

The Distribution of Gomphocerinae Taxa in the Black Sea Region of Turkey: The Role of Vegetations and Elevations

Abbas MOL¹

Mehmet Sait TAYLAN²

Ünal ZEYBEKOĞLU³

Deniz ŞİRİN^{4*}

¹Health Academy, Emergency Aid and Disaster Management
Department, Aksaray University, Aksaray, TURKEY

²Department of Biology, Science Institute, Hakkari University, Hakkari, TURKEY

³Department of Biology, Faculty of Art and Science,
Ondokuz Mayıs University, Samsun, TURKEY

⁴Department of Biology, Faculty of Art and Science,
Tekirdağ Namık Kemal University, Tekirdağ, TURKEY

e-mails: ¹abbasmol19@gmail.com, ²msaittaylan@hakkari.edu.tr,

³unalz@omu.edu.tr, ^{4*}denizsirin19@gmail.com

ORCIDS IDs: ¹0000-0003-0660-967X, ²0000-0002-2084-920X, ³0000-0001-7595-9572,
^{4*}0000-0001-5475-173X

ABSTRACT

In the conducting the present study, the Gomphocerinae specimens were collected from June to September between 2003 and 2017 according to factors such as the Black Sea Region's topography, its vegetation and altitudes. A total of 207 different localities (including 70 main localities) from 25 provinces in region (7 of them from neighbour to region provinces) were visited. Approximately 5991 adult sample belonging to Gomphocerinae subfamily were collected from the Black Sea region. The collected samples comprised 53 Gomphocerinae taxa, belonging to 17 genera. The total number of Gomphocerinae taxa in the study area reached to 59 with six species from the literature. According to data from this study and other literature, the Black sea region ranks first among the geographical regions of Turkey with regard to the presence of the Gomphocerinae genera and its species number. It has been determined that some 17 species in area belong to Europe (Boreal) sub-region in Palaearctic. The data reveal that the Gomphocerinae taxa prefers mostly altitudes ranging between 600 and 2250 meters in *Castanetum zone*, *Broad-leaf deciduous forest zone*, and *subalpine meadows* in this elevational range. According to all data from this study, the Gomphocerinae taxa prefer the Black Sea Region as refugia.

Key words: Orthoptera, Gomphocerinae, zoogeographical zones, vegetation zones, Black Sea Region, Anatolia.

INTRODUCTION

Anatolia is represented during the glacial periods one of the most important refuges for various species in western Asia and southern Europe along with Spain, Italy, Greece, Balkans and Caucasus (Hewitt, 1996). Anatolia plays the role of a land bridge for the distribution of fauna elements from east to west and from north to south; as part of the Palaearctic region, it contains a high proportion of endemic plant and animal species (Akman, 1993; Demirsoy, 2002; Atalay, 2015).

The following factors constitute the reasons for the high rate of endemism in Anatolia: (i) acting as a bridge for the exchange of fauna between Eurasia and Africa; (ii) having contacts with different land masses and sometimes the loss of this connection at different geological times; and (iii) showing topographical and climatically large changes in a very short distance, by which bringing biotope diversity along with species diversity (Demirsoy, 1997; 2002; Çıplak, 2008), and being in the “gene center” position for many taxa (Hewitt, 1996; 2000; Çıplak, 2008). In addition, Anatolia acts as “refugia” for many species through the Pliocene and Pleistocene glacial periods in the last 2.4 MY, especially for those forms that prefer colder climates and for many species in interglacial periods; it also acts as a bridge during the migration from south to north for the warm climate preferring taxa (Demirsoy, 1977; 2002; Çıplak, 2004; 2008; Mol & Zeybekoğlu, 2013). The phytogeographical and zoogeographical studies should be evaluated together in order to understand the reasons for the richness of biodiversity in the region, the formation of fauna, and how the area is affected. There are few essential studies for the investigation of Anatolia biogeography (Uvarov, 1921; 1934; Weidner, 1969; Demirsoy, 1977; 2002; Çıplak, Demirsoy, & Bozcuk, 1993, 1996; Çıplak & Demirsoy, 1996; Hewitt, 1996; 2000; Çıplak, 2004; 2008).

Gomphocerinae (Orthoptera: Acrididae) includes 1738 taxa belonging to 192 genera in Holarctic region (Cigliano, Braun, Eades, & Otte, 2018). The number of the Gomphocerinae taxa shows a variety in southern refugia, namely are 65 taxa in Spain, 56 in France, 42 in Italy, 45 in Greece, and 98 taxa in Turkey (Bei-Bienko and Mistshenko, 1951; Harz, 1975; Demirsoy, 1977, 2002; Mol & Zeybekoğlu, 2013; Ünal, 2015; Cigliano et al, 2018). Literature reports that Gomphocerinae taxa prefer mostly the cold climate of the northern hemisphere, and cold and ever green vegetation in the central and northern parts of Europe and Asia (Bei-Bienko and Mistshenko, 1951; Harz, 1975; Demirsoy, 1977). Considering the ecological preferences of the Gomphocerinae subfamily, it appears that the Black Sea region and partly the Eastern Anatolia region of Anatolia are the fit areas where this demand can be answered. Especially the Black Sea region is known for its temperate rainforest ecosystem whereas most of the area is covered by coniferous or broadleaf forests and subalpine meadows which develop in the temperate zone and receive heavy rainfall (Şensoy, Demircan, Ulupinar, & Balta, 2008; Atalay, 2015).

This study aims to contribute to the zoogeography of Turkey by revealing the role of the vegetation and altitude role in the distribution of the Gomphocerinae taxa in the Black Sea region.

MATERIALS AND METHODS

The specimens were collected from June to September between 2003 and 2017 by taking in consideration factors such as the Black Sea Region's topography, its vegetation and altitudes. A total of 207 different localities (including 70 main localities which were visited more than two times) from 25 provinces in region (7 of them from neighbouring provinces the region) were visited and the field trip was performed (Fig. 1). Gomphocerinae taxa were sampled with an insect net and the most commonly used method to determine relative abundance and to estimate the grasshopper species composition (Gardiner, Hill, & Chesmore, 2005). Samples were collected using the insect net during daytime on the feeding habitats. Most of the collected samples were identified by using the morphological characters (Uvarov, 1934; Bei-Bienko & Mistschenko, 1951; Karabağ, 1953, 1957, 1959, 1963; Harz, 1975; Demirsoy, 1977; Salman, 1978; Soltani, 1978; Willemse, 1985). The songs of some species, especially those belonging to the genera *Stenobothrus* and *Chorthippus*, were recorded by different song recorder equipments (Sony tape recorder, Tascam DR-100 and Tascam HD-P2). The acoustic characters of the species were compared to those from the literature (Ragge & Reynolds, 1998; Savitsky, 2007; Vedenina & Helversen, 2009; Şirin, Helversen, & Çıplak, 2010b; Şirin, Mol, & Çıplak, 2011; Şirin, Mol, & Akyıldız, 2014; Mol, 2012) in order to be identified. The altitudinal distribution and the vegetation zones preference of the taxa collected by the authors and reported in previous studies (Salman, 1978; Ünal, 1999, 2008, 2010) were demonstrated according to the related literature (Atalay, 2015). Atalay (2015) analyzed and described in detail the vegetation zones of the Black Sea region; we simplified these zones and compared them with the grasshopper distribution in the area. The generally vegetation zones of the Black Sea region are grouped into 5 main vegetation zones, the Maquis zone (mostly between 0-200 m), *Castanetum* zone (mostly between 200-600 m), the Broad-leaf deciduous forest zone (mostly between 600-1200 m), the Conifer forests zone (mostly between 1200-2000 m), and the Subalpine meadows (mostly over the 2000 m) (Figs. 2, 3).

According to Uvarov (1921), the distribution of the Palaearctic region Orthoptera taxa is divided into 4 sub-regions, and this view is particularly widely used in the description of the structure of the fauna of Anatolia and the Caucasus. These sub-regions are: (1) Boreal sub-region (Central and Northern Europe): (2) Step sub-region (Angara: Caspian vicinity, Central and Northern Asia): (3) sub-region Mediterranean; and (4) Eremial sub-region (Syrio Eremial, Irano-Turanian and African origin ones). In this study, we followed Uvarov (1921) sub-regions description for Gomphocerinae subfamily members.

RESULTS AND DISCUSSION

Approximately 5991 adult samples belonging to Gomphocerinae subfamily were collected from the Black Sea region (Table 1). The collected samples comprised 53 Gomphocerinae taxa, belonging to 17 genera (Table 1) could not collect six Gomphocerinae species (Table 1), which are mentioned in literature (Salman, 1978; Ünal, 1999, 2008).

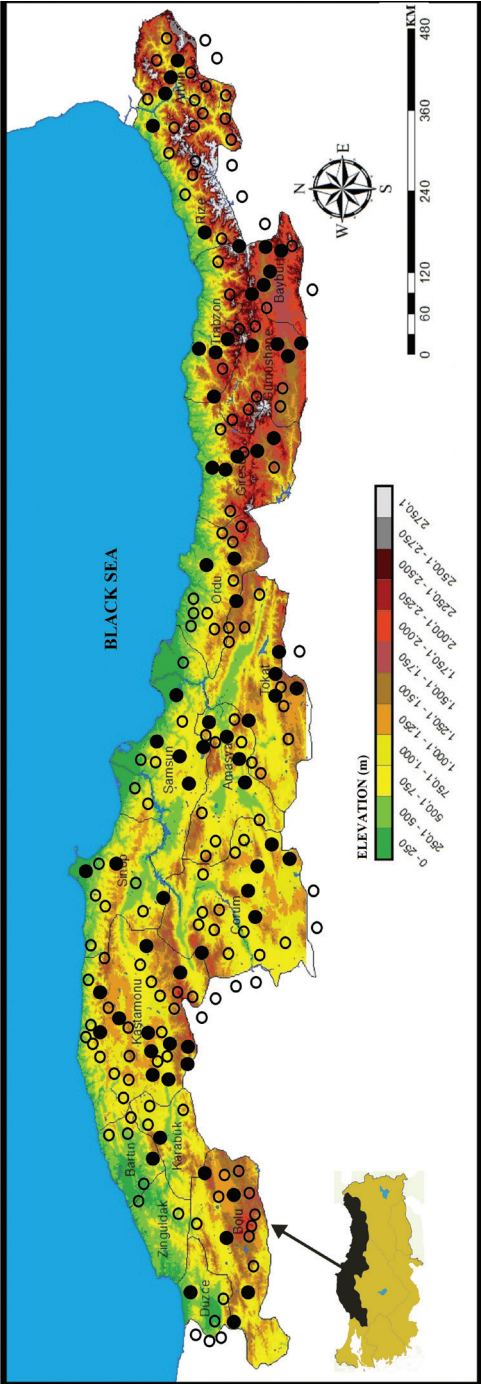


Fig. 1. The localities visited to collect Gomphocerinae taxa in Black Sea Region of Turkey (filled circles represent the main localities which were visited by the researchers more than two times and small circles represent the only one time visited locality).

The Distribution of Gomphocerinae Taxa in the Black Sea Region of Turkey

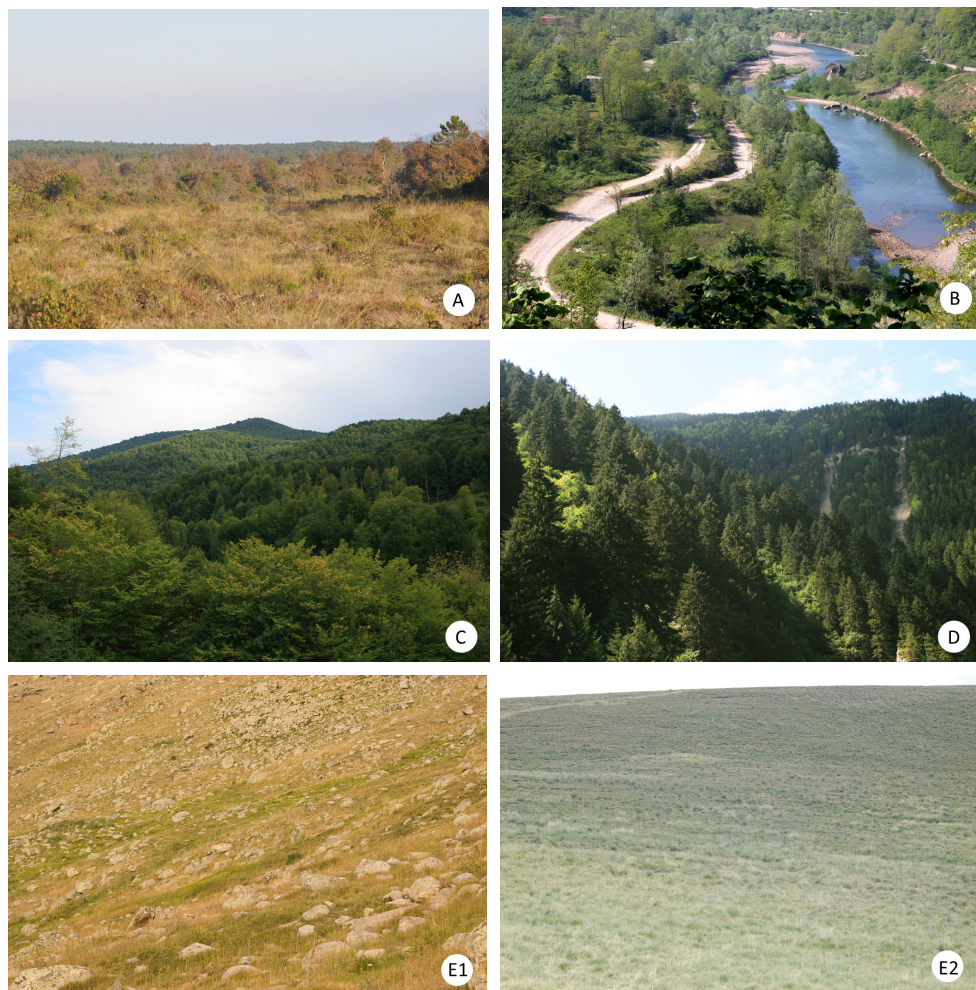


Fig. 2. The photographs of the general vegetation zones of the Black Sea region A: Maquis zone, B: Castanetum zone, C: Broad-leaf deciduous forest zone, D: Conifer forests zone and E1-E2: Subalpine meadows.

The total number of Gomphocerinae taxa in the study area reached 59 with six species from the literature. According to data from this study and the literature, the Black sea region ranks first among the geographical regions of Turkey with the Gomphocerinae genera and species number (Figs. 4 A-B). The genus *Chorthippus* diversity was first ranked (15 species, representing 25.43% of the total grasshoppers' species richness) in study area. This genus was followed by *Stenobothrus* (11 species, representing 18.64% of the total grasshoppers' species richness) in the study area. Our data are consistent with the data from previous studies reporting that the most diverse genera in the Gomphocerinae members are *Chorthippus* with 25 taxa and *Stenobothrus* with 16 taxa in Anatolia (Demirsoy, 2002; Ünal,

2015). These two genera cover 45% of the Gomphocerinae fauna of the Blacksea region and these data correspond to the assumptions that *Chorthippus* and *Stenobothrus* are the mountainous forms which dispersed to Anatolia from northern territories during cold periods of glacial cycles (Uvarov, 1921; Demirsoy, 1977). The *Omocestus* and *Dociostaurus* are represented by six and five species respectively, in the sampling area (Table 1); these are also known from Anatolia with 9 species for *Dociostaurus* and 7 species for *Omocestus* (Demirsoy, 2002; Ünal, 2015). The *Gomphocerus*, *Euchorthippus*, and *Ramburiella* were represented by four, three and two species, respectively, in the Black Sea region. The other genera in the area are *Duroniella*, *Ptygippus*, *Euthystira*, *Arcyptera*, *Pararcyptera*, *Eremippus*, *Stauroderus*, *Pseudochorthippus*, *Aeropedellus*, *Dasyhippus*, *Rammehippus*, and *Myrmeleotettix*, each being represented by one species (Table 1).

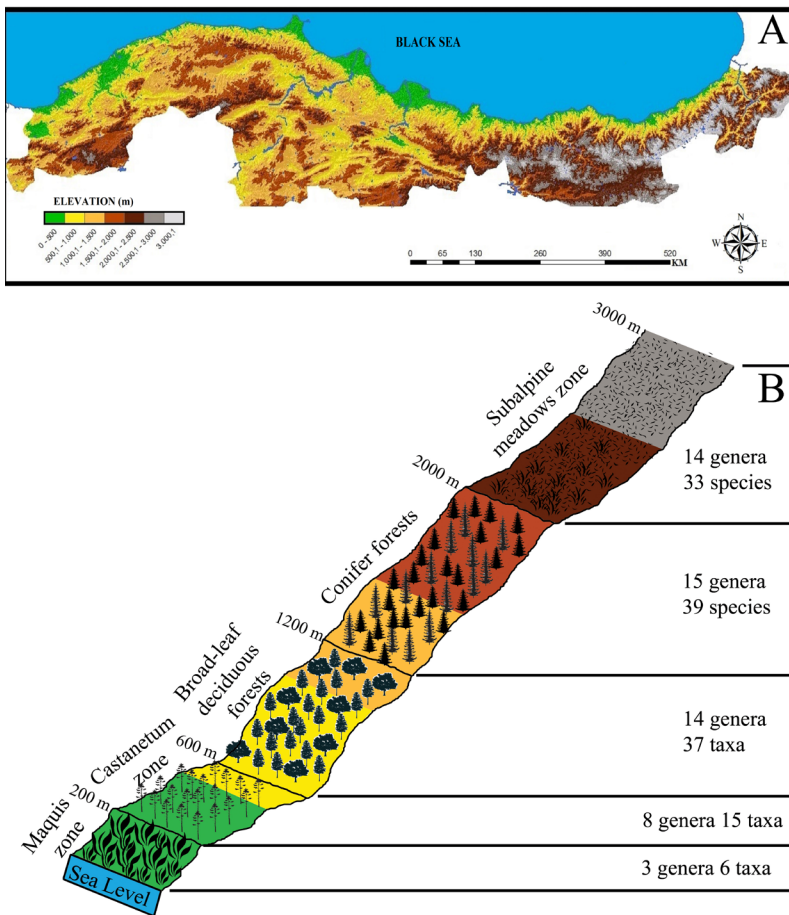


Fig. 3. A: The map of study area with elevational gradient. B: Vegetation zones of the study area according to altitudinal level and distribution of Gomphocerinae taxa in each zones.

The Distribution of Gomphocerinae Taxa in the Black Sea Region of Turkey

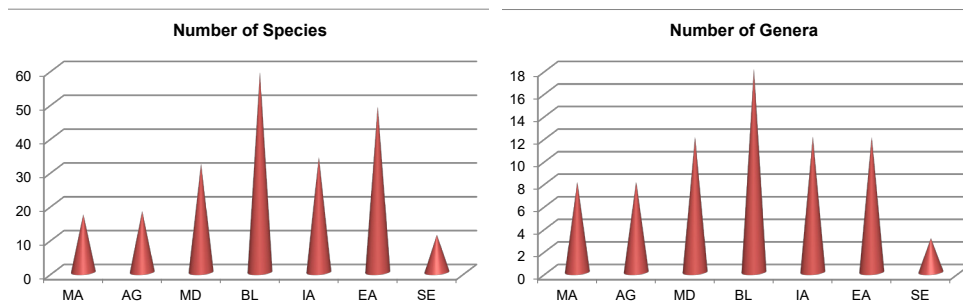


Fig. 4. The number of species (A) and genera (B) of Gomphocerinae in the geographical regions of Turkey (Ma: Marmara region, AG: Aegean region, MD: Mediterranean region, BL: Black Sea region, IA: Inner Anatolia region, EA: Eastern Anatolia region, SE: South-eastern Anatolia region).

The identified 59 Gomphocerinae taxa in the Black Sea Region were classified according to Uvarov (1921) description. The sub-regions and the numbers of the taxa belong to 17 Europe (Boreal), 16 Angara, 14 Europea-Angara, 6 Mediterranean, 4 Eremial (Iran-Turan) and 2 Eremiyal (Syrio), respectively (Table 1). Within these taxa, it was determined that 8 taxa from the sub-region of Angara, 4 taxa from the sub-region of Europe (Boreal), 1 taxon from the sub-region of Mediterranean, and 1 taxon from the sub-region of Eremial (Iran-Turan) are endemic. The number of taxa found from Black Sea region, which belongs to Europe (Boreal), European-Angara and Angara sub-regions, is 47. This number constitutes about 80% of the Gomphocerinae subfamily in the whole area (Table 1).

When we consider the altitudinal distribution of the Gomphocerinae species in the Black Sea region, the species *Pseudochorthippus parallelus* and *Chorthippus macrocerus* seem to be widespread in the altitudinal scale. However, it seems that 15 species show a very narrow distribution in altitudinal scale and they are found only in one vegetation zone of the area (Table 1). Although we are not able to measure statistically the significant proportions of the collected species, it seems that the most abundant species in the study area are *Dociostaurus brevicollis*, *Notostaurus anaticus*, *Stenobothrus lineatus*, *Omocestus haemorrhoidalis*, *Stauroderus scalaris*, *Pseudochorthippus parallelus parallelus*, *Chorthippus dichrous*, *Chorthippus apricarius apricarius*, and *Chorthippus macrocerus*.

The collected species *Eremippus zeybekoglu*, *Stenobothrus weidneri*, *S. selmae*, *Chorthippus aktaci*, *C. ilkazi*, *G. armeniacus dimorphus*, *G. sibiricus hemipterus*, *G. sibiricus acutus*, *Aeropedellus turcicus*, and *Rammehippus turcicus* are endemic to the Black Sea region, whereas *Dasyhippus uvarovi* and *Omocestus nanus* are the endemic species for Turkey (Demirsoy, 1977, 2002; Mol & Zeybekoglu, 2013). The distribution of these taxa according to vegetation zones are 1 species in *Castanetum* zone, 4 species in Broad-leaf deciduous forest zone, 9 species in Conifer forests zone, and 7 species in Subalpine meadows zone (Table 1, Fig. 5).

Table 1. The list of all taxa were collected in between 2003-2017 years in Black Sea region and the information about the specimen number, vegetation zones, Endemism, altitudinal distribution range and sub-regions detail belongs to all identified taxa from Black Sea region.

Taxa	Maquis	Castanetum	Broad-leaf deciduous forest	Conifer forests	Subalpine meadows	Endemism	Altitude	Sub-Regions
1- <i>Duroniella laticornis</i> (Krauss, 1909)	-	-	15	-	-		800	Mediterranean
2- <i>Ptygippus brachypterus</i> Mistshenko, 1951*	-	-	-	-	+		2460	Angara
3- <i>Euthystira brachyptera</i> (Ocskay, 1826)*	-	-	-	+	-		1550-1600	Europe (Boreal)
4- <i>Arcyptera fusca fusca</i> (Pallas, 1773)	-	-	3	11	9		865-2460	Angara
5- <i>Pararcyptera labiata</i> (Brulle, 1832)	-	-	22	44	2		1200-2460	Mediterranean
6- <i>Ramburiella turcomana</i> (Fis, de Wald., 1846)	-	-	6	-	-		865-1160	Mediterranean
7- <i>Ramburiella bolivari</i> (Kuthy, 1907)	-	4	-	-	-		600	Mediterranean
8- <i>Dociostaurus brevicollis</i> (Eversmann, 1848)	-	-	188	341	71		730-2460	Mediterranean
9- <i>Dociostaurus tartarus</i> Stschelkanovzev, 1921	-	3	-	-	-		600	Eremial (Iran-Turan)
10- <i>Dociostaurus genei</i> (Ocskay, 1832)*	-	+	-	-	-		600	Eremial (Iran-Turan)
11- <i>Dociostaurus moroccanus</i> (Thunberg, 1815)	-	-	3	-	-		1275	Eremial (Syrio)
12- <i>Dociostaurus haunesteini</i> Bolivar, 1893	-	-	-	3	-		1680-1790	Eremial (Iran-Turan)
13- <i>Notostaurus anatolicus</i> (Krauss, 1896)	-	-	150	156	-		625-1955	Eremial (Syrio)
14- <i>Eremippus zeybekoglu</i> Mol, 2012	-	1	-	-	-	E	600	Eremial (Iran-Turan)
15- <i>Stenobothrus weidneri</i> (Demirsoy, 1977)	-	-	9	44	18	E	1725-2302	Angara
16- <i>Stenobothrus werner</i> Adelung, 1907	-	-	10	63	58		1300-2460	Angara
17- <i>Stenobothrus sviridenkoi</i> Ramme, 1930	-	-	5	15	6		1400-2460	Angara
18- <i>Stenobothrus lineatus</i> (Panzer, 1796)	-	3	41	181	48		350-2400	Europe-Angara
19- <i>Stenobothrus fischeri</i> (Eversmann, 1848)	-	-	4	4	-		865-1350	Europe-Angara
20- <i>Stenobothrus nigrogeniculatus</i> Krauss, 1896	-	-	16	38	19		865-2460	Europe-Angara
21- <i>Stenobothrus zubowskyi</i> Bolivar, 1899	-	-	53	20	37		865-2460	Europe-Angara
22- <i>Stenobothrus mirame</i> Dirsh, 1931*	-	-	-	+	-		733-1825	Europe (Boreal)
23- <i>Stenobothrus graecus</i> Ramme, 1926	-	7	21	47	-		650-2460	Europe (Boreal)
24- <i>Stenobothrus selmae</i> Unal, 1999*	-	-	-	+	-	E	1950	Europe (Boreal)
25- <i>Stenobothrus nigromaculatus</i> (Herrich-Sch., 1840)	-	-	-	3	13		1920-2035	Europe-Angara
26- <i>Omocestus nanus</i> Uvarov, 1934	-	-	13	62	11	E	1650-2460	Angara
27- <i>Omocestus ventralis</i> (Zetterstedt, 1821)	24	18	71	-	-		200-1450	Europe (Boreal)
28- <i>Omocestus minutus</i> (Brulle, 1832)	-	-	20	-	-		850-1100	Europe (Boreal)
29- <i>Omocestus h. haemorrhoidalis</i> (Charpentier, 1825)	-	-	20	250	22		865-2460	Europe (Boreal)
30- <i>Omocestus h. ciscaucasicus</i> Mistshenko, 1951	-	-	-	-	23		2100-2460	Angara
31- <i>Omocestus petraeus</i> (Brisuot de Barn., 1855)	-	9	56	72	-		650-1800	Europe-Angara
32- <i>Stauroderus scalaris</i> (Fisch. de Wald., 1846)	-	-	61	245	44		740-2460	Europe-Angara

The Distribution of Gomphocerinae Taxa in the Black Sea Region of Turkey

Table 1. Continued.

Taxa	Maquis	Castanetum	Broad-leaf deciduous forest	Conifer forests	Subalpine meadows	Endemism	Altitude	Sub-Regions	
33- <i>Euchorthippus pulvinatus</i> (Fischer de Wald.846)	-	-	91	63	2		650-2250	Europe-Angara	
34- <i>Euchorthippus declivus</i> (Brisuot de Barn.,1855)	-	13	-	-	-		600	Europe (Boreal)	
35- <i>Euchorthippus transcaucasicus</i> Tarb., 1930*	-	-	+	-	-		1350	Angara	
36- <i>Pseudochorthippus parallelus</i> (Zetterstedt, 1821)	38	30	172	291	12		100-2250	Europe (Boreal)	
37- <i>Chorthippus karelini</i> (Uvarov, 1910)	-	-	6	9	3		1000-1860	Europe (Boreal)	
38- <i>Chorthippus labaumei</i> Ramme, 1926	-	-	-	-	15		2400-2460	Angara	
39- <i>Chorthippus loratus</i> (Fisch. de Wald., 1846)	45	29	91	-	-		100-1650	Europe-Angara	
40- <i>Chorthippus dorsatus</i> (Zetterstedt, 1821)	-	-	43	-	-		1050	Europe (Boreal)	
41- <i>Chorthippus dichrous</i> (Eversmann, 1859)	-	11	82	139	76		600-2460	Europe-Angara	
42- <i>Chorthippus a. apricarius</i> (Linnaeus, 1758)	-	-	48	121	89		900-2250	Europe (Boreal)	
43- <i>Chorthippus apricarius major</i> Plynov, 1914	-	-	-	28	98		1800-2450	Angara	
44- <i>Chorthippus bornhalmi</i> Harz, 1971	6	7	22	71	-		200-1920	Europe (Boreal)	
45- <i>Chorthippus aktaci</i> Unal, 2010*	-	-	-	+	-	E	1550-2000	Europe (Boreal)	
46- <i>Chorthippus vagans</i> (Eversmann, 1859)	-	-	42	93	13		700-2460	Europe-Angara	
47- <i>Chorthippus macrocerus</i> (Fisc. de Wald., 1846)	13	39	236	92	12		200-2460	Europe-Angara	
48- <i>Chorthippus demokidovi</i> (Ramme, 1930)	-	-	-	-	25		2360-2460	Europe (Boreal)	
49- <i>Chorthippus ilkazi</i> Uvarov, 1934	-	-	27	26	-	E	900-1920	Europe (Boreal)	
50- <i>Chorthippus biguttulus euhedicekei</i> Helversen, 1989	2	2	109	-	-		100-1300	Europe (Boreal)	
51- <i>Chorthippus mollis</i> (Charpentier, 1825)	-	-	81	76	9		630-2250	Europe-Angara	
52- <i>Gomphocerus transcaucasicus</i> Mists., 1951	-	-	2	7	51		2100-2450	Angara	
53- <i>Gomphocerus sibiricus acutus</i> Karabağ, 1957	-	-	-	7	8	E	2000-2323	Angara	
54- <i>Gomphocerus armeniacus dimorphus</i> Karabağ, 1953	-	-	-	-	16	E	2460	Angara	
55- <i>Gomphocerus sibiricus hemipterus</i> Karabağ, 1953	-	-	-	6	11	E	1800-2300	Angara	
56- <i>Aeropedellus turcicus</i> Karabağ, 1959	-	-	-	15	32	E	2150	Angara	
57- <i>Dasyhippus uvarovi</i> Karabağ, 1953	-	-	11	-	-	E	1180	Mediterranean	
58- <i>Rammeihippus turcicus</i> (Ramme, 1939)	-	-	-	186	12	E	1200-2035	Angara	
59- <i>Myrmeleotettix maculatus</i> (Thunberg, 1815)	-	-	-	14	129		2000-2630	Europe-Angara	
Total	59 taxa	6	15	37	39	33	12	100-2640	Boreal, Angara, Mediterranean, Eremial

*These species were not collected in this study.

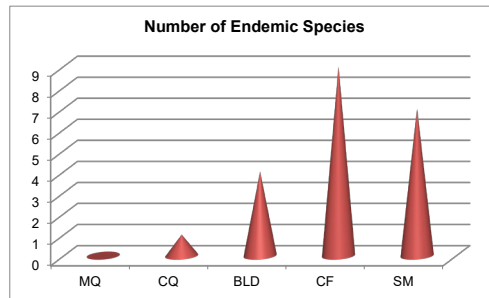


Fig. 5. The number of endemic species in the vegetation zones of the Black Sea region (MQ: Maquis zone, CA: Castanetum zone, BLD: Broad-leaf deciduous forest zone, CF: Conifer forests zone, SM: Subalpine meadows).

Among the collected 59 taxa, which show the distribution in the study area, 6 taxa belong to 3 genera in *Maquis zone*, 15 taxa belong to 8 genera in *Castanetum zone*, 37 taxa belong to 14 genera in *Broad-leaf deciduous forest zone*, 39 taxa belongs to 15 genera in *Conifer forests zone*, and 33 taxa belong to 14 genera in *Subalpine meadows* (Figs. 3, 6A,B). When the altitude increases from the *Maquis zone* to the subalpine zone, there is also an increase in the number of species (Table 1). In *Maquis zone*, minimum number of species was collected, whereas in the *Conifer forests zone* the greatest number of species was collected. According to the data of this study, Gomphocerinae taxa prefer mostly altitudes ranging between 600 and 2250 meters (Fig. 3). The specimens belonging to *C. loratus* and *O. ventralis* species were collected from the lowest locality (Samsun, Atakum, 100 m); those of *M. maculatus maculatus* were collected from the highest locality (Ovit Mountain, 2650 m) of research area. All the species collected from this locality have a northern origin (Demirsoy, 2002). There is only one study about the species richness and the relative abundance of the different families of the Caelifera in Akdaglar Mountain range, which is a part of Taurus mountains in southern part of Anatolia. It was reported that Gomphocerinae is dominant between 1000 and 2000 m with 13 species (Şirin, Eren, & Çıplak, 2010a). Taurus Mountains (including Akdaglar Range) of southern Anatolia are considered as a hotspot for Anatolian endemics (Çıplak & Demirsoy, 1995; 1996; Çıplak, 2003) and include 32 Gomphocerinae species, of which eight are endemic (Mol, 2001; Demirsoy, 2002; Çıplak, Mol, Şirin, Zeybekoğlu, & Taylan, 2005; Şirin et al, 2010b; Şirin et al, 2011). Only five of these endemic species are known from the southern part of Anatolia (Çıplak et al, 2005; Demirsoy, 2002, Şirin et al, 2010a, 2011). According to our study, the Black Sea region contains 12 endemic species and only 10 of them are known from this region. The data obtained in this study reveal (i) the species richness of the subfamily in the area; (ii) the local endemic species number; (iii) the distributional range in altitudinal scale; and (iv) the vegetational composition and climate, clearly supporting the idea that Gomphocerinae taxa prefers Black Sea region as refugia.

The Distribution of Gomphocerinae Taxa in the Black Sea Region of Turkey

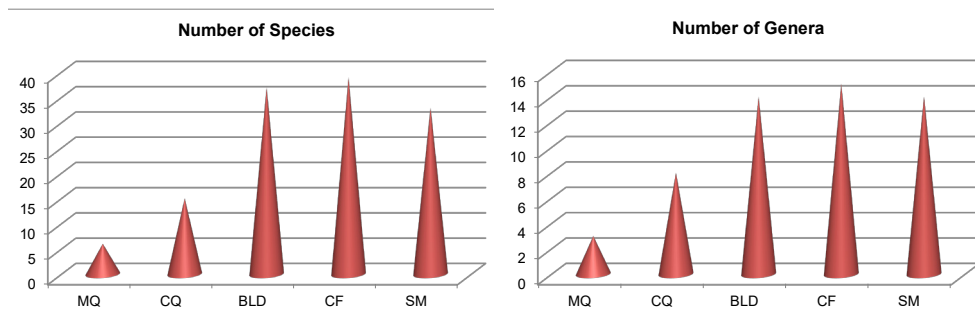


Fig. 6. The number of species (A) and genera (B) in the vegetation zones of the Black Sea region (MQ: Maquis zone, CA: Castanetum zone, BLD: Broad-leaf deciduous forest zone, CF: Conifer forests zone, SM: Subalpine meadows).

ACKNOWLEDGEMENTS

A part of this work has been supported by Research Fund of the Aksaray University, Project Number: 2015-040 and Research Fund of the Ondokuz Mayıs University, Project Number: F-296) and by Research Fund of the Tekirdağ Namık Kemal University, (Project numbers: NKUBAP.00.10.AR.15.01; NKUBAP.00.10.AR.13.07). We are also grateful to Dr. Süleyman YILMAZ (Hakkari University) for preparing GIS based map of study area, and to Dr. Petru Golban (Tekirdağ Namık Kemal University, English Language and Literature) for his valuable comments on manuscript.

REFERENCES

- Akman, Y. (1993). *Biyocoğrafya*. Palme Yayıncılık, Ankara, Turkey.
- Atalay, I. (2015). *Türkiye vejetasyon coğrafyası*. Meta Basım Matbacılık, İzmir, Turkey.
- Bei-Bienko, G.J. & Mistshenko L.L. (1951). *Locusts and grasshoppers of the USSR and adjacent countries, part II. Keys to the fauna of the USSR* (381-667). Zoological Institute of the USSR, Academy of Sciences, Moscow, Leningrad Vol: 40, Moskova-Leningrad.
- Cigliano, M. M., Braun, H., Eades, D. C., & Otte, D. (2018). Orthoptera Species File. Version 5.0/5.0. <http://Orthoptera.SpeciesFile.org>, 01.06.2018.
- Çıplak, B. (2003). Distribution of Tettigoniinae (Orthoptera, Tettigoniidae) bush-cricket in Turkey: the importance of the Anatolian Taurus Mountains in biodiversity and implications for conservation. *Biodiversity and Conservation*, 12, 47-64.
- Çıplak, B. (2004). Biogeography of Anatolia: the marker group Orthoptera. *Memorie della Società Entomologica Italiana*, 82(2), 357-372.
- Çıplak, B. (2008). The analogy between interglacial and global warming for the glacial relicts in a refugium: A biogeographic perspective for conservation of Anatolian Orthoptera. In Fattorini, S. (Ed.). *Insect Ecology and Conservation* (135-163). Research Signpost, Kerala, India.
- Çıplak, B. & Demirsoy, A. (1995). Türkiye'de Ensifera (Orthoptera, Insecta) alttakiminin endemizm acısından değerlendirilmesi. *Turkish Journal of Zoology*, 19, 213-220.
- Çıplak, B. & Demirsoy, A. (1996). Caelifera (Orthoptera, Insecta) alttakiminin Türkiye'deki endemizm durumu. *Turkish Journal of Zoology*, 20: 241-246.

- Çıplak, B., Demirsoy, A., & Bozcuk, N. (1993). Distribution of Orthoptera in relation to the Anatolian Diagonal in Turkey. *Articulata*, 8(1), 1-20.
- Çıplak, B., Demirsoy, A., & Bozcuk, A. N. (1996). Malatya ve civarı Caelifera (Orthoptera, Insecta) faunası. *Turkish Journal of Zoology*, 20, 17-31.
- Çıplak, B., Mol, A., Şirin, D., Zeybekoğlu, Ü., & Taylan, M. S. (2005). The *demokidovi*-like Short Winged *Glyptobothrus* (Orthoptera, Gomphocerinae, *Chorthippus*) of Anatolia With Description of Two New Species: from Balkans to Caucasus Through Southern Anatolia. *Transactions of the American Entomological Society*, 131(3+4), 463-489.
- Demirsoy, A. (1977). *Türkiye Caelifera (Insecta, Orthoptera) faunasının tespiti ve taksonomik olarak incelenmesi*, Atatürk Üniversitesi Basımevi, Erzurum, Turkey.
- Demirsoy, A. (2002). *Genel ve Türkiye Zoocoğrafyası "Hayvan Coğrafyası"*. 5th edition, Meteksan, Ankara, Turkey.
- Gardiner, T., Hill, J., & Chesmore, D. (2005). Review of the methods frequently used to estimate the abundance of Orthoptera in grassland ecosystems. *Journal of Insect Conservation*, 9, 151-173.
- Harz, K. (1975). *The Orthoptera of Europe*, Dr. W. Junk N. V., The Hague, Vol. II.
- Hewitt, M. G. (1996). Some genetic consequence of ice ages, and their role in divergence and speciation. *Biological Journal of the Linnean Society*, 58, 247-279.
- Hewitt, M.G. (2000). The genetic legacy of the Quarternary ice ages. *Nature*, 405, 907-913.
- Karabağ, T. (1953). Some new and less known Acrididae from Turkey. *Enstituto Espanol de Entomologia*, 29, 125-134.
- Karabağ, T. (1957). Some new Orthoptera from Turkey. *Communications*, 8(1), 13-18.
- Karabağ, T. (1959). A new *Aeropedellus* (Orthoptera: Acrididae) from Turkey, *Proceedings of the Royal Entomological Society of London*, 28(3-4), 58-60.
- Karabağ, T. (1963). Some interesting Acridoidea (Orthoptera) from Turkey. *Annals and Magazine of Natural History*, 6(13), 680-682.
- Mol, A. (2001). *Türkiye'de yayılış gösteren Chorthippus Fieber, 1852 (Acrididae, Gomphocerinae) cinsine ait türler üzerinde sistematik bir çalışma*. Yüksek Lisans Tezi, Akdeniz Üniversitesi, Fen Bilimleri Enstitüsü, Antalya.
- Mol, A. (2012). Song and morphology of some little known species of Gomphocerinae (Orthoptera, Acrididae) from Turkey with the description of a new species. *Entomologica Fennica*, 23, 127-139.
- Mol, A., & Zeybekoğlu, U. (2013). Distribution and taxonomy of Gomphocerinae (Orthoptera, Acrididae) Grasshoppers in the Anatolian Black Sea Basin and check list of Turkey subfamily fauna. *Journal of the Entomological Research Society*, 15(2), 69-102.
- Ragge, D., & Reynolds, W. J. (1998). *The songs of the grasshoppers and crickets of Western Europe*. Harley Books, Colchester, Essex.
- Salman, S. (1978). *Ağrı, Kars ve Artvin illerinin Orthoptera (Insecta) faunası üzerine taksonomik araştırmalar*. Atatürk Üniversitesi Fen Fakültesi Yayınları, Erzurum, Turkey, 82, 184.
- Savitsky, V. Y. (2007). New data on acoustic communication and ecology of grasshoppers of the genera *Eremippus* and *Dociostaurus* (Orthoptera, Acrididae) and notes on the use of bioacoustic data in supraspecific taxonomy of the subfamily Gomphocerinae. *Entomological Review*, 87(6), 631-649.
- Soltani, A. A. (1978). Preliminary synonym and description of new species in the genus *Dociostaurus* Fieber, 1853 (Orthoptera: Acridoidea; Acrididae, Gomphocerinae) with a key to the species in the genus, *Journal of Entomological Society of Iran, Supplementum*, 2(1), 1-93.
- Şensoy, S., Demircan, M., Ulupinar, U., & Balta, I. (10.01.2008). Climate of Turkey, Turkish State Meteorological Service. <http://www.dmi.gov.tr/iklim/iklim.aspx>.
- Şirin, D., Eren, O., & Çıplak, B. (2010a) Grasshopper diversity and abundance in relation to elevation and vegetation from a snapshot in Mediterranean Anatolia: role of latitudinal position in altitudinal differences. *Journal of Natural History*, 44 (21), 1343-1363.

The Distribution of Gomphocerinae Taxa in the Black Sea Region of Turkey

- Şirin, D., Helversen, O.V., & Çıplak, B. (2010b). *Chorthippus brunneus* subgroup (Orthoptera, Gomphocerinae) in Anatolia with description of two new species: data suggest an Anatolia origin for the lineage. *Zootaxa*, 2410, 1-28.
- Şirin, D., Mol, A., & Çıplak, B. (2011). *Myrmeleotettix* Bolivar (Orthoptera, Gomphocerinae) in Anatolia on the basis of morphological and behavioural characters: data suggest a new species from southern end of the Anatolian refugium. *Zootaxa*, 2917, 29-47.
- Şirin, D., Mol, A., & Akyıldız, G. (2014). The morphological and behavioral analysis of geographically separated *Rammeihippus turcicus* (Orthoptera: Acrididae: Gomphocerinae) populations: Data result in taxonomical conflict, *Journal of Insect Science*, 14(1), 1-11.
- Uvarov, B. P. (1921). The geographical distribution Orthopterous insects in the Caucasus and in Western Asia. *Proceedings of the Zoological Society of London*, 31, 447-472.
- Uvarov, B. P. (1934). Studies in the Orthoptera of Turkey, Iraq and Syria. *Enstituto Espanol de Entomologia*, 10, 21-119.
- Ünal, M. (1999). Notes on Orthoptera of western Turkey, with description of a new genus and four new species. *Journal of Orthoptera Research*, 8, 243-255.
- Ünal, M. (2008). Bolu ve Düzce illeri *Caelifera* (Orthoptera) faunası-1. *Bitki Koruma Bülteni*, 48(2), 1-31.
- Ünal, M. (2010). To the knowledge of the genus *Chorthippus* Fieber, 1853 (Orthoptera, Acrididae: Gomphocerinae) from Turkey with description of a new species. *Far Eastern Entomologist*, 215, 1-8.
- Ünal, M. (2015). Turkish Orthoptera Site (TOS). Available from: <http://www.orthoptera-tr.org>, 01.06.2018.
- Vedenina, V. & Helversen, O. V. (2009). A re-examination of the taxonomy of the *Chorthippus albomarginatus* group in Europe on the basis of song and morphology (Orthoptera: Acrididae). *Tijdschrift voor Entomologie*, 152, 65-97.
- Weidner, H. (1969). Beitrage zur Kenntnis der Feldheuschrecken (Caelifera) Anatoliens. *Mitteilungen aus dem Zoology Museum of Berlin*, 66, 145-226.
- Willemse, F. (1985). *Fauna Graeciae II. A key to the Orthoptera Species of Greece*. Hellenic Zoological Society, Athens.

Received: June 12, 2018

Accepted: May 15, 2019