippopus, P. intricata intricata* and *P. praecox praecox*) specific for the Hercynian system. In Bulgaria the Struma River valley as a part of Rilo-Rhodope massif and Pirin Mnt. is originated during Herzine epoch (HRISTOVA, 2012). In that order, biogeographical features, climate, geomorphology and paleontological history events in river basins significantly influence diversity of stoneflies at the regional level (KRNO, 2003b). Therefore, in the zoogeographic mountain subregions in which Bulgaria and North Macedonia are located, certain communities, including endemic and rare species, have been established. So far, *B. beali beali* is reported from Bulgaria (TYUFEKCHIEVA *et al.*, 2019), North Macedonia (IKONOMOV, 1983b; 1986b; MURÁNYI *et al.*, 2014; SLAVEVSKA-STAMENKOVIĆ *et al.*, 2016), Bosnia & Herzegovina (MURIĆ *et al.*, 2011), Montenegro (KACANSKI & BAUMANN, 1981) and Greece (AUBERT, 1963; BERTHÉLEMY, 1971; ZWICK, 1978; KARAOUZAS *et al.*, 2016); *L. hirsuta* is reported from Bulgaria (TYUFEKCHIEVA *et al.*, 2019), North Macedonia, Bosnia & Herzegovina, Montenegro, Greece and Romania (KARAOUZAS *et al.*, 2016) and *I. pesici* – from North Macedonia, Montenegro and Albania (MURÁNYI *et al.*, 2016).

Nowadays, due to the high environmental requirements of stoneflies, many species are reduced to small isolated groups, become vulnerable, threatened by extinction, or are already extinct (RAVIZZA & NICOLAI, 1983; ZWICK, 1992; SANCHEZ-ORTEGA & TIERNO DE FIGUEROA, 1996). Concerning the latitude, Mountains Plecoptera fauna is with less vulnerability compared to the representative one from the lowland rivers. Moreover, especially as result of the environmental changes, the most vulnerable ones are endemic taxa. While the more sustainable the rhithral stoneflies are mainly recent postglacial immigrants to Central Europe from Mediterranean refugia (ZWICK, 1982), the critically endangered and vulnerable Plecoptera are predominantly represented by ancient local fauna (neoendemics) with

strong connections to Holarctic taxa, appeared from the Mediterranean and Minor Asia. Twenty one species in South Europe are particularly threatened, where the average annual air temperature is predicted to rise about 4°C and precipitations will decrease up to 0.25 mm/day for the period 2071-2100 (GITAY *et al*., 2002).

The present work will contribute to incentive further studies of the local and regional biodiversity of Bulgarian and North Macedonian stoneflies fauna as essential element for the environmental classification of water bodies, which up to day is poorly presented and discussed for both countries.

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