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Distribution and Comparative Characteristics of the Dipteran Fauna (Insecta: Diptera) of the Vrachanska Planina, Vitosha, Rila and Pirin Mountains, Bulgaria

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Abstract: A total of 2275 species of 81 families have been recorded from the studied mountains. The degree of similarity of the dipteran fauna among these mountains is from 30.4% to 45.4%. The degree of similarity between the different vegetation belts ranges from 0% to 46.6%. The dipterans belong to 105 zoogeographical categories, divided into two supergroups: 1) species with Mediterranean type of distribution (126 species or 5.5%) – more thermophilic and distributed mainly in the southern parts of the Palaearctic and the lower parts of the mountains. The species of the southern type, distributed in the Palaearctic and beyond it, can be formally related to this group as well; 2) species with Palaearctic and Eurosiberian type of distribution (2149 species or 94.5%) – more eurybiontic and widely distributed in the Palaearctic and the mountains. The species of the northern type, distributed in the Palaearctic and beyond it, can be formally related to this group as well. The Holomediterranean, North Mediterranean and South European forms (from 0.4% to 1.0%) are the best represented in the first group. The European, Holarctic, Holoeurosiberian, Transpalaearctic and Disjunct Eurosiberian taxa (from 4.9% to 24.3%) prevail in the second group. The endemic species are 37 (1.6%). The distribution of the zoogeographical categories in the separate vegetation belts of the mountains is scrutinised.

Key words: Diptera, Bulgarian mountains, faunistic composition, zoogeography

Introduction

The Vrachanska Planina, Vitosha, Rila and Pirin Mountains are better studied with regard to the two-winged insects than the other Bulgarian mountains. There are generalised publications on their fauna that allow comparison of the fauna by families within the framework of the entire order Diptera. The mountains are karst (Vrachanska Planina Mts.), silicate (Vitosha and Rila Mts.) and karst-silicate (Pirin Mts.), meridionally situated and offer an interesting opportunity to compare the dipteran fauna.

The first data on Diptera from the Vrachanska Planina Mts. are reported by Nedelkov (1909, 1910, 1912). In 123 publications there are data related to dipterans of the mountain (Hubenov 2018b). The first data on Diptera from the Vitosha Mts. are reported by Kovachev (1905), Nedelkov (1910, 1912) and Vimmer (1916). In 128 publications there are data related to dipterans of the Vitosha Mts. (Hubenov 2018a). The first data on Diptera from the Rila Mts. are reported by Joakimoff (1899) and Nedelkov (1909, 1910, 1912). In 120 publications there are data related to dipterans of the Rila Mts. (Hubenov 2016). The study of the Pirin Mts. begins at the latest as the first data on Diptera are reported by Drensky (1929). In 82 publications there are data related to dipterans of the Pirin Mts. (Hubenov 2015b).

The data are fragmentary, concern separated parts of the mountains and are scattered in different articles, which are not specially referred to the corresponding mountains. There

are more systematic studies for the families Limoniidae, Mycetophilidae, Cecidomyiidae, Sciaridae, Simuliidae, Chironomidae, Syrphidae, Agromyzidae, Chloropidae, Muscidae and Tachinidae. The most complete are the studies of the Vrachanska Planina Mts. for Mycetophiloidea (Bechev & Pavlova 2016); of the Rila Mts. for Simuliidae (Kovachev 2000), Chironomidae (Stoichev 2000a, 2000b, 2002, 2004, Stoichev & Cernev 2001, Stoichev & Danova 2003) and Tabanidae (Ganeva 2017); of the Vitosha Mts. for Cecidomyiidae (Dimitrova 1989) and Phoridae (Langurov 2001a) and of the Pirin Mts. for Tachinidae (Hubenov 1992). Generalised studies on the tachinid fauna of these mountains are reported by Hubenov (2015b, 2016, 2017, 2018a, 2018b).

The aim of this work is to present the distribution of Diptera in the studied mountains, as well as to make a comparative zoogeographical analysis of the fauna.

Materials and Methods

The Vrachanska planina Mts. are a part of the Western Stara Planina (Balkan) Mts. The mountain is surrounded by the Varshets Basin, Vrachansko Pole Lowland, Mezdra Basin and Iskar Gorge. The Vrachanska Planina Mts. are 30 km long and 20 km wide. The maximum height at Beglichka Mogila Peak is 1482 m a.s.l. The lowest parts are at 150-200 m a.s.l. (Dinev & Mishev 1969, Minchev et al. 1980, Panayotov et al. 1989, Mutafov 2008, Nikolov et al. 2013). An open karst, rich in surface forms, has been developed. The water circulation has contributed to the formation of karst springs and cave systems. The mountains belong to the Temperate-Continental climatic area. According to the climatic vertical gradient, three climatic zones are outlined (Sabev & Stanev 1959, Tichkov 1976, 1982, Velev 1990, 2002, Stanev 1991). The vegetation is differentiated in a system of three vegetation zones (Stojanov 1966, Velchev et al. 1982, 1989, Bondev 1991, 1997, 2002, Velchev 1997, 2002): 1) Xerothermic oak forests – up to 600-700 m a.s.l.; 2) Xeromesophylic and mesophylic mixed (oak-hornbeam) forests – from 600-700 m to 900-1000 m a.s.l.; 3) Beech forests – from 900-1000 m to 1500 m a.s.l. Under the human impact the natural boundaries between the vegetation belts have been destroyed. The Vrachanska Planina Mts. belongs to the Stara Planina Zoogeographical Region and has an European and Eurosiberian faunistic character (Georgiev 1980, 1982, 1997, 2002).

The Vitosha Mts. is surrounded by the Sofia, Pernik and Samokov Basins and the Lozenska, Plana, Verila, Golo Bardo and Lyulin Mountains. The distance between the northernmost and the southernmost points of the Vitosha Mt. is 23 km and between the westernmost and the easternmost points – 19 km. The lowest parts of the mountain are at 800 m a.s.l. and the highest parts – at Cherni Vrah Peak (2290 m a.s.l.). The Vitosha Mt. represents a silicate massif consisting essentially of syenites and has significant water resources. In the Vetren-Bosnek part of the mountain, karst forms are developed. The territory over 1000 m a.s.l. is included in the Mountain climatic region (Stanev 1991, Stoyanov 2014). The vegetation is differentiated in a system of four vegetation zones (Bondev et al. 1973, Bondev 1982, 1991, 1997, 2002, Velchev et al. 1982, 1989, Velchev 1997, 2002, Gachev 2014): 1) Xeromesophylic and mesophylic mixed forests – up to 1100-1400 m a.s.l.; 2) Beech forests – up to 1400-1840 m a.s.l.; 3) Coniferous forests – up to 1700-2050 m a.s.l.; 4) Subalpine vegetation – above the upper boundary of the forest (above 1900 m a.s.l.). Under the human impact the natural boundaries between these belts have been destroyed. The Vitosha Mt. belongs to the Rila-Rhodope Zoogeographical Region and has an Eurosiberian faunistic character (Georgiev 1982, 2002).

The Rila Mts. are situated north of the Pirin Mts. and are connected with the Verila, Ihtimanska Sredna Gora and Rhodope Mountains through cols. They are over 70 km long and 50 km wide. The maximum height at Musala Peak is 2925 m a.s.l. The Rila Mts. are a silicate massif consisting essentially of granites with Pleistocene glacial forms. Gravity forms of alpine type are characteristic of the high parts. The Rila Mts. include parts of the Rila-Osogovo and Mountain climatic regions (Stanev 1991). In the cirques of the mountain 190 glacial lakes are situated. The vegetation is differentiated in a system of six vegetation belts (Stojanov 1966, Velchev et al. 1982, 1989, Velchev & Tonkov 1986, Bondev 1991, 1997, 2002, Velchev 1997, 2002): 1) Xerothermic oak forests – up to 500-700 m a.s.l.; 2) Mesophylic and xeromesophylic mixed forests – from 600-700 m to 900-1000 m a.s.l.; 3) Beech forests – from 900-1000 m to 1500-1600 m a.s.l.; 4) Coniferous forests – from 1500-1600 m to 2000-2200 m a.s.l.; 5) Subalpine vegetation – from 2000-2200 to 2500 m a.s.l.; 6) Alpine vegetation – over 2400-2500 m a.s.l. The boundaries between the vegetation belts are not defined clearly and there are mixed zones up to 200-300 m a.s.l. The Rila Mts. belong to the Rila-Rhodope zooge-

ographical region and have an Eurosiberian faunistic character (Georgiev 1982, 2002).

The Pirin Mts. are situated between the valleys of the Struma and Mesta Rivers, south of the Rila Mts., from which are separated by the Predel Col. The Paril Col separates the Pirin Mts. from the situated to the south Slavyanka Mts. The Pirin Mts. are about 80 km long and 40 km wide. The maximum height at Vihren Peak is 2914.3 m a.s.l. In the Pleistocene glacial forms have been formed. Gravity forms of alpine type are characteristic of the high parts. Climatically the Pirin Mts. include parts of the Maleshevska-Pirin Low Mountain, Mestenski and Mountain climatic areas (Stanev 1991). Glacial lakes are situated in the cirques of the granite part of the Northern Pirin, whereas the marble part is relatively anhydrous. The vegetation is differentiated in a system of six vegetation belts (Stojanov 1966, Velchev et al. 1982, 1989, Velchev & Tonkov 1986, Bondev 1991, 1997, 2002, Velchev 1997, 2002): 1) Xerothermic oak forests – up to 600-700 m a.s.l.; 2) Mesophylic and xeromesophylic mixed forests – from 600-700 m to 900-1000 m a.s.l.; 3) Beech forests – from 900-1000 m to 1500-1600 m a.s.l.; 4) Coniferous forests – from 1500-1600 m to 2000-2200 m a.s.l.; 5) Subalpine vegetation – from 2000 to 2500 m a.s.l.; 6) Alpine vegetation – over 2400-2500 m a.s.l. The Pirin Mts. belong to the Rila-Rhodope zoogeographical region and have an Eurosiberian and Submediterranean faunistic character in the lower parts (Georgiev 1982, 2002).

The material from the Vrachanska Planina Mts. has been collected after 1900 from 54 localities. The materials from the Vitosha and Rila Mountains have been collected after 1890 from 256 and 160 localities, respectively. The material from the Pirin Mts. was collected from 77 localities after 1914. Some collectors did not give accurate localities and indicated only the Pirin, Rila or Vitosha Mountains. For a number of widespread and numerous species the authors did not give the localities and mentioned they occur everywhere. Such species are included in the review only if they are reported from the studied mountains. The material is stored in the National Museum of Natural History, the Institute of Biodiversity and Ecosystem Research and the Department of Zoology of the Plovdiv University. A number of foreign entomologists have been collecting and publishing materials from Bulgaria, including from mountains studied. The species distribution in the vegetation belts is determined according to the altitude and the landscape of the localities.

The zoogeographical categorisation of the species is based on the available literature and recent electronic issues. Zoogeographical analysis for the taxa categorisation was used. This method allows obtaining data information about species complexes with different zoogeographical character based on the published data regarding species distribution and results of the faunistic research. These complexes contain zoogeographical information about the taxonomic groups which, combined with the origin of the ranges, determines the zoogeographical character of the fauna. The distribution of the species according to the zoogeographical categories in the different vegetation belts are scrutinised (Hubenov 2015b, 2016, 2017, 2018a, 2018b). The classification of the areas (Table 4) is based on the works of Geptner (1936), Darlington (1957), Kryzhanovsky (1965, 1976, 2002), de Lattin (1967), Müller (1974, 1980), Udvardi (1975), Crosskey & White (1977), Malicky et al. (1983), Gorodkov (1984), Grehan (1988, 1993), Vigna Taglianti et al. (1999), Procheş & Ramdhani (2012), Holt et al. (2013) and Ficetola et al. (2017). To compare the fauna, the Czekanowski-Dice-Sörensen coefficient of similarity was used (Czekanowski 1909, Dice 1945, Sørensen 1948).

Results

A total of 2275 species of Diptera (56.9% of the species found in Bulgaria) that belong to 81 families have been established in the Vrachanska Planina, Vitosha, Rila and Pirin Mountains so far (Table 1). The family Tachinidae is the most numerous with 257 species, followed by Phoridae – 204, Syrphidae – 204, Cecidomyiidae – 181, Limoniidae – 147, Mycetophilidae – 147, Chloropidae – 106 and Muscidae – 103 species. The remaining families contain from one to 64 species. The greatest number of species (1272 species – 31.8% of the Bulgarian species) was recorded from the Vitosha Mt., followed by the Rila Mts. (1016 species – 25.4%), Pirin Mts. (759 species – 19.0%) and Vrachanska Planina Mts. (680 species – 17.0%). A total of 58 families has been recorded from the Vitosha and Rila Mountains each, 45 families – from the Vrachanska Planina Mts. and 44 families – from the Pirin Mts. Of all 76 families known from the Vitosha, Rila and Pirin Mountains, 30 families have not been established in the Vrachanska Planina Mts. At the same time, five of the families found in the Vrachanska Planina Mts., have not been established in the Vitosha, Rila or Pirin Mountains (Table 1).

Table 1. The Diptera (Insecta) of the Vrachanska Planina, Vitosha, Rila and Pirin Mountains

Families	Total number		Vrachanska Planina Mts.		Vitosha Mt.		Rila Mts.		Pirin Mts.	
	number	%	number	%	number	%	number	%	number	%
Nematocera	**773**	**33.97**	**307**	**45.1**	**317**	**24.8**	**294**	**28.9**	**200**	**26.35**
Tipulidae	19	0.83	7	1.0	12	0.9	9	0.9		
Limoniidae	147	6.46	32	4.7	52	4.0	62	6.1	84	11.06
Pediciidae	21	0.92			6	0.5	13	1.3	9	1.18
Blephariceridae	6	0.26			6	0.5	2	0.2		
Bibionidae	4	0.18	1	0.1			4	0.4		
Hesperinidae	1	0.04	1	0.1						
Mycetophilidae	147	6.46	138	21.3	1	0.08	14	1.4	15	1.98
Ditomyiidae	1	0.04	1	0.1						
Bolitophilidae	8	0.35	4	0.6			4	0.4	5	0.66
Diadocidiidae	2	0.09	1	0.1			1	0.1	1	0.13
Keroplatidae	19	0.83	15	2.2			3	0.3	3	0.39
Macroceridae	14	0.61	11	1.6			4	0.4	4	0.53
Sciaridae	43	1.89	1	0.1	41	3.2	4	0.4		
Cecidomyiidae	181	7.96	44	6.5	138	10.8	65	6.4	54	7.11
Psychodidae	2	0.09			2	0.2				
Trichoceridae	1	0.04			1	0.08	1	0.1		
Scatopsidae	1	0.04					1	0.1		
Ptychopteridae	3	0.13	1	0.1			1	0.1	1	0.13
Dixidae	1	0.04	1	0.1						
Culicidae	12	0.53	6	0.9	10	0.8	9	0.9		
Thaumaleidae	1	0.04			1	0.08				
Simuliidae	48	2.11	8	1.2	35	2.7	37	3.6	10	1.32
Ceratopogonidae	27	1.19	20	2.9	4	0.3	6	0.6	1	0.13
Chironomidae	64	2.81	15	2.2	8	0.6	53	5.2	13	1.71
Orthorrhapha	**259**	**11.38**	**61**	**9.0**	**125**	**9.8**	**121**	**11.9**	**53**	**6.98**
Coenomyiidae	1	0.04					1	0.1		
Xylophagidae	1	0.04			1	0.08				
Stratiomyidae	25	1.10	8	1.2	10	0.8	5	0.5	12	1.58
Rhagionidae	9	0.39	1	0.1	5	0.4	5	0.5	8	1.05
Athericidae	2	0.09			2	0.2				
Tabanidae	50	2.20	19	2.8	21	1.6	38	3.7	5	0.66
Vermileonidae	1	0.04	1	0.1						
Acroceridae	1	0.04							1	0.13
Bombyliidae	24	1.05	13	1.9	13	1.0	9	0.9		
Therevidae	4	0.17			2	0.2	2	0.2		
Asilidae	45	1.98	17	2.5	22	1.7	23	2.3	11	1.45
Empididae	43	1.89	1	0.1	29	2.3	8	0.8	7	0.92
Hybotidae	11	0.48			5	0.4	5	0.5	3	0.39
Microphoridae	2	0.09			2	0.2				
Dolichopodidae	40	1.76	1	0.1	13	1.0	25	2.5	6	0.79
Cyclorrhapha	**1243**	**54.64**	**312**	**45.9**	**830**	**65.3**	**601**	**59.1**	**506**	**66.67**
Platypezidae	1	0.04					1	0.1		
Phoridae	204	8.97	4	0.6	203	16.0	1	0.1	2	0.26
Pipunculidae	19	0.83			7	0.6	5	0.5	14	1.84
Syrphidae	204	8.97	41	6.0	130	10.2	149	14.7	49	6.46
Micropezidae	1	0.04			1	0.08				
Conopidae	26	1.14	3	0.4	8	0.6	20	2.0	2	0.26
Lonchaeidae	1	0.04			1	0.08				
Otitidae	1	0.04			1	0.08				
Platystomatidae	1	0.04			1	0.08				
Tephritidae	21	0.92	5	0.7	9	0.71	8	0.80	2	0.26

Table 1. Continuation

Piophilidae	1	0.04							1	0.13
Lauxaniidae	1	0.04					1	0.10		
Cremifaniidae	1	0.04					1	0.10		
Chamaemyiidae	15	0.66			6	0.5	1	0.10	12	1.58
Dryomyzidae	1	0.04			1	0.08				
Sciomyzidae	4	0.18	1	0.1	2	0.2	2	0.2		
Sepsidae	2	0.09			1	0.08			1	0.13
Agromyzidae	60	2.63			19	1.5	48	4.7	15	1.98
Opomyzidae	6	0.26			6	0.5	2	0.2	3	0.39
Periscelididae	1	0.04			1	0.08				
Braulidae	1	0.04			1	0.08				
Carnidae	6	0.26			3	0.2			5	0.66
Milichiidae	5	0.22			1	0.08	1	0.1	4	0.53
Chloropidae	106	4.66	23	3.4	79	6.2	61	6.0	72	9.49
Heleomyzidae	11	0.48	8	1.2	2	0.2	2	0.2		
Sphaeroceridae	7	0.31	3	0.4			2	0.2	2	0.26
Camillidae	1	0.04							1	0.13
Drosophilidae	3	0.13	2	0.3			1	0.1		
Diastatidae	1	0.04					1	0.1	1	0.13
Ephydridae	48	2.11	6	0.9	29	2.3	26	2.5	33	4.35
Hippoboscidae	4	0.18	2	0.3	2	0.2	2	0.2	2	0.26
Nycteribiidae	5	0.22	5	0.7						
Scathophagidae	6	0.26	4	0.6	2	0.2	2	0.2		
Anthomyiidae	17	0.75	10	1.5	9	0.7	3	0.3	1	0.13
Fanniidae	11	0.48	11	1.6	2	0.2	2	0.2	6	0.79
Muscidae	103	4.53	48	7.1	53	4.2	55	5.4	49	6.45
Calliphoridae	22	0.97	6	0.9	15	1.2	14	1.4	3	0.39
Sarcophagidae	52	2.28	8	1.2	25	2.0	24	2.4	18	2.37
Rhinophoridae	2	0.09			1	0.08	1	0.1		
Hypodermatidae	1	0.04			1	0.08				
Gasterophilidae	3	0.13	1	0.1			3	0.3		
Tachinidae	257	11.30	121	17.8	208	16.3	162	15.9	203	26.74
Families	**81**	**75.7**	**46**	**43.4**	**58**	**54.7**	**58**	**54.7**	**44**	**41.5**
Species	**2275**	**56.9**	**680**	**17.0**	**1272**	**31.7**	**1016**	**25.4**	**759**	**19.0**

Discussion

The low degree of similarity of Diptera among the mountains (30.4% to 45.4%) is due to their specific natural conditions and insufficient studies. The degree of similarity is the highest between the Rila and Pirin Mts. (Table 2). It could be explained with the close location of these mountains and the developed six vegetation belts. Higher is the similarity between the xeromesophilic and mesophilic mixed forests belt (oak-hornbeam) forests, while similarity is lacking in the alpine belt (Table 3). The higher degree of similarity between the Vitosha and Rila Mts. is explicable considering the silicate character, the mountain climate and the pronouncedly Eurosiberian faunistic character of these mountains. The low degree of similarity between the Vrachanska Planina and Vitosha Mts. is connected with the pronouncedly xerothermic habitats of the Vrachanska Planina Mts. (karst massif) and the presence of only two comparable vegetation belts [xeromesophilic and mesophilic oak-hornbeam forests and beech forests (poorly developed in the Vrachanska Planina Mts.)]. The higher degree of similarity between the Vrachanska Planina and Pirin Mts. is related to the karst half of North Pirin, the presence of xerothermic habitats in the lower parts of the mountain and the expressed Sub-Mediterranean faunistic character of the western slope of the Pirin Mts. In some better studied separated dipteran families, the degree of similarity among the mountains considered, is higher (about 60% in the family Tachinidae). Most dipteran species have vast ranges. The endemics comprise 1-1.5% of the Bulgarian species (Hubenov 2008a). Usually they are newly described taxa or rare species with unclear distribution. In the scrutinised mountains the percentage of endemism varies from 0.6% (Vrachanska Planina Mts.) to 1.7% (Pirin Mts.).

The taxa presence is connected with the exploration of the corresponding mountain region. This is evident when comparing the established species with regard to the localities they were found (Hubenov 2015b, 2016, 2018a, 2018b). From the dipterans of the Vrachanska Planina Mts., only the family Mycetophilidae which had been a subject of Ph.D. thesis, is evenly distributed according to the vegetation belts and parts. For the remaining families the taxa distribution is connected with the degree of study and has no systematic character. Six areas of detailed research are outlined in the Vrachanska Planina Mts. (over 50 species found). First are the surroundings of Vratsa (146 species) and Parshevitsa Chalet (100 species) – the most visited places of the mountain. Regarding the other parts of the mountain, the surroundings of Gara Lakatnik Station, Ledenika Chalet, Matnitsa River and Iskar Gorge (from 44 to 72 species) are better studied. Of the inner parts of the mountain, the surroundings of the Ledenika Cave and Parshevitsa Chalet are better studied. Most species, known from these areas, are from eight families (Mycetophilidae, Cecidomyiidae, Ceratopogonidae, Tabanidae, Syrphidae, Chloropidae, Muscidae and Tachinidae). It is evident that the localities from which the most material is collected, are concentrated around the popular starting points for entering the Vrachanska Planina Mts. and the main tourist centers or routes (Hubenov 2018b). Of all 54 localities, a total of 17 (31.5%) localities are over 800 m a.s.l. The remaining localities are in the lower parts or in the periphery of the mountain. It is seen, according to these data, that the territory of the Vrachanska Planina Mts. is unsufficiently explored.

The large number of localities (256) and the smaller area of the Vitosha Mt. give the impression of being evenly studied (Hubenov 2018a). This is so the families Cecidomyiidae and Phoridae, which have been a subject of dissertation works. For the remaining families the taxa distribution is connected with the extent to which the corresponding mountain region has been studied and has no systematic character. Four areas of detailed research (over 70 species found) are outlined. First are the surroundings of Knyazhevo (81 species) and Dragalevtsi (75 species) – the most visited places in the mountain. The large number of species known from the region of Bosnek Village (73 species) and Kirova Livada Meadow (72 species) are due to the five better studied families (Sciaridae, Cecidomyiidae, Phoridae, Chloropidae and Tachinidae). Regarding the other parts of the mountain, the surroundings of Boyana and Simeonovo and the Vladaya, Bistritsa and Zheleznitsa Villages (from 35 to 68 species) are better studied. Of the inner parts of the mountain, the surroundings of the Aleko Chalet, Golyamata Gramada, Kopitoto Peak and Zlatni Mostove (from 48 to 56 species) are better studied. It is seen that the localities from which the most material is collected, are concentrated around the popular starting points for entering the Vitosha Mt. and the main tourist centers or routes. In contrast to the other three mountains, where significant areas have not been studied (Hubenov 2015b, 2016, 2018b), there are no unexplored territories in the Vitosha Mt., from which a material (even single specimens) has not been collected.

Five areas of detailed research are outlined in the Rila Mts. (over 80 species found – Hubenov 2016). First are the surroundings of the Rila

Table 2. Degree of similarity of the Diptera fauna of the separate mountains

Mountains	Vitoshsa Mt.	Rila Mts.	Pirin Mts.
Vrachanska Planina Mts.	30.4% (297)	33.5% (284)	35.6% (256)
Vitoshsa Mt.		43.8% (501)	40.4% (411)
Rila Mts.			45.4% (403)

Note. Common species are given in brackets.

Table 3. Similarity of the Diptera fauna by vegetation belts in percentages of the Rila and Pirin Mountains

Vegetation belts of the Pirin Mts.	Vegetation belts of the Rila Mts.					
	1	2	3	4	5	6
1	40.8 (108)					
2		46.6 (163)				
3			40.9 (234)			
4				30.7 (83)		
5					25.7 (23)	
6						0 (0)

Note. 1 – Xerothermic oak forests, 2 – Mesophyllic and xeromesophyllic oak-hornbeam forests, 3 – Beech forests, 4 – Coniferous forests, 5 – Subalpine vegetation, 6 – Alpine vegetation. Common species are given in brackets.

Monastery (266 species) and Borovets (179 species) – the most visited places of the mountains. The popular starting points for entering Rila Mts., Blagoevgrad and Yundola (89-98 species), also form a group of well-studied regions. The Parangalitsa Reserve (120 species), where there is a research base of the Bulgarian Academy of Sciences, is also well-studied. Of the other parts of the mountain, the surroundings of Belovo, Kostenets, Dolna Banya, Govedartsi Village, Dupnitsa and the Predela area (from 36 to 47 species) are better studied. Of the inner parts of the mountain, the surroundings of the Kravarsko Dere River, Kirilova Polyana, the valley of Rilska Reka River, the Slavovo area and the chalets Malyovitsa and Musala (from 30 to 53 species) are better studied. The localities from which the material is collected, are concentrated around the popular tourist centers or routes.

Six areas of good research are outlined in the Pirin Mts. (over 70 species found – Hubenov, 2015b). First are the surroundings of Bansko (132 species) and Melnik (139 species) - the most visited places at the foot of the mountains. The popular resorts and starting points for entering Pirin Mts. – Sandanski and Lilyanovo Village, Popina laka and Razlog (from 77 to 92 species) also form a group of well-studied regions. Of the inner parts of the mountain, the surroundings of the chalets Banderitsa, Vihren, Gotse Delchev, Yavorov and Demyanitsa are better studied (from 23 to 53 species). Tthe localities from which material is collected (only 77) are concentrated around the popular tourist centers or routes.

Significant parts of the Rila and Pirin Mts. remain unexplored. This relates both to the difficulties of approaching the terrain and the insufficient studies of most families. The number of the established species represents a small part of the actual species composition of the studied mountains. The dipterans are a highly mobile group and after further investigations it can be expected significantly more species to be found. The Vrachanska Planina and Pirin Mts. are poorly studied. The dipteran fauna of the Rila Mts. is better studied than that of the Pirin Mts. but decreases vis-à-vis Vitosha Mt. This is evident when comparing the number of localities from which material is collected, the first publications, the number of publications and the taxonomic review of the established families (Table 1).

A total of 564 species have been established in the protected areas of the Rila Mts. (Hubenov 2016). In comparison with the Central Balkan National Park [184 species (Hubenov et al. 2000)], East Rhodopes [279 species (Hubenov 2004)], Vitosha Mt. [1272 species (Hubenov 2018a)], Pirin National Park [557 species (Hubenov 2015b)] and Vrachanski Balkan Nature Park [680 species (Hubenov 2018b)], the dipteran fauna (from the protected areas) of the Rila Mts. is commensurable with the fauna of the Pirin Mts. and Vrachanska Planina Mts., significantly exceeds that of the Central Balkan and East Rhodopes and decreases vis-a-vis Vitosha Mt. It should be kept in mind that Vitosha Mt. is the most well-studied Bulgarian mountain, while the Central Balkan National Park and East Rhodopes are poorly studied with respect to the two-winged insects. From the whole territory of the Stara Planina Mts. (insufficiently studied) are known about 800 species. The last studies on Diptera of the Pirin Mts. allow the fauna to be compared with these of the Rila and Vitosha Mountains. In the better studied families (Limoniidae, Simuliidae, Syrphidae, Chloropidae, Ephydridae, Muscidae and Tachinidae) the differences between the Vitosha, Rila and Pirin Mts. are not big (Table 1). Further studies of the Pirin Mts. would like increase the number of their dipterans and it might exceed most of the Bulgarian mountains. This is related to the wide variety of natural habitats, as well as the geographical location which the mountain occupies in South-west Bulgaria. Further, the Rila and Vitosha Mts. are expected to be similar to most of the Bulgarian high mountains in terms of species composition of Diptera. This relates to the natural habitats, as well as to the wide distribution of the dipterans, their high mobility and poorly expressed endemism. The Vratchanska Planina Mts. differs significantly in physiogeographical conditions from the other three mountains but the specific habitats presented there support a rich and varied fauna of Diptera.

In the xerothermic oak forests belt of the Vrachanska Planina Mts., the biggest number of species (456 species – 67.1%) has been established. This is due to the position of the most localities (37 – 68.5%) below 800 m a.s.l. In the Vitosha Mt., the biggest number of species (707 species or 55.6%) has been established in the mesophilic and xeromesophilic mixed forests belt. This is owing both to the open spaces to which species of the contiguous valleys penetrate and the great number of localities (100 or 39.1%) below 1100 m a.s.l. In contrast to the Vrachanska Planina, Rila and Pirin Mts. (where this belt is the second one), the Vitosha Mt. begins with the mesophilic and xeromesophilic mixed forests belt. In the xerothermic oak forests belt of the Pirin Mts., 273 species (36.8%) have been established, despite its limited development. This is connected both with its open spaces to which species of

the Sandanski-Petrich Valley penetrate and the belt above it. In the same vegetation belt of the Rila Mts. the species are 11.3% less (25.5% – 256 species). In this mountain the xerothermic oak forests are quite limited but there also species from the contiguous valleys penetrate in the open spaces. The lowest number of species (213 – 31.3%) of the Vrachanska Planina Mts. has been established in the xeromesophilic and mesophilic mixed forests belts. This can be related to the scarce localities (13 – 24.1%) in the belt's characteristic height range and the human impact on the boundaries between the belts of the Vrachanska Planina Mts. For this reason, some authors combine the first two belts as an oak forests belt (Velchev 1971). In the xeromesophilic and mesophilic mixed forests of the Rila (351 species – 35.0%) and Pirin (349 species – 47.0%) Mts., the species are significantly more (Hubenov 2017).

In the beech forests belt of the Vrachanska Planina Mts., 254 species (37.3%) have been found – less than in the Vitosha, Pirin and Rila Mts. where the percentage varies from 46.6% (Vitosha) to 73.4% (Rila). Of the presented families, most species are found in the beech forests belt in the Mycetophilidae, Bolitophilidae, Scathophagidae, Anthomyiidae and Faniidae (the better studied groups). The border between the beech and mixed forests of the Vrachanska Planina Mts. is unclear and depending on the exposure, relief and human impact; there are areas of fragmentation, mixing and replacement of beech forests with deforestation areas. The mentioned features and the scarce localities (12 – 22.2%) over 900 m a.s.l. determine the poor species richness in the beech forests belt of the Vrachanska Planina Mts. In the beech forests of the Vitosha Mt., 592 species (46.5%) have been found – less than in the Pirin and Rila Mts. Of the well-studied families Sciaridae, Cecidomyiidae, Phoridae, Chloropidae and Ephydridae, most species are found in the beech forests belt. The border between the beech and coniferous forests of the Vitosha Mt. is not clear. There are areas of mixing (200 – 300 m a.s.l.), replacement of coniferous with beech forests or deforestation areas. The greatest number of taxa have been found in the beech forest belt of the Rila (736 species or 73.4%) and Pirin (409 species or 55.1%) Mts; the border with the coniferous forests is not clear and there are wide areas of mixing. This determines the high species richness in the beech belt, the great number of common species and the similarity of the dipteran fauna from the vegetation belts 2, 3 and 4 for each mountain (Hubenov 2017). When comparing the respective vegetation belts between the two mountains (Table 3) the degree of similarity is low (from 30.7% to 46.6%). There are considerable differences between the Pirin and Rila Mts. (from 11.3% to 18.3%) in the number of species in the first three vegetation belts (especially the beech belt). They are probably owing to the specific climatic conditions of the two mountains, the nature of the plant communities in the karst areas of the Pirin Mts., the insufficient research of most of the families and the altitude of the localities, from which the most material originates.

The upper limit of the coniferous belt of the Vitosha Mt. (where it is developed) gradually passes into the subalpine vegetation zones with a mixture of regions. Thus, most of the species are common to both vegetation belts and the number of taxa established in the subalpine belt increases. Of the species found in the subalpine belt (143 species or 11.2%), 14 species are typical for it. *Megaselia robusta* Schmitz (Holarctic species of Phoridae) and *Platymya fimbriata* Meigen (Transpalaeartic species of Tachinidae) are boreomontane species and *Allophorocera pachystyla* Macquart (European species of Tachinidae) is a montane species. There are eight boreomontane species of Cecidomyiidae, Phoridae and Tachinidae, found in the coniferous and other vegetation belts. The percentage difference in the species composition of the subalpine belt with the Rila Mts. (99 species or 9.9%) and Pirin Mts. (79 species or 10.6%) is negligible (Hubenov 2017). However, for the Vitosha Mt., it is the last vegetation belt. More significant is the difference in the coniferous belt: 20.5% of the Vitosha Mt., 27.6% of the Rila Mts. and 35.7% of the Pirin Mts. The upper limit of the coniferous zone passes into the subalpine vegetation zones with a mixture of regions at about 200 m a.s.l. Thus, the number of taxa established in the subalpine belt of the two mountains is increased. Among the species found in the alpine belt (26 species or 2.6% in the Rila Mts. and 29 species or 3.9% in the Pirin Mts.), only four taxa collected from the Rila Mts. are typical for this belt (*Molophilus lautereri* Stary – Bulgarian endemic of Limoniidae, *Micropsectra radialis* Goet. – Palaearctic-Oriental species of Chironomidae, *Eudorylas jenkinsoni* Coe – European species of Pipunculidae, and *Didea alneti* Fall. – Holarctic species of Syrphidae). All other species have been established in the subalpine belt and most of them in other vegetation belts as well.

Regarding the hypsometric belts of the Vrachanska Planina Mts., the maximum number of species was recorded between 300 and 600 m a.s.l. In the Vitosha and Pirin Mts. this number is located between 900 and 1300 m a.s.l., and in the Rila Mts. – between 1000 and 1500 m a.s.l. [For family Tachinidae, such studies have been carried out for

the whole country and the maximum number of species was established between 400 and 1000 m a.s.l. as there are differences in the mountains of ±200 m (Hubenov 1993, 1995, 2015c)]. In some cases, the finding of species at certain altitude is accidental. The lack of systematic research on many families of Diptera, the unclear boundaries among the vegetation belts and the fragmentary data for most families do not allow explicit conclusions about the adherence of the taxa to one or another vegetation zone to be made. The distribution of species in groups according to their presence in the vegetation belts has a relative character and depends on the specific features of taxa and research areas, as well as on the duration of the research. There is a correlation between the horizontal and vertical distribution of Diptera. The species with wide vertical distribution usually comprise large areas of European, Eurosiberian, Palaearctic, Super-Palaearctic and Cosmopolitan type. The dipterans found in the subalpine and alpine zones of the Rila and Pirin Mts. have Holarctic-Oriental, Holarctic, Transpalaearctic, West and Central Palaearctic, West Palaearctic, European-North African, Holoeurosiberian, West and Central Eurosiberian, West Eurosiberian, Disjunct Eurosiberian and European ranges (Hubenov 2017). The differences of the taxa distribution in the subalpine and alpine zones of the Rila and Pirin Mts. were small: from 0.7 to 1.3% for both mountains. The differences between the separate areographical categories were higher and reached up to 5.4-7.5% (for the Holarctic species).

The zoogeographical categorisation of the species was made on the basis of current data about their distribution. Thus, the dipterans were divided into 105 categories, combined into two main groups and six complexes (Table 4).

Species distributed in the Palaearctic and beyond it. This complex (512 species – 22.5%) includes 34 categories, of which 27 combined species of northern type (widely distributed in the Holarctic and Palaearctic) and seven species of southern type (distributed only in the southern parts of the Palaearctic). The difference between mountains varies from 20.0% (for the Vitosha Mt.) to 31.6% (for the Vrachanska Planina Mts.). The difference between the vegetation belts in the separate mountains reaches 26.7% – from 18.1% (beech forests of the Vitosha Mt.) to 44.8% (alpine belt of the Pirin Mts.). The highest differences (%) between the different vegetation belts of the mountains (from 20.9% to 44.8% – xerothermic oak forests and alpine vegetation) were established in the Pirin Mts. (Hubenov 2017). The highest difference of 19.0% has been recorded in the beech forest belts of the Vitosha Mt. (18.1%) and the Vrachanska Planina Mts. (37.1%). In the other vegetation belts this difference was from 0.2% to 15.8%. The establishment of other species of the complex of the northern type in the last two vegetation belts is very likely, owing to their distribution and insufficient studies of the higher parts of the mountain. It is known that the species of the northern type have vast areas and ecological flexibility. In the Superpalaearctic complex, the Holarctic species prevail: 280 species or 12.3% (from 9.7% in the Pirin Mts. to 14.4% in the Vrachanska Planina Mts., from 72 species in the Pirin Mts. to 137 species in the Vitosha Mt.). Of the other areographical categories ,the Holarctic-Oriental [51 species – 2.2% (23 to 31 species, 2.2% to 4.0% in the separate mountains)] and Palaearctic-Oriental [46 species – 2.0% (13 to 29 species, 1.7% to 2.9%)] forms are better presented. The species of the southern type (11 species – 0.5%) are represented in the first two vegetation belts (one species is also found in the beech forest belt in the Pirin Mts.). The complex is not important for the zoogeographical characteristic of the dipterans in the studied region because of the small number of species (3-7 species or 0.3-0.7%). Usually the Super Palaearctic complex were scantly presented and is not determinant for the zoogeographical characteristic of taxa in the Bulgarian terrestrial fauna (with the exception of the coastal fauna). Only in a highly mobile forms (such as Diptera), the complex was well presented and could reach 20-25% (Hubenov 2015a). It was better represented in the Vrachanska Planina Mts. than in the Vitosha, Rila and Pirin Mts. (Table 4). In the two-winged insects significant numbers of synanthropic and synbovil forms with cosmopolitan or subcosmopolitan distribution occur. They have anthropogenic areas, structured with the development of human civilisation (before the contemporary studies).

Species distributed only in the Palaearctic but in more than one subregion (Palaearctic type). Taxa, whose areas include more than one Palaearctic subregion in latitudinal direction, belong to this group. They are well represented in the high mobile groups and comprise about 25-30% of the species composition. Twenty-six areographical categories have been registered, including 527 species (23.2%) of the fauna (Table 4). The character of the Palaearctic complex was determined by the Transpalaearctic [126 species – 5.5% (from 6.8% to 8.7% from the separate mountains)], West Palaearctic [89 species – 3.9% (от 2.9% до 6.5%)], European-North African [67 species – 2.9% (from 2.4% to 3.5%)] and West and Central Palaearctic [50

species – 2.2% (from 2.3%to 3.2%)] species. The correlation of these categories is the same in the separate vegetation belts and ranges from 0.5 to 9.9% (1 to 59 species) in the Vrachanska Planina Mts., from 0.7 to 7.5% (1 to 53 species) in the Vitosha Mt., from 0.2 to 11.0% (6 to 117 species) in the Pirin Mts. and from 1.6% to 12.2% (3 to 196 species) in the Rila Mts. The Holopalaearctic (26 species or 1.1%), Disjunct Palaearctic (29 species or 1.3%), Eurosiberian-Central Asian (37 species or 1.6%) and European-South-West Asian (24 species or 1.0%) species are well presented (Table 4). Their presence in the separate mountains varies from 0.4 to 2.6% (4 to 26 species). Twenty-nine species (1.3%) have a longitudinal disjunction of the areas with regard to Siberia and Central Asia – eight species from the Vrachanska Planina and Rila Mts. each, 26 species from the Vitosha Mt. and 13 species from the Pirin Mts. Probably some of these species are presented with sparse populations and will be studied in more detail as a result of further research. Most often a latitudinal disjunction of the areas of this complex is lacking (Gorodkov 1984, Josifov 1988, Hubenov 2015a). Rarely single boreomontane forms are presented. A significant part of the species with wide vertical distribution (above 20%) belong to the Palaearctic complex. It includes from 11.5% to 37.0% (from 3 to 196 species) of the species composition in the separate vegetation belts of the scrutinized mountains (Hubenov 2015b, 2016, 2017, 2018a, 2018b). The vast areas and wide vertical distribution of the taxa of this complex are an indication of the greater ecological flexibility of its species. The Palaearctic complex (like the Super Palaearctic one) is best represented in the Vrachanska Planina Mts. (where it comprises 30.4% of the established species) and poorly represented in the Vitosha, Rila and Pirin Mts. (where it comprises from 23.7% to 27.5% of the known species). This is probably related to the insufficient studies of the Vrachanska Planina Mts. Thus, owing to the lack of sufficient research and the non-systematic sampling, more common and widespread species have been collected.

Species distributed within one subregion of the Palaearctic. This complex (1236 species – 54.3%) includes 165 species (39.0%) from the Vrachanska Planina, 716 species (56.3%) from the Vitosha, 486 species (47.8%) from the Rila and 382 species (50.3%) from the Pirin Mts. The complex combines species with Eurosiberian and Mediterranean type of distribution (45 categories). Endemics are also included in this complex. The Mediterranean-Central Asian species are also included here according to Kryzhanovsky (1965, 2002) and Lopatin (1989), who combine the Mediterranean and Central Asian subregions (Table 4). The species with Mediterranean type of distribution are accepted in a general way and include Submediterranean, Subiranian and Pontian faunistic elements that could be also considered separately from the Mediterranean ones (Gruev & Kusmanov 1994, 1999, Gruev 1995, Gruev & Bechev 2000).

The Eurosiberian species include 14 areographical categories (1084 species or 47.6%), of which 227 species (33.4%) are from the Vrachanska Planina Mts., 655 (51.5%) – from the Vitosha Mt., 429 (42.2%) – from the Rila Mts. and 328 (44.2%) – from the Pirin Mts. (Table 4). The European [552 species (24.3%) – from 88 to 354 species (12.9% to 27.9%) in the separate mountains], Holoeurosiberian [132 species (5.8%) – from 36 to 82 species (5.3% to 8.1%) in the scrutinized mountains] and Disjunct Eurosiberian [111 species (4.9%) – from 35 to 62 species (3.3% to 5.2%) in the separate mountains] taxa are the most numerous. The West Eurosiberian, Central and Southeast European and West and Central Eurosiberian species are well represented. The ratio of these categories is different for the separate families (the Holoeurosiberian, Disjunct Eurosiberian and European species of the family Tachinidae are almost equal in number as the Eurosiberian forms are 50% in total, while in other families the Central and South European species are better represented). The number of taxa of these categories per vegetation belt varies from 0.2% to 39.9% (1-187 species) and increases (as a percentage) with height to 2200 m a.s.l. In general view of the complex according to the vegetation belts, the changes in the separate mountains are from 27.6% to 38.6% in the Vrachanska Planina, from 49.5% to 57.3% in the Vitosha, from 30.5% to 43.0% in the Rila and from 31.5% to 45.7% in the Pirin Mts. (Hubenov 2015b, 2016, 2017, 2018a, 2018b). The greatest number of Eurosiberian species (as a percentage) are found in the beech forests and the coniferous belts – 38.6% from the Vrachanska Planina, 56.9% to 57.3% from the Vitosha and from 42.8% to 45.7% from the Rila and Pirin Mts.. In the subalpine belt of the Vitosha (57.3%) and Rila (40.4%) Mts., the Eurosiberian species predominate over the other zoogeographical categories, whereas in the Pirin Mts. they are poorly represented (35.4%). In the alpine belt of the Rila Mts.(42.%) the Eurosiberian species are also better represented than in the Pirin Mts. (31.0%). The differences in the Eurosiberian species (as a percentage) in the other vegetation belts of the Pirin and Rila Mts. are smaller (to 2.9% for the beech belt). Higher are the differences in the

Table 4. Characteristics of Diptera (Insecta) of the Vrachanska Planina, Vitosha, Rila and Pirin Mountains

Zoogeographical categories	Total number	Vrachanska Planina Mts.	Vitosha Mt.	Rila Mts.	Pirin Mts.
Species distributed in Palaearctic and out of it	**512 (22.50)**	**214 (31.6)**	**254 (20.0)**	**258 (25.4)**	**156 (21.0)**
North type	**501 (22.02)**	**209 (30.7)**	**247 (19.4)**	**255 (25.1)**	**151 (20.3)**
Cosmopolitan	13 (0.57)	13 (1.9)	12 (0.9)	7 (0.7)	6 (0.8)
Semicosmopolitan	7 (0.31)	6 (0.9)	3 (0.2)	3 (0.3)	3 (0.4)
Holarctic-Paleotropical-Neotropical	3 (0.13)	1 (0.1)	3 (0.2)	3 (0.3)	1 (0.1)
Holarctic-Paleotropical-Australian	4 (0.17)	2 (0.3)	1 (0.08)	5 (0.5)	3 (0.4)
Holarctic-Paleotropical	3 (0.13)	2 (0.3)	1 (0.08)	2 (0.2)	1 (0.1)
Holarctic-Neotropical-Australian	2 (0.09)		2 (0.1)		
Holarctic-Neotropical-Oriental	16 (0.70)	8 (1.2)	5 (0.4)	9 (0.9)	5 (0.7)
Holarctic-Neotropical-Afrotropical	3 (0.13)	1 (0.1)	2 (0.1)	2 (0.2)	2 (0.3)
Holarctic-Oriental-Australian	3 (0.13)	2 (0.3)	1 (0.08)	1 (0.1)	
Holarctic-Afrotropical-Australian	2 (0.09)		1 (0.08)	1 (0.1)	
Holarctic-Neotropical	11 (0.48)	5 (0.7)	6 (0.5)	4 (0.4)	3 (0.4)
Holarctic-Afrotropical	5 (0.22)	3 (0.4)	2 (0.1)	3 (0.3)	1 (0.1)
Holarctic-Oriental	51 (2.24)	27 (4.0)	28 (2.2)	31 (3.0)	23 (3.1)
Holarctic-Australian	5 (0.22)	2 (0.3)	4 (0.3)	5 (0.5)	2 (0.3)
Palaearctic-Paleotropical-Australian	7 (0.31)	5 (0.7)	4 (0.3)	3 (0.3)	4 (0.5)
Palaearctic-Afrotropical-Australian	1 (0.04)			1 (0.1)	
Palaearctic-Oriental-Australian	3 (0.13)	1 (0.1)	3 (0.2)	2 (0.2)	
Palaearctic-Paleotropical	8 (0.35)	4 (0.6)	3 (0.2)	6 (0.6)	4 (0.5)
Palaearctic-Afrotropical-Neotropical	2 (0.09)	1 (0.1)			
Palaearctic-Afrotropical	6 (0.26)	3 (0.4)	2 (0.1)	2 (0.2)	3 (0.4)
Palaearctic-Oriental	46 (2.02)	18 (2.6)	23 (1.8)	29 (2.9)	13 (1.7)
Palaearctic-Australian	1 (0.04)	1 (0.1)		1 (0.1)	1 (0.1)
West Palaearctic-Afrotropical	4 (0.17)	3 (0.4)			1 (0.1)
West Palaearctic-Oriental	12 (0.53)	2 (0.3)	3 (0.2)	10 (1.0)	2 (0.3)
West Palaearctic-Neotropical	1 (0.04)		1 (0.08)		
Disjunct Palaearctic-Oriental	2 (0.09)	1 (0.1)		1 (0.1)	1 (0.1)
Holarctic	280 (12.30)	98 (14.4)	137 (10.8)	124 (12.2)	72 (9.7)
South type	**11 (0.48)**	**5 (0.7)**	**7 (0.6)**	**3 (0.3)**	**5 (0.7)**
South Palaearctic-Paleotropical-Australian	1 (0.04)				1 (0.1)
South Palaearctic-Paleotropical	1 (0.04)		1 (0.08)		
South Palaearctic-Afrotropical	2 (0.09)	1 (0.1)	2 (0.1)	1 (0.1)	1 (0.1)
South Palaearctic-Oriental	2 (0.09)	1 (0.1)	1 (0.08)		
Paleotropical-Mediterranean	1 (0.04)				1 (0.1)
Afrotropical-Mediterranean	1 (0.04)	1 (0.1)	1 (0.08)	1 (0.1)	1 (0.1)
Oriental-Mediterranean	3 (0.13)	2 (0.3)	2 (0.1)	1 (0.1)	1 (0.1)
Species with Palaearctic distribution	**1763 (77.49)**	**472 (69.4)**	**1018 (80.0)**	**745 (73.3)**	**586 (79.0)**
Palaearctic type	**527 (23.16)**	**207 (30.4)**	**302 (23.7)**	**259 (25.5)**	**204 (27.5)**
Holopalaearctic	26 (1.14)	16 (2.3)	18 (1.4)	18 (1.8)	19 (2.6)
Transpalaearctic	126 (5.54)	59 (8.7)	87 (6.8)	78 (7.7)	58 (7.8)
West and Central Palaearctic	50 (2.20)	20 (2.9)	30 (2.4)	23 (2.3)	24 (3.2)
West Palaearctic	89 (3.91)	44 (6.5)	37 (2.9)	46 (4.5)	26 (3.5)
Disjunct Palaearctic	29 (1.27)	8 (1.2)	26 (2.0)	8 (0.8)	13 (1.7)
South Palaearctic	4 (0.17)	2 (0.3)	2 (0.1)	3 (0.3)	2 (0.3)
European-Anatolian-North African	6 (0.26)	2 (0.3)	5 (0.4)	1 (0.1)	
European-North African	67 (2.94)	19 (2.8)	31 (2.4)	35 (3.5)	26 (3.5)
Eurosiberian-Anatolian-Central Asian	4 (0.17)	2 (0.3)	2 (0.1)	1 (0.1)	
Eurosiberian-Central Asian	37 (1.63)	10 (1.5)	17 (1.3)	22 (2.2)	8 (1.1)
Eurosiberian-Iran-Turanian	2 (0.09)	2 (0.3)			
West Eurosiberian-Anatolian-Central Asian	2 (0.09)		1 (0.08)	1 (0.1)	
West Eurosiberian-Central Asian	4 (0.17)		3 (0.2)	1 (0.1)	2 (0.3)
West Eurosiberian-West Central Asian	2 (0.09)		2 (0.1)		
West Eurosiberian-Iran-Turanian	2 (0.09)	2 (0.3)	1 (0.08)	1 (0.1)	
West Eurosiberian-Anatolian-Turanian	3 (0.13)	2 (0.3)	1 (0.08)		
West Eurosiberian-Anatolian	2 (0.09)	2 (0.3)	2 (0.1)		
West Eurosiberian-Turanian	3 (0.13)	3 (0.4)	1 (0.08)		

Table 1. Continuation

Zoogeographical categories	Total number	Vrachanska Planina Mts.	Vitosha Mt.	Rila Mts.	Pirin Mts.
European-Central Asian	4 (0.17)	3 (0.4)	1 (0.08)	2 (0.2)	3 (0.4)
East European-Central Asian	1 (0.04)				1 (0.1)
European-West Central Asian	9 (0.39)		4 (0.3)	4 (0.4)	5 (0.7)
European-Southwest Asian	24 (1.05)	4 (0.6)	14 (1.1)	4 (0.4)	6 (0.8)
European-Anatolian-Iran-Turanian	3 (0.13)	2 (0.3)	1 (0.08)		
European-Iran-Turanian	11 (0.48)	2 (0.3)	5 (0.4)	8 (0.8)	8 (1.1)
European-Iranian	1 (0.04)	1 (0.1)			
European-Turanian	16 (0.70)	2 (0.3)	11 (0.9)	3 (0.3)	3 (0.4)
Eurosiberian type	**1084 (47.65)**	**227 (33.4)**	**655 (51.5)**	**429 (42.2)**	**328 (44.2)**
Holoeurosiberian	132 (5.80)	36 (5.3)	69 (5.4)	82 (8.1)	50 (6.7)
West and Central Eurosiberian	56 (2.46)	16 (2.3)	28 (2.2)	27 (2.6)	29 (3.9)
West Eurosiberian	71 (3.12)	12 (1.7)	45 (3.5)	42 (4.1)	27 (3.6)
Disjunct Eurosiberian	111 (4.88)	35 (5.1)	62 (4.9)	34 (3.3)	39 (5.2)
European and South Siberian	15 (0.66)	9 (1.3)	10 (0.8)	6 (0.6)	11 (1.5)
European-Anatolian	26 (1.14)	8 (1.2)	13 (1.0)	10 (1.0)	4 (0.5)
European	552 (24.26)	88 (12.9)	354 (27.9)	183 (18.0)	141 (19.0)
Central and East European	2 (0.09)	1 (0.1)		2 (0.2)	
Central and South European-Anatolian	11 (0.48|	4 (0.6)	5 (0.4)	5 (0.5)	3 (0.4)
Central and Southeast European-Anatolian	3 (0.13)	2 (0.3)	1 (0.08)	2 (0.2)	
Central and Southeast European-Lebanonian	1 (0.04)			1 (0.1)	
Central (Middle) and South European	67 (2.94)	10 (1.5)	41 (3.2)	25 (2.5)	18 (2.4)
Central and Southeast European	33 (1.45)	6 (0.9)	21 (1.6)	10 (1.0)	6 (0.8)
East European	4 (0.17)		4 (0.3)		
Mediterranean type	**115 (5.05)**	**34 (5.0)**	**46 (3.6)**	**45 (4.4)**	**41 (5.5)**
Mediterranean and South Siberian	3 (0.13)		1 (0.08)	3 (0.3)	1 (0.1)
North Mediterranean and South Far East	1 (0.04)	1 (0.1)			
Mediterranean and Southwest Siberian	1 (0.04)		1 (0.08)	1 (0.1)	1 (0.1)
Mediterranean-Central Asian	8 (0.35)	3 (0.4)	3 (0.2)	6 (0.6)	6 (0.8)
North Mediterranean-Central Asian	2 (0.09)	1 (0.1)		1 (0.1)	
Mediterranean-West Central Asian	5 (0.22)		3 (0.2)	2 (0.2)	2 (0.3)
Mediterranean-Iran-Turanian	6 (0.26)	4 (0.6)	2 (0.1)		
Northeast Mediterranean-Iran-Turanian	1 (0.04)				1 (0.1)
Mediterranean-Turanian	3 (0.13)		1 (0.08)	1 (0.1)	2 (0.3)
North Mediterranean-Turanian	5 (0.22)		2 (0.1)	1 (0.1)	3 (0.4)
South European and South Siberian	2 (0.09)			1 (0.1)	2 (0.3)
Southeast European and South Siberian	1 (0.04)	1 (0.1)			
Central and South European-Iran-Turanian	4 (0.17)	1 (0.1)	2 (0.1)	2 (0.2)	1 (0.1)
Central (Middle) and South European-Iranian	3 (0.13)	3 (0.4)			
Central (Middle) and South European-Turanian	1 (0.04)	1 (0.1)			
Central and Southeast European-Iran-Turanian	1 (0.04)				1 (0.1)
Central and Southeast European-Iranian	1 (0.04)	1 (0.1)			
Central and South European-North African	5 (0.22)	1 (0.1)	4 (0.3)	1 (0.1)	1 (0.1)
South European-North African	2 (0.09)	1 (0.1)	1 (0.08)	1 (0.1)	
Southeast European-North African	1 (0.04)		1 (0.08)		
Holomediterranean	23 (1.01)	9 (1.3)	9 (0.7)	8 (0.8)	10 (1.3)
North Mediterranean	10 (0.44)	3 (0.4)	3 (0.2)	6 (0.6)	4 (0.5)
South European	12 (0.53)	1 (0.1)	7 (0.5)	7 (0.7)	3 (0.4)
Southeast European-Anatolian	4 (0.17)	3 (0.4)	1 (0.08)		
Southeast European	4 (0.17)		3 (0.2)	1 (0.1)	
East Mediterranean	1 (0.04)		1 (0.08)		1 (0.1)
Balkan-Anatolian	5 (0.22)		1 (0.08)	3 (0.3)	2 (0.3)
Endemics	**37 (1.63)**	**4 (0.6)**	**15 (1.2)**	**12 (1.2)**	**13 (1.7)**
Balkan subendemic	4 (0.17)	1 (0.1)	1 (0.08)	2 (0.2)	1 (0.1)
Balkan endemic	7 (0.31)	1 (0.1)	3 (0.2)	1 (0.1)	4 (0.5)
Bulgarian endemic	20 (0.88)		11 (0.8)	7 (0.7)	6 (0.8)
Regional endemic	6 (0.26)	2 (0.3)		2 (0.2)	2 (0.3)
Total	**2275**	**680**	**1272**	**1016**	**759**

Eurosiberian species with the Vrachanska Planina and Vitosha Mts. (to 14.1-18.3%). A number of disjunctive areas are presented – a longitudinal disjunction for parts of Siberia and Central Asia (Table 4) and latitudinal disjunction with typical for the Eurosiberian complex boreomontane, boreoalpine and arctic-alpine distribution (Gorodkov 1984, Josifov 1988, Hubenov 2015a). Of interest is the significant presence of Eurosiberian species in the first two vegetation belts of the separate mountains. This could be explained in three ways: 1) possibly a part of these species to have unclear Palaearctic distribution; 2) the humid mountain valleys characterised with cooler climate, have facilitated the migration of the above-mentioned forms to the lowlands; 3) predominant research of the lower parts of the mountain compared to the higher ones. Finding of the Eurosiberian boreomontane forms at low altitudes has also been reported for other insect groups as Heteroptera, Cerambycidae (Coleoptera) and Tachinidae (Diptera) by Josifov 1963, 1976, Georgiev & Hubenov 2006, Hubenov 1992, 2008b. For Cerambycide this fact is due to the large afforestations of conifers in the first two vegetation belts. Probably because of this, many boreomontane and montane species that feed on conifers, go down below 1000 m a.s.l. There is a significant difference among the Vitosha, Rila and Pirin Mts. with respect to the Eurosiberian species which are more (42.8-51.5%) than in the Vrachanska Planina Mts. (33.4%). There are no big differences in the vertical distribution of the complex (with the exception of the alpine belt – 11.3%) between the Rila and Pirin Mts., except that some of the areographical categories are differently presented in the subalpine and alpine belts. Probably, under further research of the Diptera fauna of the Rila and Pirin Mts. (especially in the high parts), the number of the Eurosiberian species will come closer to that of the Vitosha Mt.

The Mediterranean species include 27 areographical categories (115 species or 5.0%), of which 34 species (5.0%) are from the Vrachanska Planina, 46 (3.6%) – from the Vitosha, 45 (4.4%) – from the Rila and 41 (5.5%) – from the Pirin Mts. (Table 4). They are presented mainly in the first two vegetation belts and their number rapidly decreases with altitude. The Mediterranean species, established in one or two vegetation belts, prevail. A significant percentage of these species and their relatively scarce populations are due to the lower ecological flexibility of the Mediterranean forms in comparison with the previous ones. Because of the big variety of these areas, the group is divided into many subgroups with different origin, distribution and ecological peculiarities of the taxa. This complexity contributes to establishing of various zoogeographical classifications for Bulgaria (Josifov 1981, 1986, 1988, 1999, Gruev 1988, 1995, 2000a, 2000b, 2000c, 2002, Heiss & Josifov 1990, Gruev & Kusmanov 1994, Hubenov 1996, 2008a, Gruev & Bechev 2000, Popov 2002). The Mediterranean species include from 2.0% to 10.3% (1 to 29 species) of Diptera of the separate vegetation belts in the studied mountains (Hubenov 2015b, 2016, 2017, 2018a, 2018b). The difference between the first vegetation belt of the Pirin (10.3% – 28 species) and the other mountains [4.1% to 7.4% (from 1 to 29 species)] is due to the fact that in the neighbouring region of the Pirin Mts., the Sandanski-Petrich Valley (the region with the strongest Mediterranean influence in Bulgaria), the Mediterranean forms reach 17% (Beschovski & Hubenov 1986). The Holomediterranean [23 species – 1.0% (from 0.7% in the Vitosha Mt. to 1.3% in the Pirin Mts.)] and South European [12 species – 0.5% (from 0.1% in the Vrachanska Planina Mts. to 0.7% in the Rila Mts.)] species are the most numerous. The Mediterranean-Central Asian and North Mediterranean species are well presented in the Rila and Pirin Mts., the Mediterranean-Iran-Turanian – in the Vrachanska Planina Mts. and the Central and South European-North African forms – in the Vitosha Mt. There are no significant differences in the distribution of the separate areographical categories in the Mediterranean species of the mountains. Of the remaining categories, not all are presented in each of the mountains. In the subalpine belt five Mediterranean taxa have been established – two from the Vitosha, two from the Rila and three from the Pirin (*Prosimulium petrosum* Rubtsov – Southeast European species of the family Simuliidae, *Ogcodes lautereri* Chvala – Holomediterranean species of the family Acroceridae, *Megaselia oxybelorum* Schmitz – Holomediterranean species of the family Phoridae, *Lamproscatella unipunctata* Becker – Mediterranean-Central Asian species of the family Ephydridae, established also in the alpine belt of the Pirin Mts. and *Sarcophaga porrecta* Böttcher – South European species of the family Sarcophagidae). This could be Montane Mediterranean forms or species with unclear distribution. When comparing with the Vitosha, Rila and Pirin Mts., there is a higher percentage (3.6-4.5-5.5%) of the Mediterranean taxa southwards which is related to the specific natural conditions and geographical location of these mountains. This does not apply to the Vrachanska Planina Mts. (5.0%), which is connected with the karst terrain, xerothermic habitats and lower altitude of the mountain.

Endemics. This category includes taxa, which are not distributed outside the Balkan Peninsula. The percentage of endemism in Diptera is low – 1.6% [37 species (4 from the Vrachanska Planina, 15 from the Vitosha, 12 from the Rila and 13 from the Pirin Mts.)]. The Bulgarian endemic forms prevail (20 species – 0.9%). Endemic forms have not been established in the first two vegetation belts of the Rila Mts., unlike the Pirin Mts. Endemic forms have not been established in the subalpine belt of the Vitosha Mt., (regional forms also lack) and in the Vrachanska Planina Mts. – in the xeromesophilic and mesophilic oak-hornbeam forests. The main part of the endemic species are related to the beech and coniferous belts. This suggests that these endemic species are postglacial neoendemics which are to be connected with the Eurosiberian forms. The endemics established in the first vegetation belt of the Vrachanska Planina and Pirin Mts. probably do not belong to this category. Local endemics have not been established among Diptera from the studied mountains. The endemic dipterans are mostly newly described taxa (in the Vrachanska Planina Mts. – three species from 1985 to 1989 and one in 1859; in the Vitosha Mt. – five species from 1916 to 1940 and the others after 1964; in the Pirin Mts. – one from 1862, two from 1940 and 1942 and the others after 1970; in the Rila Mts. – one from 1930, one – from 1940 and the others after 1970). Of interest is the describing of *Cremifania bulgarica* Papp, 2010 (family Cremifaniidae, reported from 2250 m a.s.l. – the third Palaearctic species of the family) in the Rila Mts.

Conclusion

A total of 2275 species (56.9% of the species found in Bulgaria) from 81 families have been recorded from the studied mountains. The degree of similarity of the dipteran fauna among these mountains is from 30.4% to 45.4%. The degree of similarity between the different vegetation belts ranges from 0% to 46.6%. The dipterous fauna can be divided into two supergroups: 1) species with Mediterranean type of distribution (126 species or 5.5%) – more thermophilic and distributed mainly in the southern parts of the Palaearctic. The species of the southern type, distributed in the Palaearctic and beyond it, can be formally related to this group as well; 2) species with Palaearctic and Eurosiberian type of distribution (2149 species or 94.5%) – more eurybiontic and widely distributed in the Palaearctic. The species of the northern type, distributed in the Palaearctic and beyond it, can be formally related to this group as well. The zoogeographical character of the dipteran fauna is determined by the second group. The ratio between the two main groups is different in the separate mountains and vegetation belts. The Holomediterranean, South European and North Mediterranean forms are the most numerous in the first group. The European, Holarctic, Holoeurosiberian, Transpalaearctic and Disjunct Eurosiberian taxa prevail in the second group. The percentage of the typical Mediterranean species increases from north to south (3.6-4.4-5.5%, respectively). The biggest differences (from 41.6%) are found between the first vegetation belts of the Vrachanska Planina and Rila Mts.. The variety of areographical categories decreases with altitude.

Xerothermic oak forests (273 species or 36.8% from the Pirin Mts., 256 species or 25.5% from the Rila Mts., 456 species or 67.1% from the Vrachanska Planina Mts.). This vegetation belt is not presented in the Vitosha Mt. Of the species with Mediterranean type of distribution (from 7.2% to 11.7% in the separate mountains) the Holomediterranean, Mediterranean-Central Asian and North Mediterranean are the most numerous. Of the species with Palaearctic and Eurosiberian type of distribution (from 87.9% to 92.3% in the separate mountains) – the Holarctic, Transpalaearctic, Holoeurosiberian and European species are best represented. Endemic forms have not been established yet in the Rila Mts.

Mesophyllic and xeromesophyllic mixed forests (oak- hornbeam) forests (349 species or 47.0% from the Pirin, 351 species or 35.0% from the Rila, 707 species or 55.7% from the Vitosha and 211 species or 31.0% from the Vrachanska Planina Mts.). Of the species with Mediterranean type of distribution (from 2.8% to 6.6% in the separate mountains) the Mediterranean-Central Asian and Holomediterranean species prevail. Of the species with Palaearctic and Eurosiberian type of distribution (from 93.1% to 97.2% in the separate mountains) – the Holarctic, Transpalaearctic and European species are best represented. In the Pirin and Rila Mts. the number of the Holarctic-Oriental, Holarctic, Transpalaearctic, European-North African, Holoeurosiberian, West Eurosiberian, Disjunct Eurosiberian and European species is increased. The percentage of the Mediterranean species decreases. Endemic forms have not been established yet in the Rila and Vrachanska Planina Mts.. The species of southern type distributed in the Palaearctic and beyond it are not presented in the Vrachanska Planina Mts.

Beech forests (409 species or 55.1% from the Pirin, 736 species or 73.4% from the Rila, 592 species or 46.5% from the Vitosha and 251 species or

36.9% from the Vrachanska Planina Mts.). Of the species with Mediterranean type of distribution (from 1.8% to 3.1% in the separate mountains), the Mediterranean-Central Asian, Holomediterranean and South European are the most numerous and of the species with Palaearctic and Eurosiberian type of distribution (from 95.5% to 97.2% in the separate mountains) – the Holarctic and European species are best represented. Only in the Pirin Mts., the species of southern type distributed in the Palaearctic and beyond it have been established. The number of the Holarctic-Oriental, Palaearctic-Oriental, Holarctic, West Palaearctic, Holoeurosiberian (the number of the Holoeurosiberian species is increased also in the Vrachanska Planina Mts.), West and Central Eurosiberian, West Eurosiberian and European species is increased in the Rila and Pirin Mts.. Endemics have been established in the Rila Mts. Of the endemic taxa, the Bulgarian endemics prevailed. The percentage of the Mediterranean species decreases.

Coniferous forests (265 species or 35.7% from the Pirin, 277 species or 27.6% from the Rila and 260 species or 20.4% from the Vitosha Mts.). This vegetation belt is not presented in the Vrachanska Planina Mts. Of the species with Mediterranean type of distribution (six species each in the Pirin, Rila and Vitosha Mountains – from 2.2% to 2.3%), the South European species are the most numerous, while of the species with Palaearctic and Eurosiberian type of distribution (from 95.5% to 96.7% in the three mountains), the Holarctic, Transpalaearctic, Holoeurosiberian and European species prevail. Of the areographical categories, 26 are not presented in the Pirin Mts., 28 – in the Rila Mts. and 44 – in the Vitosha Mt. The Cosmopolitan, Holarctic-Oriental, Palaearctic-Oriental, West and Central Palaearctic, West Palaearctic, European-North African and Disjunct Eurosiberian species are better represented. The percentage of the Mediterranean forms is considerably decreased. In comparison with the Rila and Pirin Mts., the dipterous fauna of the Vitosha Mt. is poorly presented in the coniferous forests. This is connected with the poor floristic composition, limited area and fragmentation of the coniferous belt of the Vitosha Mt.

Subalpine vegetation (79 species or 10.6% from the Pirin Mts., 99 species or 9.9% from the Rila Mts. and 143 species or 11.2% from the Vitosha Mt.). Of the species with Mediterranean type of distribution three species have been established in the Pirin Mts. and two species each – in the Rila and Vitosha Mts. (Mediterranean-Central Asian, Holomediterranean, South European and Southeast European) and of the species with Palaearctic and Eurosiberian type of distribution (32 areographical categories in the Pirin, 31 in the Rila and 27 in the Vitosha Mts.), the Holarctic and European species are the most numerous. The Transpalaearctic, European-North African and Disjunct Eurosiberian taxa are well presented in the Vitosha Mt. but endemic forms lack. When comparing with the Rila and Pirin Mountains, the species composition of the Vitosha Mt. in the subalpine zone is richer. This is connected with the lower height of the Vitosha Mt. and the lack of a pronounced coniferous belt in the southern parts of the mountain. This part of the Rila and Pirin Mts. has been poorly explored and excluding some families, the studies are fragmentary.

Alpine vegetation (29 species or 3.9% from the Pirin and 26 species or 2.6% from the Rila Mts.). This vegetation belt is not presented in the Vitosha Mt. One Mediterranean species (*Lamproscatella unipunctata* Becker of the family Ephydridae) has been recorded from the Pirin Mts. and only species with Palaearctic and Eurosiberian type of distribution belonging to 16 areographical categories have been established in the Rila Mts. The Holarctic and European taxa are the most numerous. The remaining categories are represented by one – two species each. One Bulgarian endemic (*Molophilus lautereri* Stary of the family Limoniidae) has been recorded from the Rila Mts. With the exception of four families, studies on the two-winged insects in this vegetation belt of the Pirin and Rila Mts. are almost lacking.

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