Land snail diversity in a threatened limestone district near Istanbul, Turkey

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Abstract

Land snail diversity in a threatened limestone district near Istanbul,Turkey.— The limestone meadows located to the north–northwest of Istanbul, Turkey, are in danger of being overrun by the rapidly expanding city. Past surveys showed that these habitats harbor rare plant species, including endemics to Turkey. To further evaluate the conservation value of these habitats, especially in terms of the often neglected invertebrates, one limestone area to the north of Küçükçekmece Lake and surrounding Sazlidere Dam was surveyed for land snails. Our findings strengthen the case for the protection of these unique habitats. Twenty–four species of land snails were identified in the survey area. Of these, 21 are native to Turkey, including three whose type location is Istanbul. In addition, two species that are at or near the limits of their ranges are considered to represent peripheral populations that may be especially worth conserving. Although the area surrounding Sazlidere Dam is under protection, the other limestone habitats are severely threatened by ongoing development.

Key words: Biodiversity, Conservation, Istanbul, Pulmonata, Prosobranchia.

Resumen

Diversidad de los caracoles terrestres en una zona caliza amenazada cercana a Estambul, Turquía.— Las praderas calcáreas situadas al NNO de Estambul están en peligro de ser rápidamente invadidas por la ciudad en expansión. Estudios anteriores demostraron que estos hábitats albergan especies vegetales raras, incluyendo algunos endemismos turcos. Con objeto de seguir evaluando el valor conservativo de dichos hábitats, en especial en cuanto a los invertebrados, a menudo ignorados, se han estudiado los caracoles terrestres de una zona calcárea al norte del lago Küçükçekmece y alrededor de la presa Sazlidere. Nuestros descubrimientos enfatizan la necesidad de una política de protección de estos hábitats únicos. En el área estudiada se identificaron 24 especies de caracoles terrestres. De ellas, 21 son nativas de Turquía, incluyendo tres cuya localización tipo es Estambul. Además, se considera que dos especies que se hallan en o cerca de los límites de su zona de distribución representan poblaciones periféricas especialmente merecedoras de conservación. A pesar de que la zona que rodea a la presa Sazlidere está protegida, el resto de los hábitats calcáreos está muy amenazado por el creciente desarrollo.

Palabras clave: Biodiversidad, Conservación, Estambul, Pulmonata, Prosobranchia.

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Introduction

Unprotected wildlife habitats located near expanding residential or industrial centers are subject to rapid and permanent destruction. Especially in developing countries, unique habitats near growing cities may be destroyed before they are properly surveyed and measures implemented for their protection. One case in point is the city of Istanbul, whose population has grown from about 800,000 in 1927 to 10 million in 2000 (Istanbul Metropolitan Municipality, 2005). Prior to the 20th century, the then much smaller city of Istanbul was surrounded by villages separated from each other by more or less degraded, but nevertheless uninhabited and undeveloped land that included agricultural fields and orchards (Anonymous, 1844). Such areas must have provided habitats for at least some of the native wildlife. However, since the beginning of the 20th century, the rapidly expanding Istanbul has absorbed most of the villages, turning them into districts within the city and, in the process, has all but decimated the wildlife habitats.

Özhatay et al. (2003) recently brought attention to several threatened unique habitats (designated as Important Plant Areas) surrounding Istanbul that are rich in rare and endemic plant species. One of these Important Plant Areas is the limestone meadows to the north–northwest of Istanbul. Özhatay et al. (2003) singled out three remaining fragments of these meadows in the region extending west from the vicinity of the town of GaziosmanpaÔa north of Istanbul to the north of the Küçükçekmece Lake and identified 19 rare plant taxa, including seven that are endemic to Turkey, growing on these meadows. The westernmost of these fragments is located along Sazli Creek (Sazli Dere) that empties into Küçükçekmece Lake (fig. 1). To supply drinking water for Istanbul, Sazlidere Dam was recently built over this creek, partly flooding the creek's broad valley.

Istanbul and its environs are the type locations of about 10 species of land snails that were described mostly in the 19th century (Schütt, 2001). Unfortunately, because of the ongoing loss of land to development, it has now become difficult to find habitats in and around the city that still maintain the original native land snail fauna. Our attention was, therefore, attracted to the Sazli Creek area not only because of the presence of limestone, which generally supports a high diversity of land snails, but also because of the threatened status of this habitat type in the Istanbul area. Furthermore, the area had not been properly surveyed for land snails. Therefore, to further evaluate the conservation value of the limestone meadows, especially in terms of the diversity of their fauna of native land snails, we conducted a land snail survey of the Sazlidere Dam area.

Materials and methods

The study area, located west of the city of Istanbul, extended from the north of Küçükçekmece Lake up the broad valley of Sazli Creek to the low limestone hills surrounding Sazlidere Dam (fig. 1). The area was not forested, but consisted of meadows and grassy hills with limestone outcrops. The survey was conducted on two days (26 VI and 8 VII 2004). Twelve stations, scattered along an approximately 12.5–km long transect, were designated in the field (fig. 1), but during the analysis of the results three of the stations (C4, C5 and C6) that were located within less than 100 m of each other were treated as one. The UTM coordinates (for zone 35) and elevation of each station were measured with a GPS receiver with an accuracy of about 10 m.

The following list gives the description and coordinates of each station (fig. 1): C1. Limestone cliff above road to Ôamlar Village; UTM E646269 m, N4548620 m; elevation 20 m. C2. Northeast bank of Sazli Creek; UTM E645861 m, N4548704 m; elevation 0 m; C3. Rocky hill northeast of Sazli Creek; UTM E645575 m, N4550187 m; elevation 70 m; C4–C6. Rocky hill south of road to Sazlidere Dam; UTM E645578 m, N4550370 m; elevation 55 m; C7. Limestone rocks near unpaved road, north of Ôamlar Village; UTM E646246 m, N4554293 m; elevation 100 m; C8. Limestone rocks on hillside above Sazlidere Dam lake; UTM E645082 m, N4553385 m; elevation 30 m; C9. Limestone rocks along grassy field; UTM E643946 m, N4553427 m; elevation 25 m; C10. Limestone rocks on hillside above unpaved road, north of old limestone quarry. UTM E641977 m, N4555331 m; elevation 25 m; C11. Grassy field along road to Hadimköy, west of roadway across Sazlidere Dam lake; UTM E638674 m, N4557811 m; elevation 25 m; C12. Limestone rocks on hillside facing a residential district, north of Küçükçekmece Lake; UTM E646015 m, N4547613 m; elevation 65 m.

Surface collections were done at each station by two or three people. In addition, soil samples were taken from six stations, sieved and sorted for small shells. The identifications of *Oxyloma elegans*, *Monacha ocellata*, *Monacha solidior*, *Xerolenta obvia*, *Xeropicta krynickii* and *Cernuella virgata* were confirmed by dissection. Sixty–one lots (537 specimens), including at least one lot of every land snail species found in the study area (excluding *Eobania vermiculata*), have been deposited with the Carnegie Museum of Natural History, Pittsburgh, PA, U.S.A. (CM 70300–70357, 70762–70764). Additional lots are in the collection of the first author. Reference samples of *Albinaria caerulea* were obtained from the Field Museum of Natural History (FM), Chicago, U.S.A.

Results

We found 24 species of land snails in the survey area, representing 12 families (table 1). In addition, slug shells were collected at stations C1 and C9, but these could be identified only to the family level (Reuse, 1983). A live, dormant *Eobania vermiculata* was seen at station C1 but not taken. Fourteen species (58% of total) were found only as empty shells (table 1) and

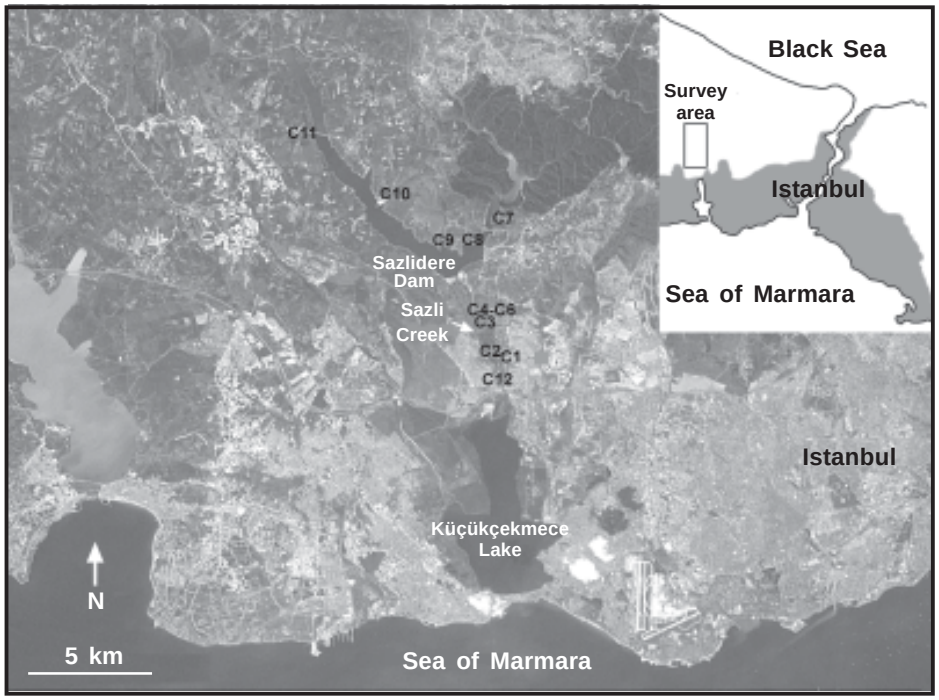

Fig. 1. The survey site showing the locations of the collection stations. The inset shows the location of the survey site in relation to the metropolitan Istanbul (shaded area). The background satellite photograph (file name: ISS008–E–21753.jpg, taken on 16 IV 2004) was downloaded from http://eol.jsc.nasa.gov (image courtesy of the Image Analysis Laboratory, NASA Johnson Space Center).

Fig. 1. Lugar del estudio mostrando la situación de las estaciones de recolección. El recuadro muestra la localización del lugar de estudio en relación con el área metropolitana de Estambul (área sombreada). La fotografía de satélite del fondo (nombre del archivo: ISS008–E–21753.jpg, tomada el 16 IV 2004) se bajó de http://eol.jsc.nasa.gov (por cortesía del Image Analysis Laboratory, NASA Johnson Space Center).

two species (8% of total) only as live specimens. We consider 21 of the land snail species to be native to the survey area. *Cochlicella acuta*, *Cernuella virgata* and *Eobania vermiculata* are non–native species that have been introduced to Turkey.

Additional notes on some of the species

Pomatias elegans

The earliest record of *P. elegans* from around Istanbul dates to the 19th century (Sturany, 1894). This species strictly requires calcareous substrates (Boycott, 1934) and we found it quite abundantly at some of our stations.

Oxyloma elegans

Two individuals were found crawling on plants growing in Sazli Creek at station C2. *Oxyloma elegans* is found throughout Europe (Hecker, 1965; Kerney & Cameron, 1979) and has been recorded in Turkey before (Schütt, 2001). However, our record of this species appears to be the first for the Istanbul area. *Oxyloma elegans* cannot always be reliably separated from *O. sarsii* (Esmark, 1886) by shell characteristics (Kerney & Cameron, 1979). Therefore, the previous records of *O. elegans* and *O. sarsii* from Turkey that were not confirmed by dissection may not be reliable.

Pupilla cf. *sterrii*

The *Pupilla* shells from stations C1 and C12 were finely striated and their apertures had three teeth: a parietal, a palatal and a deep columellar that was visible when the aperture was turned slightly sideways (fig. 2). The sample of nine adult shells from C1 had a mean length of 2.83 mm and a mean diameter of 1.57 mm. To identify these specimens, we considered two species: *P. triplicata* (Studer, 1820) and *P. sterrii*. Although *P. sterrii* is stated to have usually two teeth, a parietal and a palatal (Kerney & Cameron, 1979; Falkner, 1990), we identified our specimens tentatively as *P. sterrii* rather than *P. triplicata*, because the microsculpture of our shells agreed better with that of *P. sterrii* and the dimensions of our specimens were closer to those of *P. sterrii* and slightly above the ranges, especially for diameters, of those of *P. triplicata* (Germain, 1930; Kerney & Cameron, 1979).

Table 1. The land snail species collected in the survey area and the stations where each was found: * Species that were found only as empty shells. (For information on stations see the text, Material and methods, and fig. 1.)

Tabla 1. Especies de caracoles terrestres recogidas en la zona de estudio y estaciones donde se hallaron. Los asteriscos indican las especies de las que sólo se encontraron conchas vacías. (Para información sobre las estaciones ver el texto, Material and methods, y la fig. 1.)

Snail species	Stations
*Pomatias elegans** (Müller, 1774)	C3, C4–C6, C7, C8, C9, C12
Oxyloma elegans (Risso, 1826)	C2
*Truncatellina cylindrica** (Férussac, 1807)	C4–C6
*Granopupa granum** (Draparnaud, 1801)	C1, C4–C6, C8, C12
Pupilla cf. *sterrii** (Voith, 1838)	C1, C12
*Pleurodiscus balmei** (Potiez and Michaud, 1838)	C1, C9
*Chondrus tournefortianus** (Férussac, 1821)	C3, C8
*Multidentula ovularis** (Olivier, 1801)	C1, C3, C4–C6, C8
Mastus carneolus (Mousson, 1863)	C1, C3, C4–C6, C7, C8, C9, C10, C11, C12
*Oxychilus hydatinus** (Rossmässler, 1838)	C1, C3, C4–C6
*Cecilioides acicula** (Müller, 1774)	C4–C6, C10
Albinaria caerulea (Deshayes, 1835)	C1, C3, C4–C6, C7, C8, C12
*Bulgarica denticulata** (Olivier, 1801)	C1, C3, C4–C6, C8, C9, C12
*Cochlicella acuta** (Müller, 1774)	C1, C7, C10
Trochoidea pyramidata (Draparnaud, 1805)	C1, C3, C4–C6, C7, C8, C9, C10, C12
*Monacha claustralis** (Mousson, 1859)	C10, C11
Monacha ocellata (Roth, 1839)	C1, C8, C9, C11
Monacha solidior (Mousson, 1863)	C3, C7, C8, C9
Xerolenta obvia (Menke, 1828)	C1, C3, C4–C6, C8, C9, C10, C12
Xeropicta krynickii (Krynicki, 1833)	C1, C2, C3, C4–C6, C7, C8, C9, C10, C11, C12
Cernuella virgata (Da Costa, 1778)	C1, C2, C3, C7, C8, C9, C10, C11, C12
Eobania vermiculata (Müller, 1774)	C1
*Helix lucorum** Linnaeus, 1758	C1, C8, C9
*Helix pomacella** Mousson, 1854	C4–C6, C11
Limacidae	C1, C9

Multidentula ovularis
This species was not previously recorded from the province of Istanbul (Forcart, 1940; Schütt, 2001). We found it in abundance at our station C3 and less abundantly at three other stations.

Albinaria caerulea
This strictly calciphilic species was abundant at several of our stations. Several subspecies of *A. caerulea* are distributed along the coastal regions of southwestern Turkey (Örstan, 2001), on the Greek islands near mainland Turkey (Nordsieck, 1977; Zilch, 1977) and in Attiki, Greece (Giokas & Mylonas, 2002). In addition, Schütt (2001) gave a record of *A. caerulea* from Çatalca, about 18 km west of our survey area. We compared our specimens with samples of *A. caerulea caerulea* from the island of Chios (FM 206645), *A. caerulea milleri* (Pfeiffer, 1850) from the island of Delos (FM 206815), and *A. caerulea maculata* (Rossmassler, 1836) and *A. caerulea calcarea* (Boettger, 1878) from the vicinity of Ephesus, Turkey (Örstan, private collection). Using these comparisons, we determined that our specimens were conchologically closest to the nominal subspecies. We note that our specimens were also identical to the Field Museum lot of *A. caerulea caerulea* (FM 161499) with the collection location given broadly as "Thracien, Istanbul".

Fig. 2. A specimen of *Pupilla* cf. *sterrii* (2.7 x 1.5 mm) from station C1. Arrows point at the teeth.

Fig. 2. Ejemplar de Pupilla *cf.* sterrii *(2,7 x 1,5 mm) de la estación C1. Las flechas señalan los dientes.*

Discussion

We are unaware of any previously published survey of the land snails of the Sazlidere Dam area. However, we found published records for four species of land snails from the vicinity: *C. acuta* from Küçükçekmece (Sturany, 1902), *M. carneolus* from YeÕilköy (previously San Stefano) and Florya, districts southeast of Küçükçekmece Lake (Sturany, 1902; Gittenberger, 1967) and *O. hydatinus* and *A. caerulea* from Çatalca west of our survey area (Riedel, 1995; Schütt, 2001). We also found these four species in our survey (table 1). Sturany's 1902 record of *C. acuta* from Küçükçekmece indicates that this introduced species has been in the area for more than 100 years.

In the survey area we saw *A. caerulea* aestivating attached to limestone rocks. There is evidence that *Albinaria* species that aestivate on rocks have occasionally been transported to areas outside of their native ranges by humans on rocks intended for buildings or other purposes (Welter–Schultes, 1998). Therefore, we considered the possibility that *A. caerulea* was introduced to our survey area on rocks that were brought from elsewhere, perhaps southwestern Turkey. However, because of the relatively slow dispersal rate (~2 m/year) of *Albinaria* species (Schilthuizen & Lombaerts, 1994), unintentional introductions by humans usually result in localized distributions of the introduced species (Welter–Schultes, 1998). In comparison, the distance between the two farthest stations where we found *A. caerulea*, about 6.7 km, indicates that the distribution of the species in our survey area was not localized. We also note that Schütt's (2001) record of *A. caerulea* from Çatalca, west of our survey area, suggests that the range of this species extends over an even wider area. Moreover, there is no evidence that large quantities of calcareous rocks were transported into the Sazli Creek area in the past (such materials are rarely used in modern buildings); the limestone quarry near station C10 that was in operation until recently indicates that limestone was actually exported from the area. Therefore, these arguments lead us to conclude that *A. caerulea* is native to the survey area.

In addition to the previously published records listed above, Chalcolithic fossils of *Helix pomatia* Linnaeus, 1758 (from a layer ~6880 radiocarbon years B.P.) were reported from the Yarimburgaz Cave within our survey area (Meriç et al., 1991). However, because *H. pomatia* is not an extant species in Turkey (Schütt, 2001; Yildirim et al., 2004), we suggest that the specimens Meriç et al. (1991) reported as *H. pomatia* are probably the conchologically similar *H. lucorum*, which we found at stations C1, C8 and C9. Nevertheless, we note that the present day range of *H. pomatia* extends from northern Europe through the Balkan Peninsula down to Macedonia (Falkner, 1990) and that during the Chalcolithic period the species may have lived as far south as our survey area or may have been taken there by humans.

We found only empty shells of 14 species (58% of total) and only live specimens of two species (8% of total). These results, obtained during the dry season in the Istanbul area, are comparable to the results Rundell & Cowie (2003) obtained in Hawaiian dry forests, where 40 to 47% of species were collected dead only and 0 to 7% live only. As Rundell & Cowie (2003) pointed out, if a survey produces only empty shells of a species, this result may imply that the species is either very rare or extinct at that location. However, since most snail species hide deep in the soil or under rocks during the dry season, we believe that we would have found live specimens of most, if not all, of the recorded species if we had collected during a rainy period, or if we had searched more intensely. We consider our results as constituting a baseline and we believe that only by conducting follow–up surveys of the area in the future will it be possible to accurately monitor any changes in the extant land snail fauna.

Özhatay et al. (2003) based their arguments for the conservation value of the last remaining limestone meadows in the Istanbul area on their botanical richness. The results of our survey add four additional justifications for the protection of these habitats. First, the majority of the land snail species found in the survey area (21 out of 24) are native to Turkey. We believe that the protection of the few remaining undeveloped areas in and around Istan-

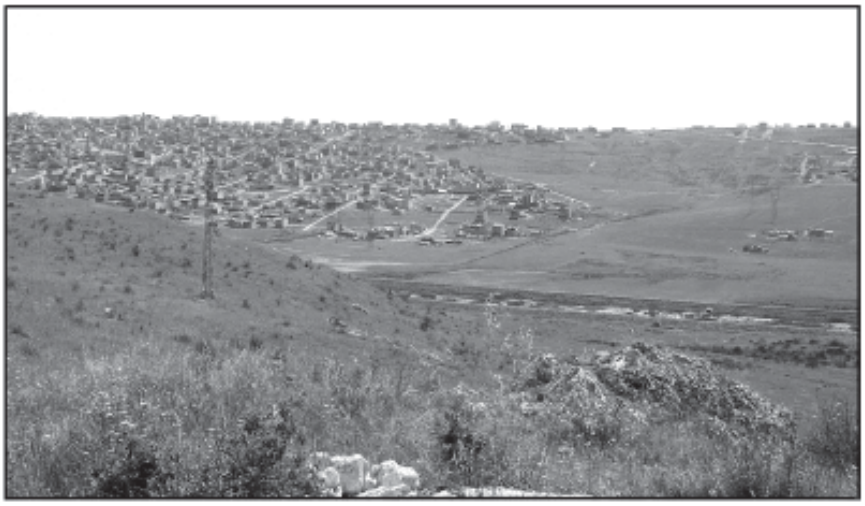

Fig. 3. Residential development that is gradually overrunning the limestone hills. The photograph was taken on 26 VI 2004 from station C6 (the rocks in the foreground) looking west across the broad valley of Sazli Creek.

Fig. 3. Desarrollo urbano que gradualmente va invadiendo las colinas calizas. La fotografia se tomó el 26 VI 2004 desde la estación C6 (rocas del primer plano) mirando hacia el oeste a través del ancho valle del riachuelo Sazli.

bul is urgently necessary to provide habitats for the snail species that are native to the region.

Second, Istanbul is the type location of three of the species that we found: *M. carneolus*, *M. ocellata* and *H. pomacella*. For taxonomical reasons, we think that it is very important to protect the type locations of animal and plant taxa. If in the future specimens are needed for critical taxonomical comparisons, for example for genetic or anatomical analyses, the most suitable place to get specimens that are likely to be the same species as the one that was described from the type location would be the type location itself. Although the Sazlidere Dam area was not specified as the type location of any of these species, we believe that the area is close enough to Istanbul to be considered within the type location. Therefore, considering that the original type locations within Istanbul are likely to have been destroyed by now, the protection of the nearby areas with the same species would ensure the survival of these taxonomically important populations.

Third, some of the species we found, for example, *P. elegans* and *A. caerulea*, are strict calciphiles and would not survive on noncalcerous substrates. The strict dependence of these species on calcareous rocks and soil underlines the need to protect their limestone habitats.

Fourth, in our survey area *P. elegans* and *A. caerulea* may be at or near the limits of their distribution ranges. The range of *P. elegans* extends from England and an isolated spot in western Ireland to northwestern Turkey (Kerney & Cameron, 1979; Örstan, 2005). The Istanbul area may be at or close to the southeastern limit of the range of this species (Örstan, 2005). As for *A. caerulea*, all of its other known populations are from southwestern Turkey (Örstan, 2001), the adjacent Greek islands (Nordsieck, 1977; Zilch, 1977) and southern Greece (Giokas & Mylonas, 2002), so the Istanbul area certainly represents the northernmost limit of its range. Since peripheral populations are often genetically and morphologically divergent from central populations, and since genetically divergent populations are valuable as potential sites of future speciation events (Mayr, 1970; Lesica & Allendorf, 1995), peripheral populations are important candidates for conservation (Lesica & Allendorf, 1995). At least until further studies have been carried out to evaluate the degree of genetic divergence from central populations of the peripheral land snail colonies around Istanbul, the habitats of peripheral land snail colonies should be protected.

Özhatay et al. (2003) classified the conservation needs of these limestone meadows as "very urgent". Our observations during the survey support the determination of Özhatay et al. (2003) that the limestone meadows north–northwest of Istanbul are under imminent threat from the expansion of the nearby residential neighborhoods. For example, our station C1 was on a cliff below a densely populated hilltop, while C12 was less than 100 m from recently constructed apartment buildings. The overtaking of the latter station by further develop-

ment is probably only a matter of time. A photograph taken from station C6 (fig. 3) shows the extent of encroaching development and illustrates the general threat these habitats are facing.

On the other hand, the presence of a dam within our survey area that was built to supply water for the ever–growing population of Istanbul paradoxically offers some protection to the surrounding land (Özhatay et al., 2003). The regulations of the municipal agency that administers the dam, Istanbul Su ve Kanalizasyon Idaresi (ISKI; Istanbul Water and Sewer Administration), prohibit all development, other than those associated with water purification, within 1000 m of water reservoirs if the water collection basin in question extends at least that far (ISKI, 2004). Therefore, if these regulations are enforced as intended, the presently undeveloped land within 1,000 m of the dam lake may be considered to be under protection for the time being. However, the same regulations do allow for residential buildings outside the 1,000–m limit, which means that our stations C1, C2, C3 and C12 and the surrounding areas located up to about 4 km away from Sazlidere Dam may be lost in the future unless protected.

Turkey currently has a number of national parks and various types of nature conservation areas (Kaya & Raynal, 2001; Guclu & Karahan, 2004). The protection provided by such areas to all wildlife notwithstanding, the establishment of parks and conservation areas is usually justified in terms of the protection they will offer to mostly large mammals, birds and plants (Yilmaz, 1998; Kaya & Raynal, 2001; Guclu & Karahan, 2004), while the conservation needs of invertebrates are almost never taken into consideration. The land snail faunas in many countries are increasingly being threatened with extinction (Lydeard et al., 2004). Turkey has a rich land snail fauna with many endemic species (Schütt, 2001) that, in our opinion, deserve no less protection than any other animal or plant group. We hope that our results regarding these threatened limestone meadows will bring attention to the conservation needs of the native land snails in particular and invertebrates in general.

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