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The distribution and biogeography of Mutillidae (Hymenoptera: Aculeata) in Turkey

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Abstract

Faunistic studies on Mutillidae from Turkey are reviewed and the distribution and biogeography of the Turkish mutillid fauna is analyzed. A total of 65 species and 3 subspecies belonging to 21 genera of the subfamilies Myrmosinae, Pseudophotopsidinae, Myrmillinae, Mutillinae and Dasylabrinae have been recorded from Turkey. Species composition, diversity and proportion of endemism varies considerably between the biogeographic subregions of the country.

Key words: Hymenoptera, Mutillidae, distribution, biogeography, Turkey.

Zusammenfassung

Vorliegende Arbeit behandelt eine biogeografische Analyse der Hymenopterenfamilie Mutillidae in der Türkei. 65 Arten und 3 Unterarten aus 21 Gattungen gehören den Unterfamilien Myrmosinae, Pseudophotopsidinae, Myrmillinae, Mutillinae und Dasylabrinae an.

Introduction

Turkey is generally divided into seven geographical regions. These geographical regions were separated according to their climate, location, flora and fauna, human habitat, agricultural diversities, transportation, topography and so on. Four regions were named after the seas bordering them; the Aegean Region, the Black Sea Region, the Marmara Region and the Mediterranean Region. The other three regions were named in accordance with their location in the whole of Anatolia; Central, Eastern and Southeastern Anatolia Regions (Fig. 1, 2). Turkey is mountainous mass averaging about 1.000 meters in height. The topographic and climatic structure give to the country the opportunity to hosts a rich and diverse fauna. Turkey is one of the most interesting countries from the view points of Hymenoptera taxonomy and biogeography. Economically, aesthetically and biologically there are few groups of animals that are as important to man as the Hymenoptera. The Hymenoptera is one of the four great orders of insects, the order three being Coleoptera, Lepidoptera, and Diptera. Each order includes over 100.000 described species around the world, with Coleoptera having over 300.000 (GOULET & HUBER 1993).

Turkey occupies Asia Minor between the Mediterranean Sea and the Black Sea and stretches into continental Europe. Turkey has long been known to possess a potentially rich Mutillidae fauna, which is also very rich in comparison with other Mediterranean countries that are well known for their high biodiversity. Therefore, Turkey is biogeographically one of the most interesting countries in the West Palaearctic region, where many faunistic and systematic studies about the Mutillidae have been conducted by some foreign and native researchers. However, no attempt has been made to prepare the distribution and biogeography of the Mutillidae in Turkey, although knowledge about the vespid fauna of Turkey is essential for all researchers who are interested in the Mutillidae of the West Palaearctic region.

In this study, the studies on the Mutillidae in Turkey were reviewed (RADOSZKOWSKI 1890; ANDRÉ 1899-1903; INVREA 1952; NAGY 1972; SUÁREZ 1975; LELEJ 1985; NONVEILLER 1994; ÖZBEK et al. 1999; PAGLIANO & STRUMIA 2007; PETERSEN 1988; YILDIRIM 2006; LELEJ 2002; LELEJ & YILDIRIM 2009) and the distribution and biogeography of the Turkish fauna of Mutillidae is analyzed.

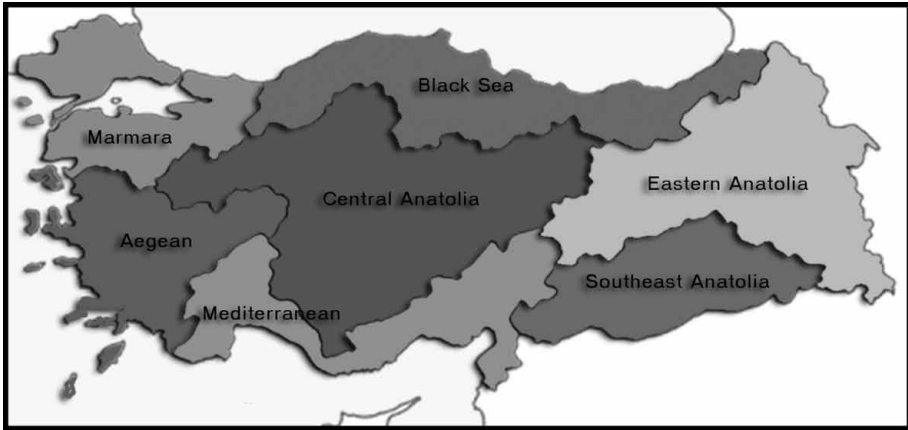


Fig. 1: Biogeographical map of Turkey.



Fig. 2: Administrative map to provinces of Turkey (from LELEJ & YILDIRIM 2009).

Material and Methods

In this study, the previous studies on the Mutillidae of Turkey are reviewed and the distribution and biogeography of the Turkish fauna of Mutillidae is analyzed. The genera, species and subspecies whose type localities are in Turkey are marked with an asterisk. Comparative data are taken from YILDIRIM & WAHIS (2011) for Pompilidae and from YILDIRIM (2012) for Vespidae.

Faunal similarities between biogeographical regions of Turkey were evaluated, without regard to differences in region area by using Sorensen's coefficient of similarity (see LEGENDRE & LEGENDRE 1998). The similarity matrix resulting from pair-wise calculations was then subjected to unweighted arithmetic average clustering (UPGMA; PAST program, version 1.57, HAMMER et al. 2006).

Result and Discussion

As a result, a total of 65 species and 3 subspecies from 21 genera belonging to five subfamilies Myrmosinae, Pseudophotopsidinae, Myrmillinae, Mutillinae and Dasylabrinae from Mutillidae were recorded from Turkey. Among them, the type localities of 9 species in Mutillidae are situated in Turkey. Separately, 5 species are considered endemic (Table 1, 2).

Table 1: The current knowledge of Mutillidae in Turkey.

Present in Turkey					Number of type localities situated in Turkey	
Family	Subfamily	Genus	Species	Sub species	Species	Endemic species
Mutillidae	Myrmosinae	<i>Krombeinella</i>	6	-	1	-
		<i>Myrmosa</i>	1	-	-	-
		<i>Paramyrmosa</i>	2	-	-	-
	Pseudophotopsidinae	<i>Pseudophotopsis</i>	2	-	-	-
	Myrmillinae	<i>Myrmilla</i>	10	-	1	1
		<i>Platymyrmilla</i>	1	-	-	-
		<i>Sigilla</i>	1	-	-	-
	Mutillinae	<i>Ctenotilla</i>	1	-	-	-
		<i>Macromyrme</i>	1	-	-	-
		<i>Mutilla</i>	3	-	-	-
		<i>Ronisia</i>	2	1	-	-
		<i>Tropidotilla</i>	4	-	-	-
		<i>Dentilla</i>	4	-	2	-
		<i>Nemka</i>	1	1	-	-
		<i>Physetopoda</i>	4	-	-	-
		<i>Skorikovia</i>	3	-	1	1
		<i>Smicromyrme</i>	9	-	1	-
		<i>Artiotilla</i>	1	-	-	-
		<i>Trogaspidia</i>	1	-	-	-
	Dasylabrinae	<i>Dasylabris</i>	4	1	-	-
		<i>Stenomutilla</i>	4	-	3	3
Total		21	65	3	9	5

Table 2: Distribution of Mutillidae in biogeographical regions of Turkey.

Names of taxa	EA	SA	BS	CA	MD	A	M	E
<i>Myrmosinae</i> FOX 1894								
<i>Krombeinella</i> PATE 1947								
<i>Krombeinella aramaea</i> (SUÁREZ 1963)	-	+	-	-	-	-	-	
<i>Krombeinella beaumonti</i> (INVREA 1953)	+	-	-	-	-	-	+	
* <i>Krombeinella gaullei</i> (INVREA 1952)	-	-	-	-	-	-	+	
<i>Krombeinella hebraea</i> (SUÁREZ 1963)	-	-	-	-	+	-	-	
<i>Krombeinella longicollis</i> (TOURNIER 1889)	+	-	+	-	-	-	-	
<i>Krombeinella wolffi</i> (INVREA 1963)	+	-	+	-	-	-	+	
<i>Myrmosa</i> LATREILLE 1796								
<i>Myrmosa atra</i> PANZER 1801	+	-	+	-	-	-	+	
<i>Paramyrmosa</i> SAUSSURE 1880								
<i>Paramyrmosa brunnipes</i> (LEPELETIER 1845)	-	-	-	-	-	-	+	
<i>Paramyrmosa radoszkowskyi</i> (SAUSSURE 1880)	+	+	+	-	-	-	+	
<i>Pseudophotopsisinae</i> BISCHOFF 1920								
<i>Pseudophotopsis</i> ANDRÉ 1896								
<i>Pseudophotopsis schachruda</i> (SKORIKOV 1935)	+	-	-	-	+	+	+	
<i>Pseudophotopsis syriaca</i> (ANDRÉ 1900)	-	-	-	-	+	+	+	
<i>Myrmillinae</i> BISCHOFF 1920								
<i>Mymilla</i> WESMAEL 1851								
<i>Myrmilla (Eurygnathilla) emiliae</i> (DALLA TORRE 1897)	-	+	-	-	-	-	-	
<i>Myrmilla (Myrmilla) anopla</i> SKORIKOV 1927	+	-	-	-	-	-	-	
<i>Myrmilla (Myrmilla) calva</i> (VILLERS 1789)	+	-	+	+	-	-	-	
<i>Myrmilla (Myrmilla) caucasica</i> (KOLENATI 1846)	+	-	+	+	-	-	+	
<i>Myrmilla (Myrmilla) corniculata</i> (SICHEL & RAD. 1869)	+	-	-	-	-	-	-	
<i>Myrmilla (Myrmilla) lezginica</i> (RADOSZKOWSKI 1885)	+	-	-	-	-	+	-	
<i>Myrmilla (Pseudomutilla) atalanta</i> NAGY 1967	-	-	-	-	-	-	+	
* <i>Myrmilla (Pseudomutilla) filippovi</i> LELEJ 1985	-	-	-	-	+	-	-	+
<i>Myrmilla (Pseudomutilla) glabrata</i> (FABRICIUS 1775)	-	-	-	+	-	-	+	
<i>Myrmilla (Pseudomutilla) vutshetitshi</i> SKORIKOV 1927	+	-	+	+	-	-	-	
<i>Platymyrmilla</i> ANDRÉ 1899								
<i>Platymyrmilla quinquefasciata</i> (OLIVIER 1811)	-	-	-	-	-	+	-	
<i>Sigilla</i> SKORIKOV 1927								
<i>Sigilla dorsata</i> (FABRICIUS 1798)	-	-	-	-	+	-	-	
<i>Mutillinae</i> LATREILLE 1802								
<i>Mutillini</i> LATREILLE 1802								
<i>Ctenotilla</i> BISCHOFF 1920								
<i>Ctenotilla caeca</i> (RADOSZKOWSKI 1879)	+	-	+	-	+	-	-	

Names of taxa	EA	SA	BS	CA	MD	A	M	E
<i>Macromyrme</i> LELEJ 1984								
<i>Macromyrme binotata</i> (RADOSZKOWSKI 1879)	+	-	-	-	-	-	-	
<i>Mutilla</i> LINNAEUS 1758								
<i>Mutilla europaea</i> LINNAEUS 1758	+	-	+	-	-	-	-	
<i>Mutilla quinque maculata</i> CYRILLO 1787	+	-	-	-	+	-	-	
<i>Mutilla richterae</i> LELEJ 1984	-	-	-	-	-	+	-	
<i>Ronisia</i> COSTA 1858								
<i>Ronisia brutia brutia</i> (PETAGNA 1787)	+	-	-	+	+	+	+	
<i>Ronisia brutia duplex</i> (RADOSZKOWSKI 1885)	+	-	+	-	-	+	+	
<i>Ronisia marocana</i> (OLIVIER 1811)	-	-	-	+	+	-	-	
<i>Tropidotilla</i> BISCHOFF 1920								
<i>Tropidotilla griseascens</i> (LEPELETIER 1845)	+	-	-	-	+	-	+	
<i>Tropidotilla litoralis</i> (PETAGNA 1787)	+	-	+	+	-	-	+	
<i>Tropidotilla sareptana</i> (ANDRÉ 1901)	+	-	-	-	-	-	-	
<i>Tropidotilla semirufa</i> (ANDRÉ 1893)	+	-	-	-	-	-	-	
<i>Smicromyrmini</i> BISCHOFF 1920								
<i>Dentilla</i> LELEJ in LELEJ & KABAKOV 1980								
* <i>Dentilla curtiventris</i> (ANDRÉ 1901)	+	+	+	+	-	+	+	
<i>Dentilla erronea</i> (ANDRÉ 1902)	+	-	-	-	-	-	+	
<i>Dentilla persica</i> (SICHEL & RADOSZKOWSKI 1869)	+	-	-	-	-	-	-	
* <i>Dentilla ursina</i> (NAGY 1972)	-	-	-	+	-	-	-	
<i>Nemka</i> LELEJ 1985								
<i>Nemka viduata viduata</i> (PALLAS 1773)	+	-	+	-	+	+	+	
<i>Nemka viduata bartholomaei</i> (RADOSZKOWSKI 1865)	-	-	-	+	-	-	-	
<i>Physetopoda</i> SCHUSTER 1949								
<i>Physetopoda daghestanica</i> (RADOSZKOWSKI 1885)	+	-	+	-	-	-	-	
<i>Physetopoda punctata</i> (LATREILLE 1792)	+	-	-	-	-	-	-	
<i>Physetopoda scutellaris</i> (LATREILLE 1792)	+	-	+	+	+	-	+	
<i>Physetopoda similis</i> (LELEJ 1984)	+	-	+	+	-	-	+	
<i>Skorikovia</i> OVTCHINNIKOV 2002								
* <i>Skorikovia anatolica</i> LELEJ 2009	+	-	-	+	-	-	-	+
<i>Skorikovia radoszkovskii</i> (SKORIKOV 1935)	+	-	-	+	-	-	-	
<i>Skorikovia transcaucasica</i> (LELEJ 1985)	+	-	-	-	-	-	-	
<i>Smicromyrme</i> THOMSON 1870								
<i>Smicromyrme (Astomyrme) ausonius</i> INVREA 1950	+	-	+	-	+	-	+	
<i>Smicromyrme (Eremotilla) novaki</i> INVREA 1954	+	-	-	-	-	-	-	
* <i>Smicromyrme (Eremotilla) schwarzi</i> SUÁREZ 1975	+	-	-	+	+	-	+	
<i>Smicromyrme (Erimyrme) azerbaidzhanicus</i> LELEJ 1985	+	-	-	-	-	-	-	

Names of taxa	EA	SA	BS	CA	MD	A	M	E
<i>Smicromyrme (Erimyrm) pulawskii</i> SUÁREZ 1975	+	-	+	+	-	+	+	
<i>Smicromyrme (Erimyrm) sicanus</i> (DE STEFANI 1887)	+	-	-	-	-	-	+	
<i>Smicromyrme (Smicromyrme) ruficollis ruficollis</i> (FAB. 1793)	+	-	-	+	+	-	+	
<i>Smicromyrme (Smicromyrme) rufipes</i> (FABRICIUS 1787)	+	-	-	-	-	-	-	
<i>Smicromyrme turanicus</i> (MORAWITZ 1893)	+	-	-	+	-	-	-	
<u>Peterseniidiini</u> LELEJ 1996								
<i>Artiotilla</i> INVREA 1950								
<i>Artiotilla biguttata</i> (COSTA 1858)	+	-	-	-	-	-	+	
<u>Trogaspidiini</u> BISCHOFF 1920								
<i>Trogaspidia</i> ASHMEAD 1899								
<i>Trogaspidia catanensis</i> (ROSSI 1794)	+	-	-	-	-	-	+	
<u>Dasylabrinae</u> INVREA 1964								
<i>Dasylabris</i> RADOSZKOWSKI 1885								
<i>Dasylabris (Craspedopyga) mandersternii cypria</i> (SICHEL & RADOSZKOWSKI 1870)	+	+	+	+	+	+	+	
<i>Dasylabris (Craspedopyga) mandersternii mandersternii</i> (RADOSZKOWSKI 1865)	+	+	-	+	+	-	-	
<i>Dasylabris (Dasylabris) maura maura</i> (LINNAEUS 1758)	+	-	+	+	-	-	+	
<i>Dasylabris (Inbaltilla) biblica</i> INVREA 1950	-	-	-	-	+	-	-	
<i>Dasylabris (Inbaltilla) scutilla</i> SKORIKOV 1935	+	-	+	+	-	-	-	
<i>Stenomutilla</i> ANDRÉ 1896								
* <i>Stenomutilla (Stenomutilla) acanthosterna</i> NONVEILLER 1994	+	-	-	-	-	-	-	+
* <i>Stenomutilla (Stenomutilla) anatolica</i> NONVEILLER 1994	+	-	+	-	-	-	-	+
<i>Stenomutilla (Stenomutilla) bizonata</i> (SMITH 1856)	+	-	+	+	+	+	-	
* <i>Stenomutilla (Stenomutilla) osellai</i> NONVEILLER 1994	+	-	-	-	-	-	-	+
Total species and subspecies	52	6	23	23	19	12	29	5

Remarks: SA – Southeastern Anatolia, EA – Eastern Anatolia, BS – Black Sea, CA – Central Anatolia, MD – Mediterranean, A – Aegean, M – Marmara, E – endemic species and subspecies, * The type locality is Turkey.

There are great differences in species composition and richness between the biogeographic regions of Turkey (Table 2, Fig. 3): 52 species and subspecies of the Mutillidae have been recorded from Eastern Anatolia (77 % of the recorded species and subspecies), 6 from Southeastern Anatolia (9 % of the recorded species and subspecies), 23 from Black Sea (34 % of the recorded species and subspecies), 23 from Central Anatolia (34 % of the recorded species and subspecies), 19 from Mediterranean (28 % of the recorded species and subspecies), 12 from the Aegean region (18 % of the recorded species and subspecies) and 29 from Marmara (43 % of the recorded species and subspecies). Apparently, species diversity is higher in the Eastern and Marmara region than in other regions. It is evidently that diversity of the mutillid species in Southeastern Anatolia will be no less than in Marmara region and current number (six species) will be increased.

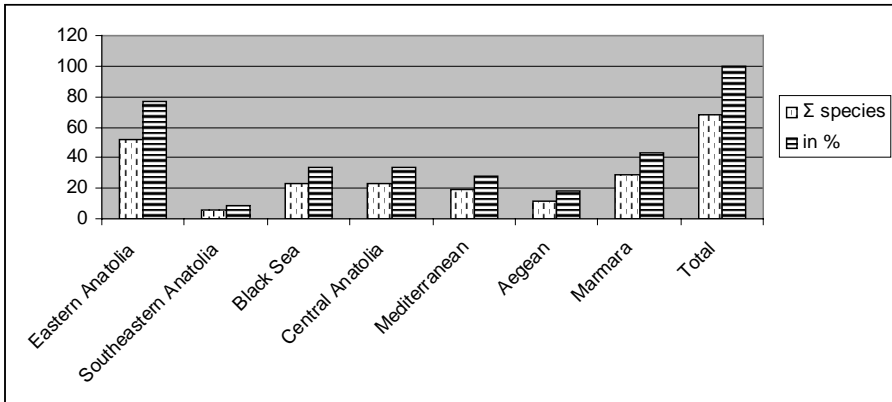


Fig. 3: Number of species and subspecies of Mutillidae in the biogeographical regions of Turkey.

Cluster analysis of faunal similarities among seven biogeographical regions of Turkey produce three major clusters (Fig. 4): Mediterranean and Aegean (bootstrap probability 42 %) and Central Anatolia, Marmara, Eastern Anatolia, and Black Sea (bootstrap probability 76 %), which united in one (bootstrap probability 81 %). This united large cluster belongs to East Mediterranean province of Palaearctic (the division of Palaearctic follows SEMENOV-TIAN-SHANSKIJ 1935). In all cluster analysis (Mutillidae, Pompilidae, Vespidae, see Figs. 4, 6, 8) Southeast Anatolia demonstrates minimal similarity (0.2, 0.45, 0.3 correspondently) with other Turkish fauna and belongs to Sumerian province of Palaearctic. East Anatolian and Central Anatolian faunas have highest similarity among Mutillidae, Pompilidae and Vespidae (0.5, 0.75, 0.7 correspondently) and include most of the wasp species distributed in Turkey.

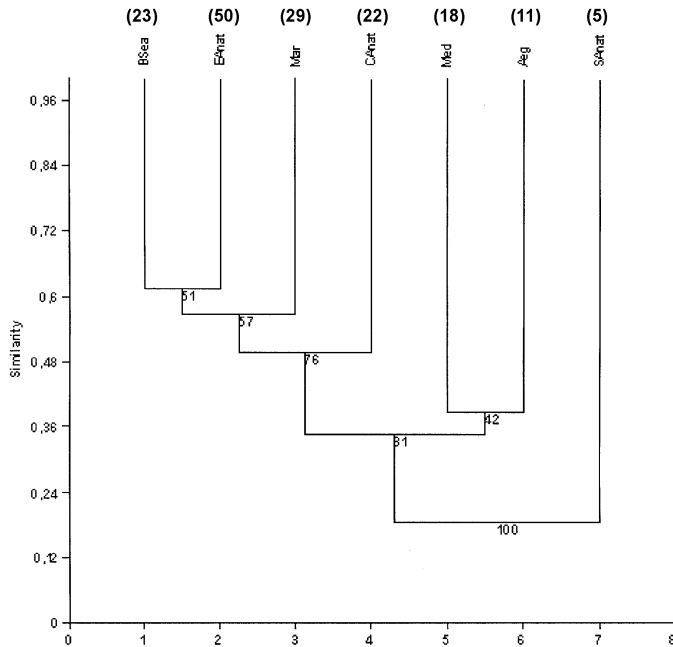


Fig. 4: Similarity of 65 species of Mutillidae from seven biogeographical regions of Turkey. (Dice, $r=0.88$). Bootstrap probabilities (expressed in percentages) are indicated at node of each cluster. The number of species is given above the region name. Names of regions: Aeg – Aegean, Bsea – Black Sea, CAnat – Central Anatolia, EAnat – Eastern Anatolia, Mar – Marmara, Med – Mediterranean, SAnat – Southeastern Anatolia.

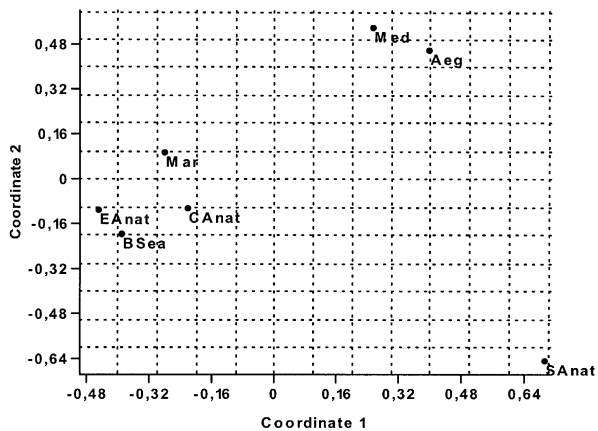


Fig. 5: Ordination of the seven biogeographical regions of Turkey in the reduced space of the first two principal coordinates for 65 species of Mutillidae. (Dice, $r=0.88$). The names of regions see Fig. 4.

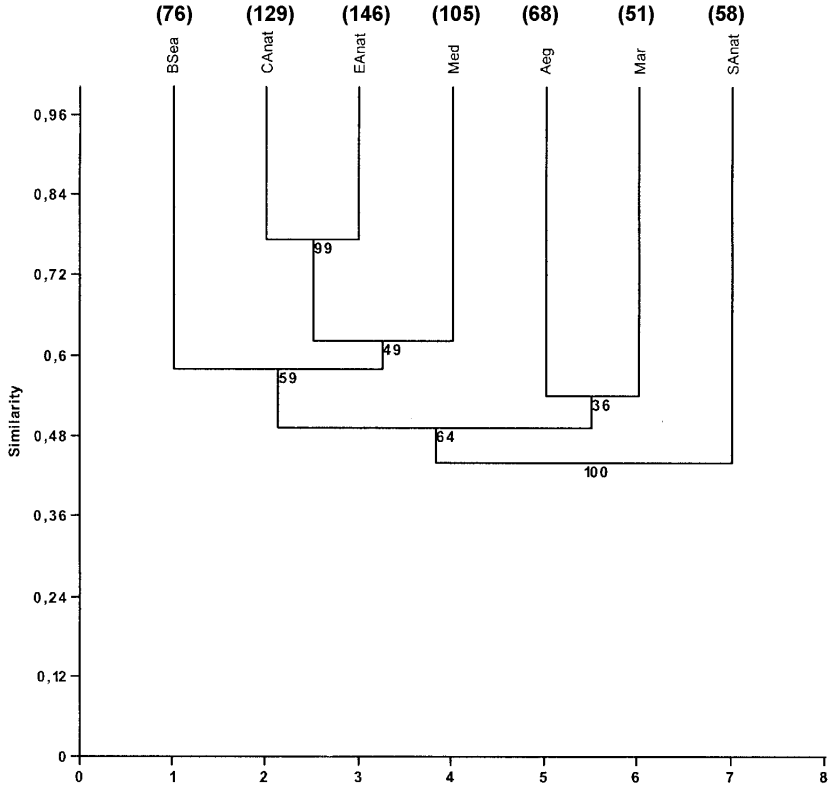


Fig. 6: Similarity of 200 species of Pompilidae from seven biogeographical regions of Turkey. Bootstrap probabilities (expressed in percentages) are indicated at node of each cluster. (Dice, $r=0.88$). The number of species is given above the region name. Names of regions: Aeg – Aegean, Bsea – Black Sea, CAnat – Central Anatolia, EAnat – Eastern Anatolia, Mar – Marmara, Med – Mediterranean, SAnat – Southeastern Anatolia. (Data from YILDIRIM & WAHIS 2011).

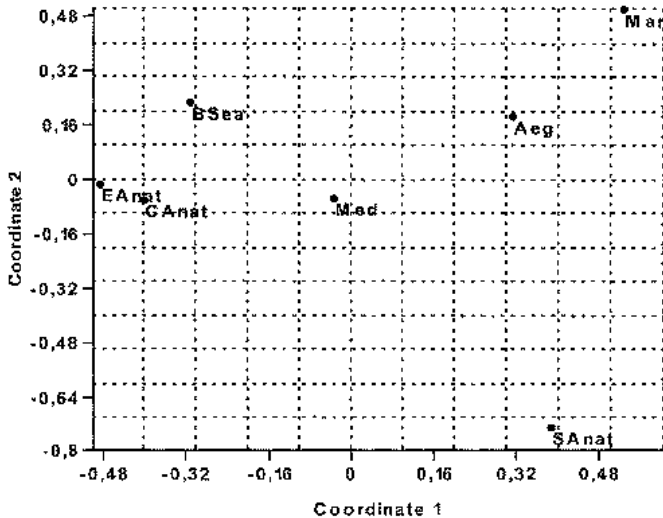


Fig. 7: Ordination of the seven biogeographical regions of Turkey in the reduced space of the first two principal coordinates for 200 species of Pompilidae. (Dice, $r=0.88$). The names of regions see Fig. 6. (Data from YILDIRIM & WAHIS 2011).

The mutillid fauna of Turkey is known rather well and currently includes 65 species and three subspecies from 21 genera. Among them, the type localities of nine species in Mutillidae are located in Turkey. Moreover, five species are considered endemic. These species: *Myrmilla (Pseudomutilla) filippovi* LELEJ 1985 from Mediterranean region, *Skorikovia anatolica* LELEJ 2009 and *Stenomutilla anatolica* NONVEILLER 1994 from Eastern and Central Anatolia regions, *Stenomutilla acanthosterna* NONVEILLER 1994 and *Stenomutilla osellai* NONVEILLER 1994 from Eastern Anatolia region. Eastern Anatolia region has the richest mutillid fauna and highest level of endemism (Table 1, 2). Turkish mutillid fauna is very rich. The fauna of the Mutillidae of Turkey contains a large number of species in comparison to others countries of the Mediterranean region, which is well known for its high biodiversity. Separately, 186 species and subspecies in 29 genera from Europe (ĆETKOVIĆ 2011), 57 species and subspecies in 20 genera from Greece, 47 species and subspecies in 19 genera from Azerbaijan, 43 species and subspecies in 19 genera from Armenia and 24 species and subspecies in 14 genera from Georgia (LELEJ & YILDIRIM 2009) (Table 3, Figure 10). The great richness and diversity of the Turkish mutillid fauna is the result of the various topographic and climatic structure of the country. In other hand Turkey is a boundary of East Mediterranean, Sumerian and Irano-Turanian provinces of Palaearctic region that caused the richness of the fauna.

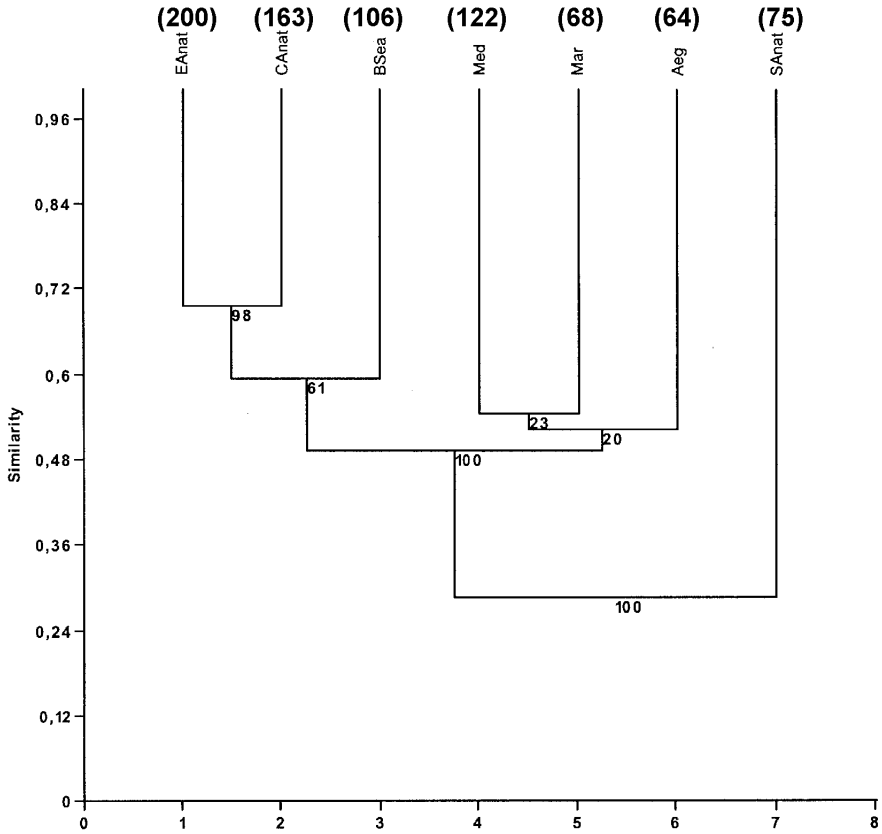


Fig. 8: Similarity of 298 species of Vespidae from seven biogeographical regions of Turkey. Bootstrap probabilities (expressed in percentages) are indicated at node of each cluster. (Dice, $r=0.92$). The number of species is given above the region name. Names of regions: Aeg – Aegean, Bsea – Black Sea, CAnat – Central Anatolia, EAnat – Eastern Anatolia, Mar – Marmara, Med – Mediterranean, SAnat – Southeastern Anatolia. (Data from YILDIRIM 2012, in press).

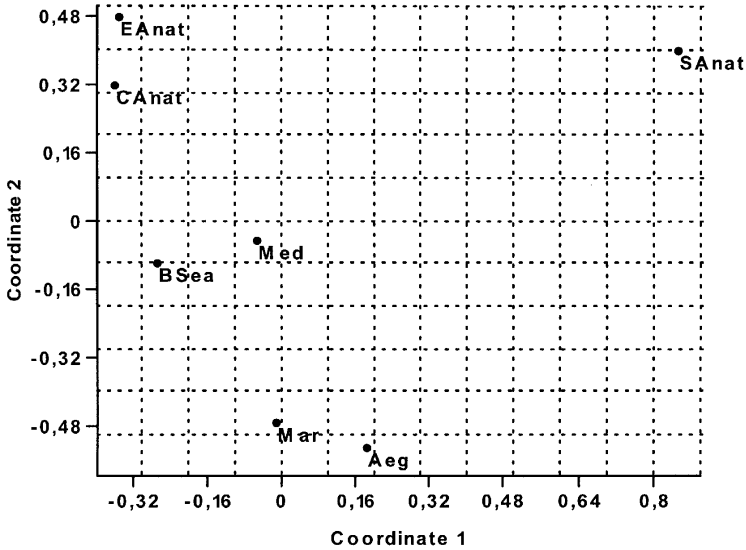


Fig. 9: Ordination of the seven biogeographical regions of Turkey in the reduced space of the first two principal coordinates for 298 species of Vespidae. (Dice, $r=0,92$). The names of regions see Fig. 8. (Data from YILDIRIM 2012, in press).

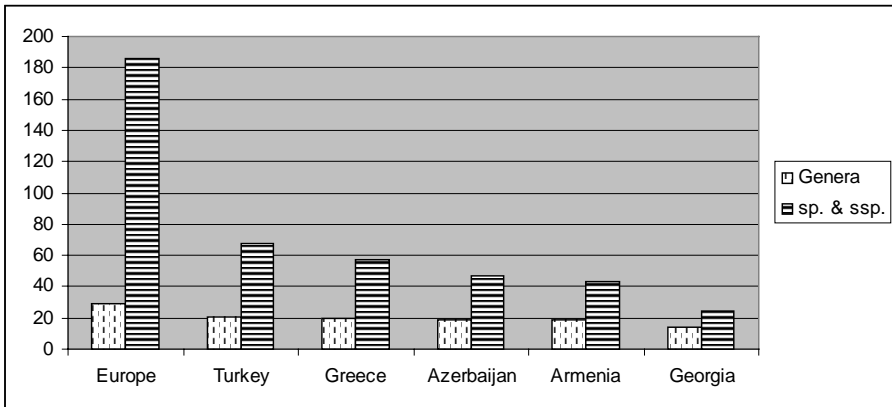


Fig. 10: Number of genera, species and subspecies of Mutillidae in Turkey, Europe, Greece, Azerbaijan, Armenia, and Georgia (based on table 3).

Table 3: The current knowledge of Mutillidae in Turkey, Europe, Greece, Azerbaijan, Armenia, and Georgia.

Family	Subfamilies	Number of taxa in Turkey		Number of taxa in Europe		Number of taxa in Greece		Number of taxa in Azerbaijan		Number of taxa in Armenia		Number of taxa in Georgia	
		Genera	sp. and ssp.	Genera	sp. and ssp.	Genera	sp. and ssp.	Genera	sp. and ssp.	Genera	sp. and ssp.	Genera	sp. and ssp.
Mutillidae	Myrmosinae	3	9	4	20	2	4	2	2	2	3	2	2
	Pseudophotopsidinae	1	2	1	4	1	2	1	2	1	3	1	1
	Myrmillinae	3	12	5	28	3	11	2	7	2	4	2	4
	Mutillinae	12	36	14	101	12	35	13	29	12	23	8	14
	Dasylabrinae	2	9	3	28	2	5	1	7	2	10	1	3
	Ticoplinae	-	-	2	5	-	-	-	-	-	-	-	-
	Total	21	68	29	186	20	57	19	47	19	43	14	24

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