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ÜMİT KEBAPÇI

MEHMET ZEKİ YILDIRIM

İSKENDER GÜLLE

MUSTAFA ÖZTOP

DUYGU CEREN ÇAĞLAN

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Research Article

The land snail fauna of Mut District (Mersin Province, Turkey)

Ümit KEBAPÇI*, Mehmet Zeki YILDIRIM, İskender GÜLLE, Mustafa ÖZTOP, Duygu Ceren ÇAĞLAN
Faculty of Arts and Science, Mehmet Akif Ersoy University, 15030, Burdur - TURKEY

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Abstract: The land snail fauna of the Mut District was surveyed during the spring (April-May) of 2008. A total of 31 species and subspecies—9 (29%) of them endemics—belonging to 26 genera and 14 families were determined from 41 localities. Dominant families were Enidae, Orculidae, and Hygromiidae. Humidity, vegetation, and habitat type were the determinants of species richness in the study area. Species composition, according to cluster and multivariate analyses, was also found to be affected by the altitude factor.

Key words: Gastropoda, endemism, Göksu River, Mut

Mut ilçesinin kara salyangoz faunası (Mersin, Türkiye)

Özet: 2008 yılı bahar aylarında (Nisan-Mayıs) Mut ilçesinin kara salyangozu faunası incelenmiştir. 41 lokaliteden 14 familya ve 26 cinse ait toplam 31 tür ve alttür tespit edilmiş olup, bunların 9 adedi (% 29) ise endemiktirler. Enidae, Orculidae ve Hygromiidae dominant familyalar olarak tespit edilmişlerdir. Nemlilik, bitki örtüsü ve habitat tipi tür zenginliğini belirleyici faktörler olarak gözlenmişlerdir. Yapılan kümeleme ve çok değişkenli analizlerine göre, tür kompozisyonu üzerinde bu faktörler yanında yükselti faktörünün de etkili olduğu saptanmıştır.

Anahtar sözcükler: Gastropoda, endemizm, Göksu Irmağı, Mut

Introduction

The terrestrial malacofauna of the Mediterranean region of Turkey is notably diverse with a high level of endemism. The Taurus Mountains, which extend across the region, present a wide range of habitats with extensive altitudinal variation. In deep contrast to the rather well-known coastal areas, the much larger interior heights of these mountains are generally poorly known. Due to uneven topography, high levels of endemism, and the restricted distribution among mollusk species in the region, detailed and focused malacofaunistic surveys are needed. The Central Taurus Mountains, specifically the Göksu Valley area where Mut District is situated, are among the malacologically least known parts of Turkey; only few sporadic records are available. To date, only 6 species of land snails have been recorded from Mut District: *Vitrea* sp. and *Eopolita protensa tenerrima* (Hesse 1914) from Alahan Monastery, 25 km NNW Mut (Riedel, 1995a); *Rupestrella rhodia* (Roth 1839); *Turcozonites silifkeensis* Menkhorst & Riedel 1995; *Monacha merssinae* (Mousson 1874); and *Helix dickhauti* (Kobelt 1903) from Mut (Schütt, 2001).

Our study presents malacological results of a detailed faunistic survey in Mut District.

* E-mail: kebapci@mehmetakif.edu.tr

Materials and methods

Study area

Mut District (2554 km^2) of Mersin Province lies between 36°7′ and 36°21′N and 32°56′ and 33°56′E; it is surrounded by the districts of Silifke, Gülnar, and Ermenek, and Karaman Province (Akarsu, 1960). To the west, the terrain is deeply penetrated by 2 main branches of the Göksu River, and the Göksu and Ermenek streams. Great altitudinal differences [from 2025 m (Büyük Eğre Mountain summit) to 250 m] are made visible through high vertical cliffs along the river and connected streams, which create a variety of relatively unexplored habitats in the valley. The Göksu Valley forms the border between the Western and Central Taurus chains. The latter, characterized by higher elevation and undulating topography, covers a much broader area in Mut District (Figure 1).

The basin was tectonically shaped by Pre-Alpine and Post-Miocene movements. Miocene formations, mainly middle Miocene limestone and sandstone, prevail in the area. In the valley Pliocene limestone of terrestrial origin is also present. The stratigraphical gap between Cretaceous and Miocene sediments indicates marked erosion during a terrestrial phase (Akarsu, 1960; Çiçek, 2001).

Due to the rain shadow of the Taurus Mountains and the continental effect of Göksu Valley (Atalay and Efe, 2010), Mut Basin has a relatively arid transitional climate with an average annual rainfall of 414.4 mm and monthly average temperatures ranging from 6.9 °C (January) to 30.1 °C (July) (Buldur et al., 2007; Ünal and Sağlam, 2009). However, the higher altitudes of south facing slopes receive a greater amount of precipitation (Atalay and Efe, 2010).The Ermenek-Mut area is considered one of the plant endemism centers of Turkey. Garrigue vegetation is present in the thermo-mediterranean belt, while groups of *Tamarix smyrnensis, Salix alba, Cupressus sempervirens*, and several *Populus* species—including the rare *P. euphratica*—can be found along the Göksu River. Although thoroughly disturbed, at elevated areas from 700 to 900 m a.s.l. *Pinus brutia* forest is the dominant vegetation type and it continues up to 1200 m as mixed stands together with *P. nigra*, which climbs higher in pure stands. To the east in particular, and mainly between 800 and 1400 m, groves of *Juniperus oxycedrus* and 5 species of *Quercus*—including the

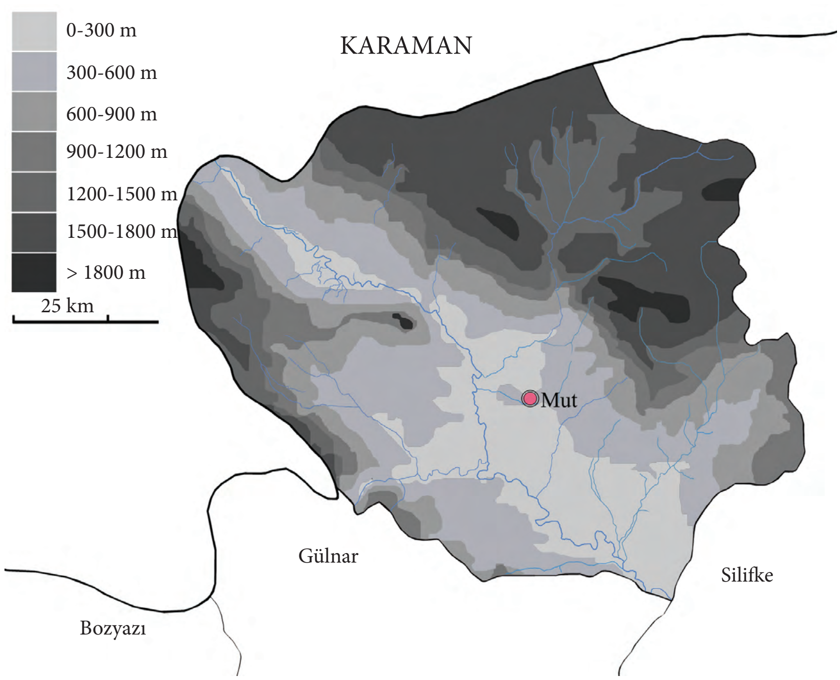

Figure 1. Topographical map of the study area.

recently described *Quercus trojana* subsp. *yaltirikii*—can be seen. At higher altitudes *Juniperus excelsa* and *Abies cilicica* subsp. *isaurica*, and rarely *Cedrus libani*, form the forest cover. However, in the high plateaus and flat montane areas a typical steppe vegetation occurs (Zielinski et al., 2006; Buldur et al., 2007; Doğan et al., 2007).

Sampling, identification, and data analysis

The field study was carried out in and around Mut District in April and May of 2008. From 41 localities within the district area a total of 1128 specimens of land snails (excluding incomplete shells and juveniles) were collected by hand or with tweezers and brushes (Table 1, Figure 2). Sampling was carried out for at least 30 min by 6 people per site. Empty shells were put in zip lock bags, and the relaxed live specimens were put into vial tubes with 70% ethanol. Materials were identified in the laboratory according to shell characters and, when necessary, genital anatomy using descriptive information present in the literature (Forcart, 1940; Likharev and Rammelmeier, 1962; Kerney and Cameron, 1979; Gittenberger and Menkhorst, 1991; Gittenberger and Menkhorst, 1993; Hausdorf, 1996, 2000; Wiktor, 2000; Schütt, 2001, 2005). The dissections and measurements of the shells were carried out with a stereo microscope (Olympus SZX12) equipped with a digital camera system. The material has been deposited in the Zoological Museum at Mehmet Akif University, Arts and Science Faculty (MAZM).

The coordinates, altitude, and observational data (about topography, geology, and vegetation type) were recorded in the field. Localities were numbered in chronological order and coded with a capital letter 'M' (Table 1).

In the text and in statistical analyses, species and subspecies were used unambiguously as taxonomical units. All but the 2 species apparently nonnative to the region (see Discussion) were included in the analyses. Descriptive statistics were performed using PAST. For evaluation of the distance between collection sites the presence/absence data were analyzed by distance-based ordination methods, principal coordinates analysis (PCoA), and nonmetric multidimensional scaling (NMDS). Applicable to a broad range of distances or dissimilarity coefficients (Gower, 1967), PCoA is a preferred method when dissimilarity measure is assumed to have a linear relationship with ecological distance, especially when studying variation among communities with low beta-diversity levels (Faith et al., 1987). NMDS is another indirect gradient analysis method commonly used in ecological studies (Legendre and Legendre, 1998; Nekola, 2003), in which nonmonotonic responses are assumed and the stress is minimized (Minchin, 1987; Zuur et al., 2007). Applying PCoA and NMDS, variation of species assemblages along the altitudinal gradient was analyzed using 3 almost equally represented altitudinal groups (<1000, 1000-1400, >1400 m a.s.l.). A Euclidean distance matrix was used to study dissimilarity between sites, and the Jaccard index was used to measure 'co-occurrence' of the species (Real and Vargas, 1996; Legendre and Legendre, 1998; Zuur et al., 2007). It should be noted that a special case arises when a Euclidean index is applied to PCoA, as the results are equal to those of principal components analysis (PCA). Moreover, cluster analysis (CA), according to Ward's method, was applied to classify natural groups. Genus level input data were used in CA, as the ecological preferences of closer species are generally similar, in order to include all sample data and to simplify graphical representation.

Habitat type (Table 2), without any reference to general characteristics or a categorization, refers to the type of habitat recorded during field observations. The term 'quasiendemic' is used here for the taxa (including those reported only as empty shells) reported outside Turkey from bordering areas only (e.g., continental islands).

Results

Species account

In the present study 31 species and subspecies from 26 different genera and 14 families were determined from the material, which included 1128 intact specimens from 41 localities (Table 2). Among these taxa, 9 (29%) were endemic to Turkey, and 5 (16%) were quasiendemics. The dominant families were Enidae, Orculidae, and Hygromiidae. The distribution of species by locality, split into 3 altitudinal groups, is shown in Table 3.

Table 1. Studied localities listed in chronological order.

Localities		Latitude	Longitude	Altitude (m)
M1	Sertavul Pass/25.04.2008	36°54.977′N	33°16,190′E	1655
M2	Along stream near Sertavul Yayla/25.04.2008	36°52.681′N	33°15.997′E	1416
M3	Rocks near Sertavul Yayla/25.04.2008	36°52.681′N	33°15.997′E	1410
M4	5 km S of Sertavul Yayla/25.04.2008	36°51.258′N	33°17.792′E	1436
M5	Along road to Alahan Monastery /25.04.2008	36°48.243′N	33°19.685′E	1238
M6	Alahan Monastery/25.04.2008	36°47.474′N	33°21.107′E	1245
M7	Mut Castle /25.04.2008	36°38.653′N	33°26.063′E	339
M8	Kurt Suyu Stream/25.04.2008	36°30.514′N	33°32.729′E	93
M9	Kaynakbaşı Spring/25.04.2008	36°36.183′N	33°38.058′E	365
M10	Sason Canyon-Kıca village/26.04.2008	36°42.463′N	33°43.800′E	1279
M11	Above Göğden Suyu Stream/26.04.2008	36°48.202′N	33°39.188′E	1393
M12	Göğden Suyu Stream/26.04.2008	36°48.940′N	33°38.964′E	1376
M13	Göğden Suyu Stream/26.04.2008	36°48.078′N	33°38.774′E	1381
M14	Pamuklu Spring /26.04.2008	36°40.481′N	33°38.341′E	670
M15	Hacı Ahmetli vil./26.04.2008	36°40.281′N	33°34.804′E	1217
M16	Karaekşi Camp Site /27.04.2008	36°40.684′N	33°28.003′E	486
M17	Hacı Nuhlu vil./27.04.2008	36°41.666′N	33°28.925′E	582
M18	Mavga Castle/17.05.2008	36°43.758′N	33°30.333′E	1371
M19	Kozlar village /17.05.2008	36°43.897′N	33°30.804′E	1394
M20	Kumru Yayla/17.05.2008	36°44.603′N	33°30.902′E	1624
M21	Pirinç Suyu Valley/17.05.2008	36°45.298′N	33°28.237′E	1625
M22	Söğütözü /17.05.2008	36°47.942′N	33°34.412′E	1414
M23	Ballı vil. /17.05.2008	36°53.292′N	33°38.132′E	1487
M24	Near Ballı vil. /17.05.2008/17.05.2008	36°54.281′N	33°41.107′E	1697
M25	Between Ballı vil. and Güldere/ 17.05.2008	36°52.964′N	33°42.628′E	1808
M26	Dağpazarı Church /17.05.2008	36°49.689′N	33°28.103′E	1311
M27	Environs of Kravga vil./18.05.2008	36°43.399′N	33°18.419′E	715
M28	Özlü vil./18.05.2008	36°42.768′N	33°12.869′E	917
M29	Göksu road/18.05.2008	36°43.205′N	33°11.757′E	875
M30	Kravga village/18.05.2008	36°45.189′N	33°10.714′E	395
M31	Topkaya vil./18.05.2008	36°50.465′N	33°05.367′E	637
M32	Between Çampınar vil. and Güzelyayla/18.05.2008	36°51.830′N	33°02.733′E	804
M33	Çampınar Yayla/18.05.2008	36°50.347′N	33°02.309′E	1311
M34	Gençler vil. /18.05.2008	36°44.782′N	33°17.389′E	658
M35	Köstel Mountain on Dağ Pazarı road/19.05.2008	36°47.700′N	33°25.535′E	1429
M36	Dağ Pazarı road/19.05.2008	36°48.715′N	33°26.136′E	1545
M37	Dağpazarı Dam reservoir/19.05.2008	36°49.074′N	33°27.376′E	1235
M38	Dağpazarı vil./19.05.2008	36°49.673′N	33°28.263′E	1279
M39	N. of Kavaközü vil./19.05.2008	36°53.844′N	33°24.046′E	1482
M40	Kavaközü vil./19.05.2008	36°52.147′N	33°23.700′E	1450
M41	Kavaközü vil., road to Sertavul Pass /19.05.2008	36°53.388′N	33°22.270′E	1627

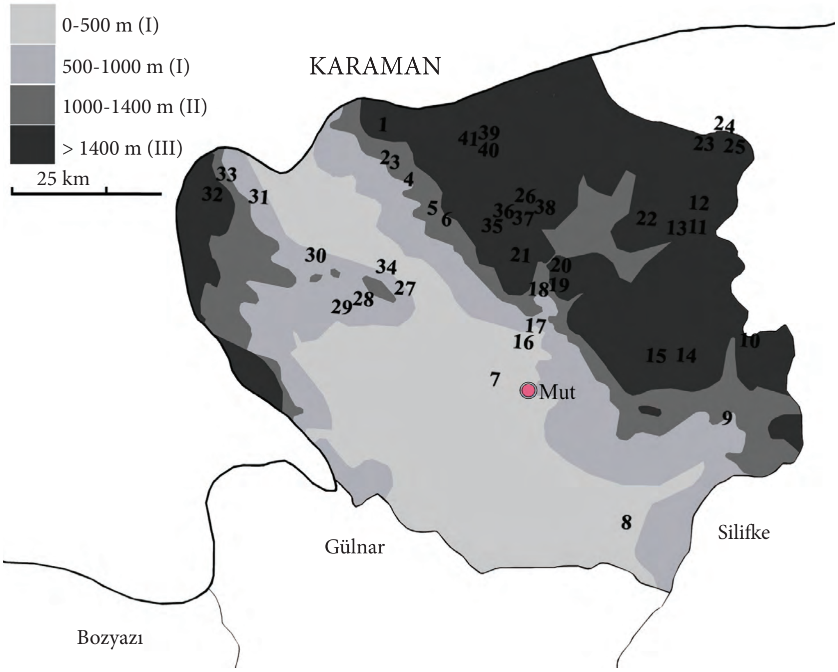

Figure 2. Map of the study area showing studied localities (M1-M41) and distribution of the localities among the 3 altitudinal groups (I = <1000 m, II = 1000-1400 m, III = >1400 m).

Table 2. Determined taxa, their habitat types, and endemicity. E: = endemic, Q = quasiendemic.

Taxon	Endemism	Habitat type
Pyramidula rupestris (Draparnaud 1801)		Limestone rocks
Orculella bulgarica (Hesse 1915)		Limestone rocks
Schileykula nordsiecki Hausdorf 1996	E	Limestone rocks
S. scyphus lycaonica Hausdorf 1996	E	Limestone rocks
Sphyradium doliolum (Bruguière 1792)		Limestone rocks
Truncatellina rothi (Reinhardt 1916)		Limestone rocks
Granopupa granum (Draparnaud 1801)		Woodland
Rupestrella rhodia (Roth 1839)		Limestone rocks
Buliminus carneus (L. Pfeiffer 1846)	Q	Limestone rocks
Turanena hemmeni Bank & Butot 1990	Q	Woodland
Pseudochondrula blanda hedjinensis (Kobelt 1907)	E	Stony highlands
P. seductilis incerta (Retowski 1883)	E	Stony steppe
Jaminia loewii loewii (Philippi 1844)	E	Stony hills
Chondrula lycaonica (Sturany 1904)	E	Limestone rocks
Mastus etuberculatus (Frauenfeld 1867)	Q	Stony hills
Oxyloma elegans elegans (Risso 1826)		Wetlands
Gallandia annularis (Studer 1820)		Stony highlands
Vitrea pygmaea (O. Boettger 1880)		Limestone rocks
Vitrea riedeli Damjanov & Pinter 1969		Limestone rocks
Turcozonites silifkeensis Menkhorst & Riedel 1995	E	Stony grassland, rocks
Oxychilus cyprius (L. Pfeiffer 1847)		Stony grassland
Eopolita protensa tenerrima Riedel 1962	Q	Stony, dry shrubland
Daudebardia rufa (Draparnaud 1805)		Rocky highland
Deroceras reticulatum (O. F.Müller 1774)		Cultivated land
Mesolimax escherichi Simroth 1899	E	Limestone rocks
Cecilioides acicula (O. F. Müller 1778)		Limestone rocks
Monacha ignorata (O. Boettger 1905)	E	Open stony grassland, limestone rocks
Xeropicta vestalis joppensis (A. Schmidt 1855)		Open steppic areas
Xeropicta derbentina (Krynicki 1836)		Open steppic areas
Helix asemnis Bourguignat 1860	Q	Limestone rocks
H. lucorum Linnaeus 1758		Cultivated land

Table 3. Distribution of determined taxa among the studied localities, split into 3 altitudinal groups (<1000, 1000-1400, >1400 m a.s.l.).

	FIRST GROUP (I)													SECOND GROUP (II)													THIRD GROUP (III)															
	M8	M7	M9	M30	M16	M17	M31	M34	M14	M27	M32	M29	M28	M15	M37	M5	M6	M10	M38	M26	M33	M18	M12	M13	M11	M19	M3	M22	M2	M35	M4	M40	M39	M23	M36	M20	M21	M41	M1	M24	M25	
Altitude (m)	93	339	365	395	486	582	637	658	670	715	804	875	917	1217	1235	1238	1245	1279	1279	1311	1311	1371	1376	1381	1393	1394	1410	1414	1416	1429	1436	1450	1482	1487	1545	1624	1625	1627	1655	1697	1808	
P. rupestris																																									+	1
O. bulgarica																									+							+										2
S. nordsiecki																						+														+			+			3
S. s. lycaonica																			+					+	+		+		+				+				+	+	+	+	+	11
S. doliolum																																							+			1
T. rothi					+																																					1
G. granum					+																																					1
R. rhodia											+																			+								+				3
B. carneus					+	+	+				+	+	+																	+												7
T. hemmeni					+																																					1
P. b. hedjinensis																						+																				1
P. s. incerta																			+				+				+						+						+			5
J. l. loewii											+	+			+		+	+				+	+		+		+	+		+	+				+			+				14
C. lycaonica																						+																				1
M. etuberculatus																					+	+	+										+									4
O. e. elegans																			+								+															2
G. annularis																									+		+		+						+	+			+	+	+	8
V. pygmaea																																						+				1
V. riedeli																																							+			1
T. silifkeensis								+																																		1
O. cyprius										+							+									+																3
E. p. tenerrima					+					+	+				+		+																									5
D. rufa																																								+		1
D. reticulatum																			+																							1
M. escherichi															+											+																2
C. acicula										+						+	+																					+	+		+	6
M. ignorata	+	+	+	+	+	+	+		+	+		+			+				+		+		+	+		+	+		+			+		+						+		21
X. v. joppensis	+	+							+											+		+		+			+													+		8
X. derbentina			+					+																																		2
H. asemnis					+	+	+	+		+				+				+																						+		8
H. lucorum																			+	+																						2
	2	2	2	1	7	3	3	3	2	5	4	3	1	1	4	1	4	2	6	2	2	6	4	3	4	3	7	1	3	3	1	2	3	1	2	2	1	5	7	6	4	

Apart from the determined specimens, some shells belonging to the genera *Mastus*, *Mesolimax*, *Monacha*, and *Helix*— either juvenile or incomplete— were identified only to genus level; however, these are thought to be conspecific with the determined taxa.

Comparison of localities

The average numbers of species and specimens for each locality are 3.12 and 27.51, respectively. The richest were M1, M3, and M16, with 7 species each; only single species could be recorded for 8 localities (Table 3).

Statistical analyses

Relation to the altitudinal gradient was tested using PCoA and NMDS. The introduced species *Deroceras reticulatum* and *Helix lucorum* were not included in the analyses. First, 2 PCoA and NDMS axes reflecting the highest variations were used in the analyses. According to the analyses by Euclidean index, an altitudinal gradient along axis 1 is present, and the first altitudinal group is clearly separable (Figure 3). The graphic representation is not changed significantly by exclusion of widespread taxa, such as *M. ignorata*. When the Jaccard index is used, the second altitudinal group overlaps with the third (in PCoA) or both groups (in NMDS). In CA (Figure 4) taxa are clustered according to their habitat needs. For instance, thermophilic *Monacha*, *Xeropicta*, *Schileykula*, and *Gallandia* were clustered separately from mesophilous and xeromesophilous taxa. In addition, within the mesophilous group, noncalciphilic *Cecilioides*, *Oxychilus*, *Eopolita*, and *Mesolimax* are clustered together.

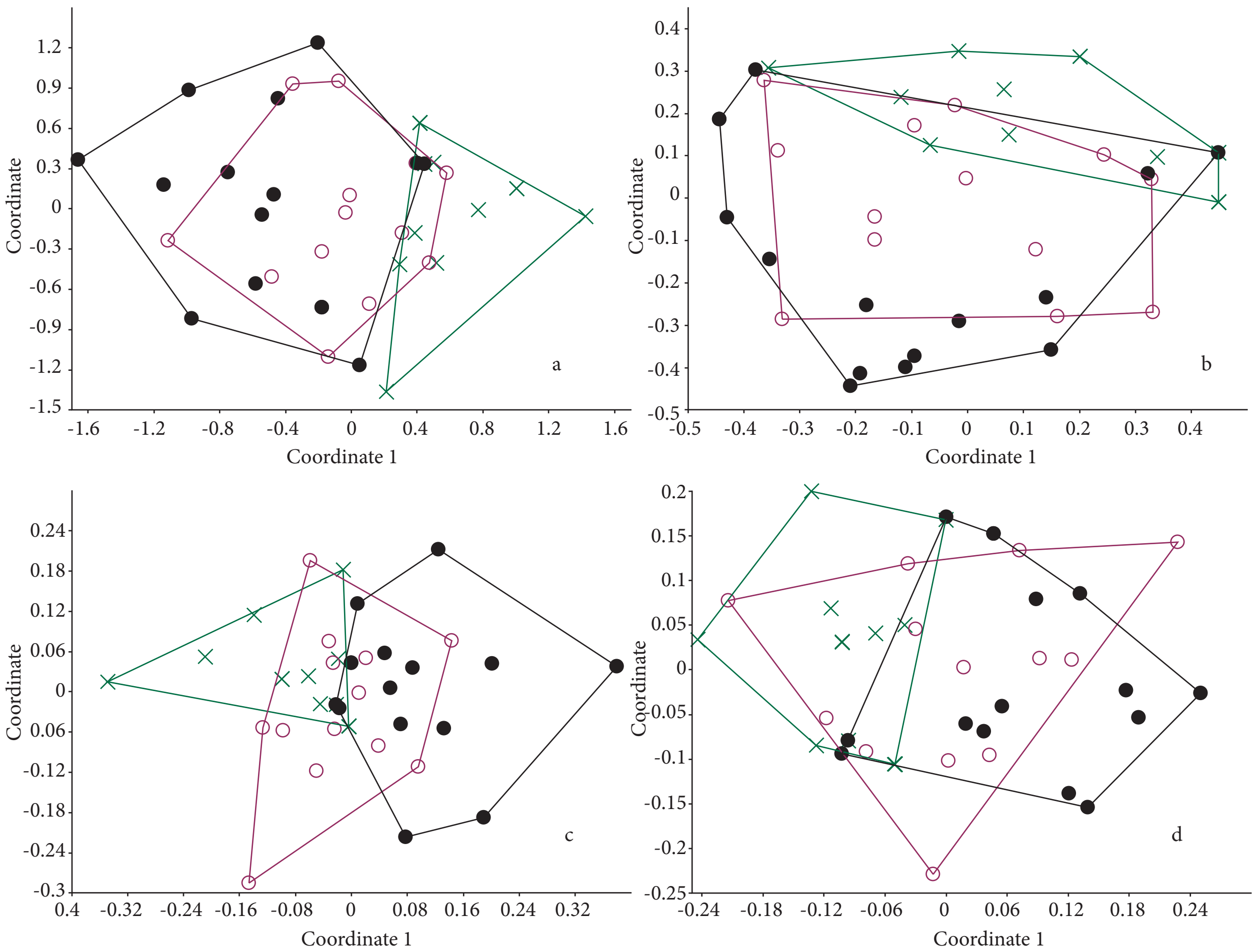

Figure 3. Scatterplots to the PCoA and NMDS analyses of the land snail taxa collected from 41 localities in Mut District. The 3 altitudinal groups (×: <1000 m, ●: 1000-1400 m, ○: >1400 m) are enclosed by convex hulls. Upper 2 plots belong to PCoA analyses using a Euclidean index (PCA) (a) and Jaccard index (b); lower 2 plots represent the NMDS analyses using Euclidean (c) and Jaccard (d) indices.

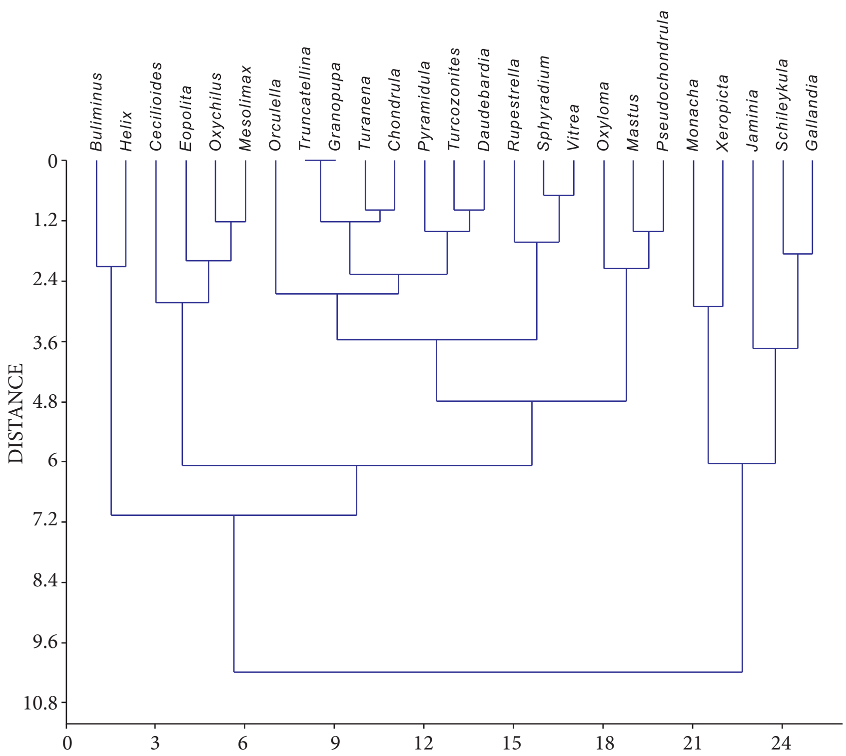

Figure 4. Cluster analysis (CA) of the land snail taxa collected during our survey in Mut District based on presence absence data.

Discussion

Due to lack of detailed surveys involving the interior parts of Mediterranean Turkey, only fragmentary information on land snail fauna exists in the literature. Despite the relatively arid climate and inaccessibility, as displayed in our results, the malacological diversity of the area is much higher than is presently known.

Against a previous total of 6 species, 1 of which was not determined to species, our survey has dramatically increased the number of taxa known from the Mut area to 31 species and subspecies. Given the large number of species recorded only once and the small sample size, and considering the lower sampling efficiency and extensive habitat variability, it is evident that there are other species awaiting discovery. Nevertheless, our findings enable us to draw a number of biogeographical and ecological conclusions.

M. ignorata and *J. l. loewii* were the most dominant taxa. On the other hand, 12 nominal taxa (*P. rupestris*, *S. doliolum*, *T. rothi*, *G. granum*, *T. hemmeni*, *P. blanda hedjinensis*, *C. lycaonica*, *V. pygmaea*, *V. riedeli*, *T. silifkeensis*, *D. rufa*, and *D. reticulatum*) corresponding to 38.7% of all taxa were determined from single localities. Single occurrences of the common species may be explained in general by small sample size; however, scarcity of the remaining species (namely, *T. hemmeni*, *P. blanda hedjinensis*, *C. lycaonica*, and *D. rufa*) is plausible due to their disjunct and/or marginal distributions in the area.

Relatively low alpha-diversity of the sampled localities (average number of species = 3.12) is a reflection of the arid climate and lower sampling efficiency on the steep slopes. The sampling effort is thought to be adequate, but increasing the collection sites to cover all habitat types present, resampling in different periods of the year, and applying soil/litter sampling methods would improve sampling efficiency.

All localities were limestone habitats. However, when species were collected from microhabitats, these were marked as 'habitat type' in Table 2. The majority of the species appear to be calciphilic; almost half (n = 14) were only collected from limestone rocks.

The soil dwelling species *C. acicula* and *D. rufa* were also present. The xerophilic Enids and Hygromiids are typical land snails found in the open habitats occupied by *P. seductilis incerta, J. loewii loewii, M. ignorata, X. vestalis joppensis*, and *X. derbentina* in our study. In higher altitudes and open upland steppe areas *P. blanda hedjinensis* and *G. annularis* were also found.

Among the species recorded once, the presence of forest inhabitants *D. rufa* and *S. doliolum* in bare rocky sites and the virtual absence of Mediterranean *T. rothi* and *G. granum* in many inclined and maquis-covered areas are notable. Although sampling efficiency may have contributed to these findings, in the case of the former 2 species, occurrences are assumed to be indicative of human disturbance, which intensifies towards the agriculturalized valley bottom.

During the field study it was observed that habitat quality (rock structure, vegetation cover, and exposure) was effective in species richness (SR). However, the altitude factor was observed to be effective in species composition (beta-diversity). Accordingly, variation of species assemblages along the altitudinal data was analyzed by PCoA and NMDS using 3 altitudinal groups (<1000, 1000-1400, >1400 m) (Table 3, Figure 3). A linear relationship between altitude and SR that increases slightly with altitude was observed. Both PCoA and NMDS, on the other hand, support a relationship between altitude and species composition. Low variation (<25%) represented by PCoA and NMDS axes along high stress values (Euclidean; 0.2524, Jaccard: 0.4) in NMDS indicates poor representation of variation. This is partially caused by the small size of the dataset, and we think it does not provide enough support to refute the null hypothesis. According to CA, in which the grouping is not affected by the exclusion of more common species, the taxa are grouped according to their ecological needs (Figure 4). This indicates that the basic ecological constraints (humidity, vegetation, and habitat type) are among the key determinants of species composition.

Despite the fair distance to the sea and relative aridity, compared with the southern coastal margins of Turkey, the diversity of land snails in Mut District is relatively high. Although a considerable amount of Mediterranean fauna is present, the fauna is transitional, representing both faunas of the coastal and interior parts.

All but 3 previously recorded species, *Rupestrella rhodia, Eopolita protensa tenerrima*, and *Turcozonites silifkeensis*, are new records for the study area. Among these, *Pyramidula rupestris, Orculella bulgarica, Schileykula nordsiecki, Sphyradium doliolum, Chondrula lycaonica*, *Pseudochondrula seductilis incerta*, *P. blanda hedjinensis, Oxyloma elegans elegans*, *Gallandia annularis, Vitrea pygmaea, V. riedeli, Deroceras reticulatum, Mesolimax escherichi*, and *Cecilioides acicula* have been recorded from the Central Taurus Mountains and Mersin Province for the first time as well (Schütt, 2005).

Monacha merssinae and *Helix dickhauti*, both recorded from Mut previously by Schütt (2001), were not determined during our study. Endemic *M. merssinae* is a small species generally found in the coastal areas and lowlands of Adana and Mersin (Hausdorf, 2000). It is largely replaced by the larger endemic *M. ignorata* at moderate to high altitudes of the Central Taurus Mountains, where it is quite common. However, *M. ignorata* was also found to be common at lower altitudes within the study area. Due to convergence and ecotypical variations in shell shape, there are difficulties in conchological identification of *Monacha* taxa. Extensive variation in size and shape were observed in *M. ignorata* specimens, some suggesting *M. merssinae* but none showing key characters of the species. It is known that *M. merssinae* occurs sympatrically with *M. ignorata* in its eastern range (Hausdorf, 2000). However, conchological identification, especially from interior areas, should be considered suspicious; for reliable identification genital anatomy should be used.

The record of *H. dickhauti* is probably based on misidentification of *H. asemnis*. Fresh shells of both can be separated by banding patterns, coloration, and aperture shape in general, but ecotypical variation in Turkish *H. asemnis* populations is also common and, especially when weathered, heavily ribbed shells may suggest the former. However, the presence of the species cannot be ruled out since other Lakes region endemics occur in the area (see below).

Both *Deroceras reticulatum* and *H. lucorum*, as suggested by their presence almost exclusively near cultivated areas and settlements in the study area, appear to be introduced species. Although widespread and common in general (Schütt, 2001; Yıldırım et al., 2004), *H. lucorum* is presumably an adventive species in most of southern Anatolia, where it is found usually as a synanthrope. *D. reticulatum*, on the other hand, occurs almost exclusively in synanthropic environments in Turkey (Wiktor, 1971, 1994; Schütt, 2001), and it is presumably not a native species (Yıldırım and Kebapçı, 2004).

Nine endemic and 5 quasiendemic land snail species (45.16% of all taxa) were found in the area. Most endemic or quasiendemic taxa belong to family Enidae, characterized mostly by xerophilous or xeromesophilous taxa (Likharev and Rammelmeier, 1962). Our study has filled the broad distributional gap between the Western Taurus and Bolkar Mountain ranges of *J. loewii loewii* and *Mastus etuberculatus*. The easternmost locality for endemic species *C. lycaonica*, previously known from the Lakes region, and the westernmost locality of the endemic subspecies *P. blanda hedjinensis*, described from a small area near Saimbeyli, are also presented here for the first time. *P. seductilis incerta* is endemic to Central Anatolia from Kastamonu to Konya. Our study extends its range farther south.

Our study also presents the easternmost locality for the endemic slug species *M. escherichi*. The phylogenetically distinct Agriolimacid genus *Mesolimax* Pollonera 1888 shows a Southwestern Anatolian distribution: *Mesolimax brauni* Pollonera 1888 extends from the eastern Aegean islands of Lesvos, Rhodos, and Karpathos to Silifke; the other species (*M. escherichi*) is known from the Lakes region to date (Wiktor, 2000, 2001; Schütt, 2001; Yıldırım and Kebapçı, 2004). The presence of *M. escherichi* in the study area, as in *C. lycaonica*, suggests a paleogeographical connection with Lakes region refugial area.

The occurrence of *Turanena hemmeni*, along with the relatively widespread *Orcullella bulgarica* and *Daudebardia rufa*, in the Göksu River Basin is also of zoogeographical interest since they show somewhat disjunct distributions in Turkey (Gittenberger and Menkhorst, 1993; Riedel, 1995a; Hausdorf, 1996).

Of the endemic genus *Turcozonites* Riedel 1987, 2 out of 7 species are restricted to the Göksu Basin. Although *T. anamurensis* Neubert and Riedel 1995 is known from several coastal localities in Anamur and Aydıncık, the range of *T. silifkeensis* stretches along the Göksu River to the interior, reaching the village of Gençali near Mut (Table 3) in the north.

It can be inferred that the Göksu River marks a migration route for mesic fauna towards interior parts, as most previous records of *T. silifkeensis* and *D. rufa* come from the Silifke area to the south (Riedel, 1995a, 1995b; Schütt, 2001). On the other hand, *O. bulgarica, S. nordsiecki, S. scyphus lycaonica, P. seductilis incerta*, and *G. annularis* are inclusions from the Central Anatolian Plateau.

These patterns suggest that the Göksu Valley has functioned both as a refugium and a dispersal pathway for various land snail taxa. Despite its arid climate, marked endemism and diversity is seen in the land snail fauna, which is mainly a combination of Taurus endemics and Mediterranean elements.

Undoubtedly, geological history and the paleogeography of the region are key factors in the formation of such a unique fauna. The Mut Basin, extending from Anamur to the Ecemiş fault, is 1 of 3 Miocene basins along the Taurus Mountains (Çiçek, 2001). During the Cenozoic, the basin remained above sea between the Eocene and early Miocene, when it sank following a long period of erosion (Akarsu, 1960; Gedik et al., 1979). After the Tortonian transgression towards the end of the middle Miocene the sea started to recede, and freshwater lakes were formed during the Pliocene (Akarsu, 1960). However, between the early Miocene (Burdigalian) and middle Pleistocene (Calabrian), a shallow marine environment persisted in the Mut Basin (Tanar and Gökçen, 1990; Yıldız et al., 2003). These data suggest that the basin initially functioned as a barrier, at least for lowland species, and during most of the late Neogene limited interexchange of land snail faunas was enabled between the Western and Central Taurus Mountains. Also, relict occurrences of lowland and highland taxa show that terrestrial habitats serving the habitat needs for Mediterranean land snail taxa were present within the basin from at least the Pliocene onwards.

Further detailed malacological surveys on either side of the basin will enable us to plot past events and their role in the distribution of land snails more precisely. Further work will also make possible a better understanding of the ecological as well as biogeographical constraints on species distribution in the region.

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