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Gastropoda from subterranean habitats in Greece[1]

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Summary

The Mediterranean mountains are known for an extended fissure network in boulders and rocks below the soil layer, the so-called superficial subterranean habitat or MSS. This habitat is used by many invertebrate animal species. Traps were used in Greek mountains in order to examine the subterranean fauna. The traps were placed in depths between 10 and 60 cm depending on the structural characteristics of the rock deposits. The present contribution provides trap results of snails (Gastropoda) from 47 different sites during the years 2007–2011. Representatives of 21 gastropod species (nine families) were recorded. Most species and most specimens belong to the families Oxychilidae and Zonitidae suggesting that many of them have a hypogean way of life. On the other side, widespread surface active species such as *Poiretia compressa*, *Pomatias elegans* and *Lindholmiola lens* were recorded in numbers suggesting that these species retreat to the MSS during the dry and hot season. Three species of Helicidae were also recorded including an undescribed representative of the genus *Josephinella*. Only empty and eroded shells of the latter were previously known. All of the species are of large or medium size indicating that this trap method probably is not suitable for catching subterranean micromolluscs.

Zusammenfassung

Die Gebirge in der mediterranen Region sind für ihr ausgedehntes Netzwerk an Rissen und Spalten in Felsen und Geröll bekannt. Dieser Lebensraum wird als MSS (Milieu Souterrain Superficiel) bezeichnet. Zahlreiche Wirbellose nutzen dieses Spaltensystem als Lebensraum. Mit Hilfe von Fallen wurde die Fauna dieses Lebensraums in Gebirgen Griechenlands untersucht. Abhängig von den strukturellen Eigenschaften der Felsablagerungen wurden die Fallen 10 bis 60 cm tief in den Untergrund eingebracht. Die hier vorgelegte Arbeit wertet die Gehäuseschnecken (Gastropoda) von 47 verschiedenen Untersuchungsflächen der Jahre 2007–2011 aus. Es wurden 21 Schneckenarten (aus neun Familien) nachgewiesen. Die größte Zahl der Arten konzentriert sich auf die Familien Oxychilidae und Zonitidae, deren Vertreter vermutlich überwiegend unterirdisch leben. Auf der anderen Seite wurden jedoch auch weit verbreitete, oberflächenaktive Arten wie *Poiretia compressa*, *Pomatias elegans* und *Lindholmiola lens* in Anzahl gefangen, die sich während der trockenwarmen Jahreszeit in das Spaltensystem zurückziehen. Auch drei Arten von Helicidae wurden nachgewiesen, darunter eine unbeschriebene *Josephinella*-Art. Von dieser Art waren zuvor nur leere, ältere Schalen bekannt. Alle Arten besitzen mittelgroße oder große Gehäuse. Das Fehlen von kleinen Arten in den Fallen lässt vermuten, dass diese Fallenmethode für den Nachweis von Mikromollusken nicht geeignet ist.

Key words: Subterranean habitat, MSS, Gastropoda, Greece

Introduction

In the Mediterranean region a comparably high proportion of insects and other invertebrate species use subterranean habitats. Firstly many species retreat from the soil surface to deeper layers in the underground during the dry and hot period of summer. Secondly the Mediterranean region is known for its high density of (karst) caves and its pronounced fissure network existing in mountain rocks. The latter is termed "superficial subterranean habitat" and was introduced in the literature under its French abbreviation MSS (Milieu Souterrain Superficiel; see Juberthie et al. 1980, 1981). The MSS is a subterranean or hypogean habitat in the strict sense of the word in contrast to the endogean or edaphic soil substrate (Giachino & Vailati 2010, Fig. 1).

1 Results of the program "Research Missions in the Mediterranean Basin" sponsored by the World Biodiversity Association onlus. XXXI. contribution.

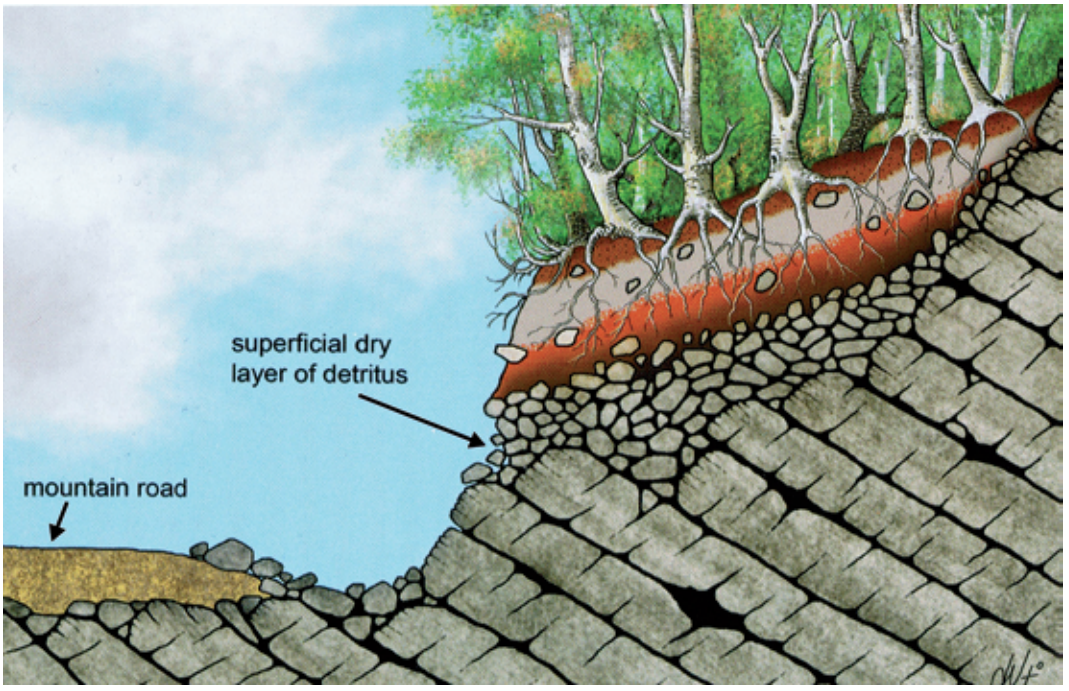

Fig. 1. Schematic figure of natural MSS (right side) and often visible anthropogenous destruction of this habitat due to road construction (left side). The "layer of detritus" below the forest soil represents the examined subterranean habitat (source of figure: GIACHINO & VAILATI 2010).

While the fauna of caves is more or less well-known today, examination of MSS started only a few decades ago and the subterranean fissure network is the last biotic frontier in European biodiversity research. Many if not most species of animal groups adapted to the life in the MSS are believed to be still undescribed. E.g. several genera of carabid and cholevid beetles or Diplopoda belong to these groups. So it is not surprising that GIACHINO & VAILATI (2011) described 27 new species of the carabid subtribe Anillina, increasing the number of known Anillina species in Greece by 180%.

Pier Mauro Giachino and Dante Vailati investigated the subterranean fauna systematically in Greek mountains using special traps placed within the MSS. It is aim of this paper to present the first results of recorded snails (Gastropoda) from these MSS traps.

Materials and methods

The material was collected in mountain areas usually characterized by fresh and humid environmental conditions, often mountain slopes with northern exposure, sometimes at the base of rock walls where clastic debris accumulated. Also slopes along roads were used for the examination. The traps were placed at depths between 10 and 60 cm depending on the structural characteristics of the rock deposits. After placement of the traps, the hole was filled with the original substrate so that the trap entrance was in contact with the fissure network of the surrounding habitat (see GIACHINO & VAILATI 2010 for a detailed description of the trap placements). A total of 5–10 traps were placed at each site with a distance of 2–10 metres between the single traps. The traps consisted of 150 ml glass jars with an opening diameter of 50 mm filled with 20 mm supersatured NaCl solution. Each trap contained a 60 mm long tube of 15 mm diameter containing fermented cheese as bait for carabid and cholevid beetles.

The traps were recovered after one or two whole years. After this long period the shells of most species were still in excellent condition while the soft body started to macerate.

Material from 49 different sites (collected between 2007 and 2011, see Figure 2) was examined. All of these sites are located in mountains between 500 and 1580 m.

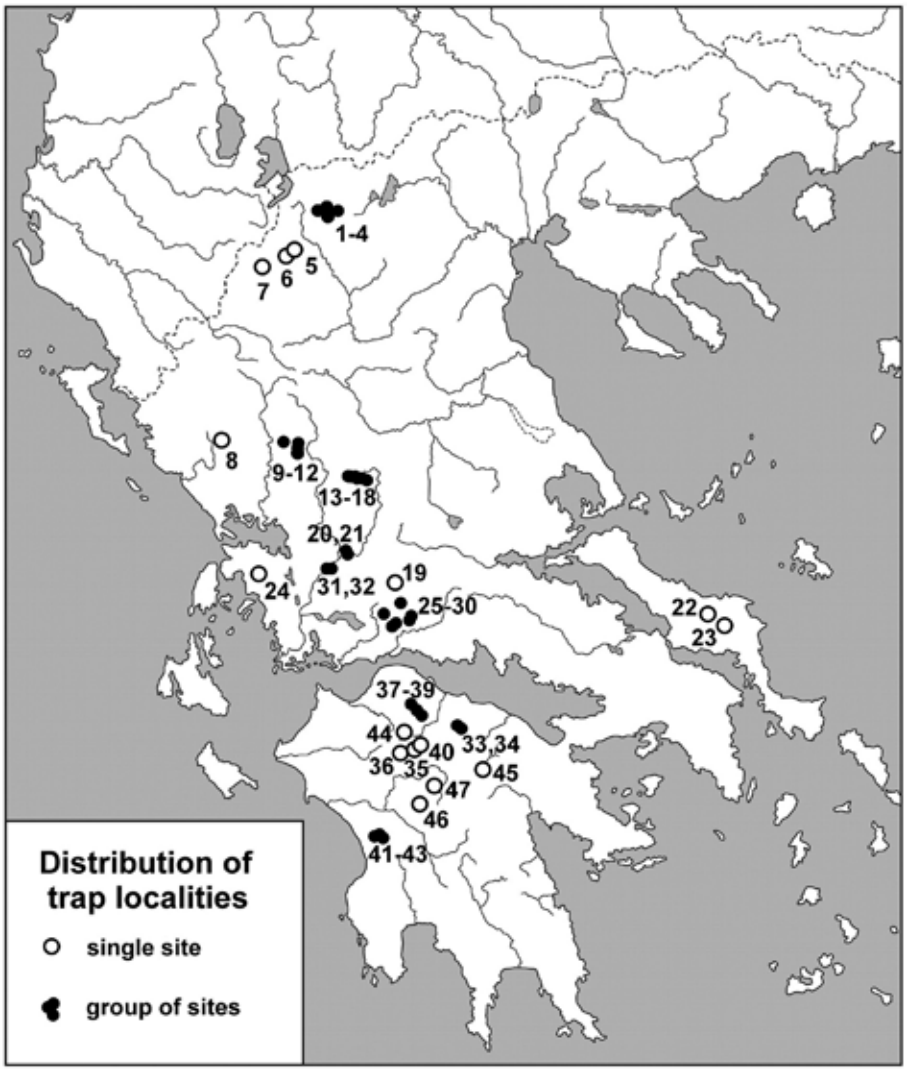

Fig. 2. Map of the examined 47 Greek sample sites.

List of examined sites with a short description of the subterranean habitat (for practical reasons the old Greek prefectures and the new administrative regions are given):

1: West Macedonia, nomos Flórina, Oros Vitsi near Drosopigi, 1260 m, N 40°39'15.3'' E 21°24'59.2'', 19.VI.2007/17.VI.2008. MSS at a SE slope of a small valley in a *Fagus* forest on schistose substrate with black humus.

2: West Macedonia, nomos Kastoriá, Oros Vitsi near A. Andónios, 1300 m, N 40°38'17.1'' E 21°19'00.7'', 18.VI.2007/17.VI.2008. MSS at a WSW road slope in a *Quercus* forest on schistose substrate with black humus and red gravel.

3: West Macedonia, nomos Kastoriá, Oros Vitsi near A. Andónios, 1320 m, N 40°39'04.3'' E 21°20'17.4'', 18.VI.2007/17.VI.2008. MSS on a northern road slope in a *Quercus* forest on schistose and breaked substrate with gravel and hazel-black clay.

4: West Macedonia, nomos Kastoriá, Oros Vitsi near Oxiá, 1580 m, N 40°37'11.5'' E 21°22'15.0'', 18.VI.2007/17.VI.2008. Habitat in a small valley (N-S direction) in a *Fagus* forest on schistose substrate with black humus.

5: West Macedonia, nomos Kastoriá, Oros Vório Kotíli, 1325 m, N 40°21'10.8'' E 21°01'92.9'', 17.VI.2007/16.VI.2008. MSS at a NW road slope in a *Fagus-Abies* forest on schistose substrate.

6: West Macedonia, nomos Kastoriá, Oros Vório near Kotíli, 1520 m, N 40°20'27.2'' E 20°59'49.9'', 17.VI.2007/16.VI.2008 and 16.VI.2008/14. VI.2010. MSS at an ENE road slope in a *Pinus-Abies-Fagus* forest on flysch substrate with black humus and clay.

7: West Macedonia, nomos Kastoriá, Oros Vório near Pefkófito, 1130 m, N 40°20'55.7'' E 20°56'20.0'', 16.VI.2008. MSS at the NW slope of a valley in a *Fagus-Pinus* forest on flysch substrate with deep, black humus.

8: Epirus, nomos Thesprotía, Oros Soulíou near Agía Kiriakí, 770 m, N 39°29'32.7'' E 20°35'12.0'', 20.VI.2007/21.VI.2008. MSS at a WSW road slope in *Abies* forest on limestone substrate with black humus and red clay.

9: Epirus, nomos Árta, Oros Athamáno, street Athamánio-Theodóriana, 1250 m, N 39°23'28.1'' E 21°11'52.7'', 2.VI.2007/14.VI.2008. MSS at a S mountain slope in *Abies* forest on limestone substrate with black humus.

10: Epirus, nomos Árta, Kakarditza, Melissourgi, Oros Mesovouni c/o spring, 1200 m, N 39°29'08.4'' E 21°08'39.6'', 15.VI.2008/16.VI.2010. MSS at a W road slope (out of forest) on limestone substrate with red clay.

11: Epirus, nomos Árta, Kakarditza, Melissourgi, Oros Tourla, 1420 m, N 39°28'30'' E 21°10'02'', 15.VI.2008/16.VI.2010. MSS at a NW mountain slope on limestone substrate without forest (Fig. 3). MSS with hazel-red clay.

12: Epirus, nomos Árta, Oros Gerakovouni, Ágnanda, Katarraktes, 1200 m, N 39°27'28'' E 21°07'30'', 14.VI.2008/15.VI.2010. MSS at a SW mountain slope on limestone substrate without forest. MSS with black humus and red clay.

13: Thessaly, nomos Kardítsa, Belokomíti, Kremasta valley, Spilia Ghaki, 1100 m, N 39°14'25.9'' E 21°42'35.5'', 12.VI.2007/12.VI.2008 and 12.VI.2008/11.VI.2010. Traps inside the Ghaki cave.

14: Thessaly, nomos Kardítsa, Belokomíti, Kremasta valley, near Spilia Ghaki, 1060 m, N 39°14'26.6'' E 21°42'37.1'', 12.VI.2008/11.VI.2010. MSS on a WSW slope of the Kremasta valley, in *Abies* forest on limestone substrate with black humus and hazel clay.

15: Thessaly, nomos Kardítsa, Oros Tripitsa, Karvasarás, 1035 m, N 39°14'51.9'' E 21°40'27.3'', 13.VI.2008/12.VI.2010. MSS on a NW slope in a small valley with stream. *Abies* forest on limestone substrate with black humus.

16: Thessaly, nomos Kardítsa, Oros Voutsikaki, Aetofolia, 1510 m, N 39°16'22.4'' E 21°40'00.6'', 13.VI.2008/12.VI.2010. MSS at an ESE slope in *Abies* forest with black humus under limestone scree.

17: Thessaly, nomos Kardítsa, Oros Voutsikaki, Mega Revma, 1125 m, N 39°15'16.6'' E 21°40'00.0'', 13.VI.2008/12.VI.2010. MSS at a W mountain slope, with gravel and hazel-red clay under limestone scree.

18: Thessaly, nomos Kardítsa, OrosKatsandoni, Karítsa, branch to Vraggiana, 1055 m, N 39°15'01.4'' E 21°41'51.4'', 12.VI.2008/11.VI.2010. MSS at a NW road slope in *Abies* forest on limestone-sandstone substrate with red clay

19: Central Greece, nomos Evritanía, Oros Kokinias, pass near Livadáki, 1495 m, N 38°42'54.6'' E 21°53'05.9'', 12.VI.2007/4.VI.2008. MSS at an E road slope without forest on limestone substrate with hazel clay. Traps were placed near the fissure network of the bedrock.

20: Central Greece, nomos Evritanía, street Agrínio-Karpeníssi, Agios Georgios, Fragistanorema Valley, 500 m, N 38°54'50.4'' E 21°36'05.2'', 10.VI.2010/30.V.2011. MSS at the SE mountain slope of a small valley with stream in Mediterranean maquis with black humus and red clay.

21: Central Greece, nomos Evritanía, street Agrínio-Karpeníssi, Agios Georgios, Soufli Rachi, 575 m, N 38°53'57.4'' E 21°35'11.7'', 10.VI.2010/30.V.2011. An apparently very dry MSS at a SSW mountain slope in Mediterranean maquis on limestone substrate.

22: Central Greece, nomos Évia, Oros Dírfi, 905 m, N 38°35'56.9'' E 23°50'23.1'', 5.VI.2010/25.V.2011. MSS at the S slope in *Abies* forest on limestone substrate with black humus (Fig. 4).

23: Central Greece, nomos Évia, Seta, Oros Lamna, 910 m, N 38°33'41.5'' E 23°55'12.6'',

7.VI.2010/26.V.2011. Habitat at a WNW slope in *Abies* forest with black humus on limestone substrate.

24: West Greece, nomos Etolía-Akarnanía, Oros Sérekas, near Megálo Spilió, 1000 m, N 38°46'06.1'' E 20°57'22.3'', 3.VI.2007/2.VI.2008 and 2.VI.2008/18.VI.2010. Subterranean traps were placed along a limestone wall just out of the Megálo Cave in a *Quercus ilex* forest at the N slope of Sérekas Mt. The traps were placed near the fissure network of the bedrock; a number of *Q. ilex* roots were present.

25: West Greece, nomos Etolía-Akarnanía street Kentrikí-Anavrití, 975 m, N 38°33'05.6'' E 21°54'28.4'', 9.VI.2007/3.VI.2008. MSS at a SE road slope on limestone substrate with red and grey clay in a Mediterranean maquis.

26: West Greece, nomos Etolía-Akarnanía street Kentrikí-Anavrití, 900 m, N 38°32'47.8'' E 21°54'09.8'', 9.VI.2007/3.VI.2008. MSS with red clay at an ENE road slope with limestone substrate in a Mediterranean maquis.

27: West Greece, nomos Etolía-Akarnanía, Nafpaktos, Oros Ardinis, 950 m, N 38°38'35.6'' E 21°50'38.4'', 4.VI.2008/8.VI.2010. MSS at a W slope in *Abies* forest with black humus under limestone scree.

28: West Greece, nomos Etolía-Akarnanía, Nafpaktos, Dorvitsiá, 760 m, N 38°33'18.2'' E 21°46'54.3'', 9.VI.2010/28.V.2011. MSS at a WSW road slope on limestone substrate in a Mediterranean maquis. Subterranean traps were placed near the fissure network of the bedrock.

29: West Greece, nomos Etolía-Akarnanía, Nafpaktos, Perivolia, 800 m, N 38°29'26.3'' E 21°51'28.4'', 9.VI.2010/28.V.2011. MSS at a W slope in a Mediterranean maquis with red clay under limestone scree.

30: West Greece, nomos Etolía-Akarnanía, Nafpaktos, street Perivolia-Ano Hora, 1235 m, N 38°31'59.4'' E 21°50'56.0'', 9.VI.2010/28.V.2011. MSS at a W mountain slope in *Abies* forest on limestone-sandstone substrate with a large amount of red clay.

31: West Greece, nomos Etolía-Akarnanía, Oros Míti, street Agrínio-Karpeníssi, near Chouni, 500 m, N 38°50'22.2'' E 21°32'53.8'', 10.VI.2010/29.V.2011. MSS at a WSW slope of a large valley in Mediterranean maquis on limestone substrate with dark clay.

32: West Greece, nomos Etolía-Akarnanía, Oros Míti, street Agrínio-Karpeníssi, outside Chouni, 630 m, N 38°50'17.0'' E 21°32'19.4'', 10.VI.2010/29.V.2011. MSS at a WNW mountain slope in an ancient limestone quarry between Mediterranean maquies and *Abies* forest. The substrate was covered with black humus or red clay.

33: West Greece, nomos Ahaïa, Oros Aroánia, Asopos Valley, Aghridhi, 940 m, N 38°02'15.6'' E 22°15'14.1'', 10.VI.2008/31.V.2010. Subterranean traps were placed at the SE mountain slope in a small valley with a small stream in Mediterranean maquis. The substrate consisted of schistose rocks mixed with limestone, black humus and hazel clay.

34: West Greece, nomos Ahaïa, Oros Aroánia, Asopos Valley, Oros Livadhaki, 1495 m, N 37°59'19.8'' E 22°17'28.2'', 10.VI.2008/31.V.2010. MSS at the SW road slope in *Abies* forest on limestone substrate. Black humus occurred in the forest and red clay at the road slope.

35: West Greece, nomos Ahaïa, Anastasi (Klitoria), 1160 m, N 37°53'53.3'' E 22°00'39.3'', 3.VI.2010/21.V.2011. MSS on a W road slope in Mediterranean maquis on limestone substrate with hazel clay.

36: West Greece, nomos Ahaïa, Aroania vill., Agia Varvara, 1085 m, N 37°52'46.1'' E 22°00'28.9'', 3.VI.2010/21.V.2011. MSS at a NNE road slope in Mediterranean maquis on limestone substrate with black clay.

37: West Greece, nomos Ahaïa, Oros Skepasto, Korfes, 910 m, N 38°05'06.0'' E 22°02'01.9'', 4.VI.2010/20.V.2011. MSS at a W mountain slope in a small valley with little stream, *Platanus*, *Robinia pseudacacia* and *Pinus* trees (Fig. 5). MSS in limestone with black clay mixed with black humus.

38: West Greece, nomos Ahaïa, Oros Skepasto, Valta, Fontana, 910 m, N 38°06'58.7'' E 22°03'33.6'', 4.VI.2010/20.V.2011. MSS at a SE mountain slope in a mixed forest on limestone substrate.

39: West Greece, nomos Ahaïa, Oros Skepasto, 1150 m, street Kerpini-Plataniotisa, N 38°04'49.8'' E 22°04'47.2'', 4.VI.2010/20.V.2011. MSS at a W road slope in a Mediterranean maquis on limestone substrate with wet red clay (Fig. 6).

Fig. 3. Oros Tourla (site 11), habitat of *Mediterranea ionica* and *Allaegopis meridionalis* (photo by P. M. Giachino).

Fig. 4. *Abies* forest at the south slope of Oros Dírfi (site 22), habitat of *Zonites euboeicus*, *Schistophallus samius* and *Lindholmiola lens* (photo by P. M. Giachino).

Fig. 5. Western mountain slope in a small valley of Oros Skepasto (site 37), locality of the undescribed *Josephinella* species (photo by P. M. Giachino).

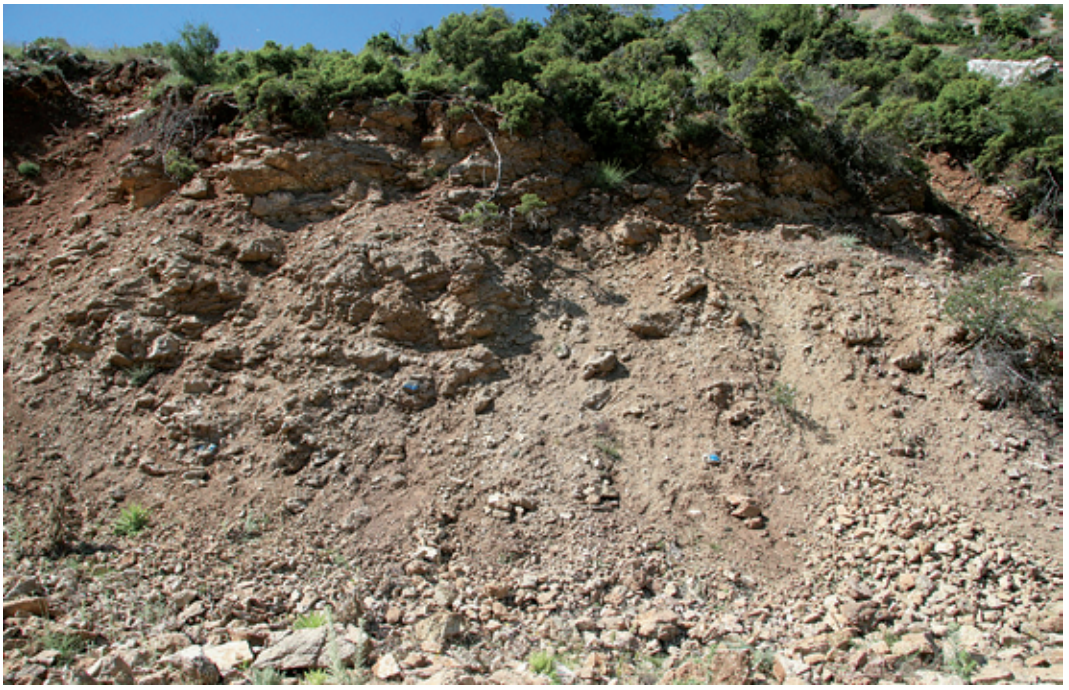

Fig. 6. Example for a trap site at a road slope (site 39, Oros Skepasto; photo by P. M. Giachino). Note the blue spots tracing the trap localities.

40: West Greece, nomos Ahaïa, street Kasteli-Kalavrita, 1040 m, N 37°53'02.5" E 22°02'49.4", 3.VI.2010/21.V.2011. MSS at an E national road slope in a Mediterranean maquis on limestone substrate with wet red clay.

41: West Greece, nomos Ilía, Oros Mínthi near Krioneri, 840 m, N 37°28'13.7" E 21°48'10.7", 6.VI.2007/8.VI.2008. MSS at a SW road slope in a Mediterranean maquis on limestone substrate with red and grey clay.

42: West Greece, nomos Ilía, Oros Mínthi near Krioneri, 880 m, N 37°28'15.0" E 21°48'03.9" 6.VI.2007/8.VI.2008. MSS at a S road slope in a Mediterranean maquis on limestone substrate with red clay.

43: West Greece, nomos Ilía, Oros Mínthi near Krioneri, 900 m, N 37°28'15.1" E 21°47'58.3" 6.VI.2007/8.VI.2008. MSS at a SSE road slope in a Mediterranean maquis on limestone substrate with wet red clay.

44: Peloponnese, nomos Korinthía, Oros Saítas, cave at the street, 1140 m, N 37°51'50.6" E 22°15'23.7", 6.VI.2008/1.VI.2010. Traps were placed in a deep pit (up to 50 m) in a limestone cave in *Abies* forest.

45: Peloponnese, nomos Argolída, Oros Oligirthos, 1245 m, N 37°47'51.8" E 22°24'16.5", 2.VI.2010/22.V.2011. MSS at a S road slope in *Abies* forest on limestone substrate.

46: Peloponnese, nomos Arkadía, Dimitsána, Artozínos, 1100 m, N 37°38'52.8" E 22°01'40.9", 7.VI.2007/7.VI.2008. MSS at a NW mountain slope in a small valley with *Robinia pseudacacia*, *Acer* and *Pinus* trees. Underground consisting of sandstone with very wet black humus.

47: Peloponnese, nomos Arkadía, Langádia, Valtessiníko, 1160 m, N 37°42'04.1" E 22°06'43.1", 6.VI.2007/6.VI.2008. *Abies* forest on limestone.

Results

A total of 21 gastropod species was recorded representing 9 families in the traps of the 47 sites. Most species and most specimens belong to the families Oxychilidae and Zonitidae suggesting that many of the recorded individuals show a hygopean way of life.

Systematic list of records (taxonomy follows that of Fauna Europaea, within families genera and species are listed alphabetically)

Pomatiidae

Pomatias elegans (O.F. Müller, 1774)
Thessaly, nomos Kardítsa: site 14 (6 specimens); site 15 (1 specimen).

Clausiliidae

Albinaria (*Graja*) *senilis epirotica* (Mousson, 1859)
West Greece, nomos Etolía-Akarnanía: site 24 (1 specimen in 2008, 1 specimen in 2010).

Oleacinidae

Poiretia compressa (Mousson, 1859) (Fig. 7)
Epirus, nomos Árta: site 9 (10 specimens); site 12 (2 specimens); Central Greece, nomos Evritanía: site 20 (2 adult and 1 juvenile specimens); site 21 (30 specimens); West Greece, nomos Etolía-Akarnanía: site 24 (1 specimen in 2008); site 27 (2 juvenile specimens); site 28 (8 specimens); site 29 (7 specimens); site 30 (1 specimen); site 31 (11 specimens); site 32 (2 specimens).

Oxychilidae

Aegopinella minor (Stabile, 1864)
West Macedonia, nomos Kastoriá: site 2 (1 specimen); site 3 (1 specimen).

Mediterranea depressa (Sterki, 1880)
West Macedonia, nomos Flórina: site 1 (8 juvenile and adult specimens).

Mediterranea inopinata (Ulicny, 1887)
West Macedonia, nomos Kastoriá: site 6 (1 specimen in 2008).

Mediterranea ionica (Riedel & Subai, 1978)
West Macedonia, nomos Kastoriá: site 4 (1 specimen); site 5 (1 specimen); site 7 (1 specimen); Epirus, nomos Thesprotía: site 8 (1 specimen); nomos Árta: site 9 (1 specimen); site 10 (1 specimen); site 11 (1 specimen); site 12 (1 specimen); Central Greece, nomos Evritanía: site 20 (1 adult, 2 juvenile specimens); nomos Évia: site 23 (1 specimen); West Greece, nomos Etolía-Akarnanía: site 24 (1 specimen each in 2008 and 2010); site 31 (1 specimen); site 32 (1 specimen); nomos Ahaïa: site 34 (1 specimen); site 39 (1 specimen).

Fig. 7. *Poiretia compressa*, widely distributed in Greece and Albania, is one of the most frequently recorded species in the traps (photo by F. Welter-Schultes, AnimalBase).

Morlina glabra (Rossmässler, 1835) (Fig. 8)
West Macedonia, nomos Kastoriá: site 6 (1 adult and 2 juvenile specimens in 2010); Epirus, nomos Árta: site 9 (2 specimens); Thessaly, nomos Kardítsa: site 13 (1 specimen in 2008, 6 specimens in 2010); West Greece, nomos Etolía-Akarnanía: site 26 (1 specimen); nomos Ahaïa: site 33 (1 juvenile specimen); site 38 (26 specimens); Peloponnese, nomos Argolída: site 45 (1 juvenile specimen).

Schistophallus samius (E. von Martens, 1889)
Central Greece, nomos Évia: site 22 (4 specimens); Peloponnese, nomos Korinthía: site 44 (2 specimens); nomos Arkadía: site 46 (1 specimen); site 47 (18 adult and juvenile specimens).

Zonitidae
Allaegopis meridionalis meridionalis Riedel, 1986
Epirus, nomos Árta: site 11 (18 adult and juvenile specimens); West Greece, nomos Etolía-Akarnanía: site 27 (2 specimens).

Allaegopis skandergianus (Polinski, 1924)
West Macedonia, nomos Kastoriá: site 3 (1 specimen); site 6 (2 specimens).

Allaegopis transiens (Mousson, 1859)
West Macedonia, nomos Kastoriá: site 5 (1 specimen); Epirus, nomos Árta: site 12 (2 juvenile specimens); Thessaly, nomos Kardítsa: site 13 (5 specimens in 2010); site 16 (11 specimens); site 17 (6 specimens).

Zonites euboeicus Kobelt, 1878
Central Greece, nomos Évia: site 22 (46 adult and juvenile specimens).

Vitrinidae
Semilimacella bonellii reitteri (O. Boettger 1880)
Thessaly, nomos Kardítsa: site 18 (1 specimen).

Fig. 8. *Morlina glabra* lives in the MSS or in caves but is also active at the soil surface (photo by F. Welter-Schultes, AnimalBase).

Fig. 9. *Lindholmiola lens*, distributed in eastern Albania, most parts of Greece and West Turkey, is the most frequently recorded representative of Helicodontidae (photo by F. Welter-Schultes, AnimalBase).

Helicidae

Thiessea euboeae (Frauenfeld, 1867)
Central Greece, nomos Évia: site 23 (1 specimen).

Josephinella sp.affin. eliaca (Kobelt, 1893)
West Greece, nomos Ahaïa: site 33 (1 juvenile specimen); site 35 (4 specimens).

Josephinella sp.nov.
West Greece, nomos Ahaïa: site 37 (1 specimen). Only empty and partly eroded shells of this species were previously known, suggesting that it has a subterranean way of life.

Helicodontidae

Helicodonta obvoluta albanica A. J. Wagner, 1914
West Greece, nomos Etolía-Akarnanía: site 26 (1 specimen).

Lindholmiola corcyrensis (Rossmässler, 1838)
West Macedonia, nomos Kastoriá: site 6 (1 juvenile specimen each in 2008 and 2010); Thessaly, nomos Kardítsa: site 18 (1 specimen); Central Greece, nomos Evritanía: site 19 (3 specimens); West Greece, nomos Etolía-Akarnanía: site 25 (16 juvenile specimens).

Lindholmiola lens (A. Ferussac, 1832) (Fig. 9)
Central Greece, nomos Évia: site 22 (12 specimens); West Greece, nomos Ahaïa: site 36 (6 specimens); site 38 (4 specimens); site 40 (9 specimens); nomos Ilía: site 41 (5 juvenile specimens); site 42 (2 specimens); nomos site 43 (2 specimens); Peloponnese, nomos Argolída: site 45 (4 adult and 3 juvenile specimens).

Hygromiidae

Monacha parumcincta (Menke, 1828)
Central Greece, nomos Evritanía: site 20 (1 adult specimen).

Discussion

Ecological data for most snail species from the Balkan Peninsula are still rare. Until today most publications concern revisions of higher taxa and descriptions of species while ecological data on the species are often not available. For this background, the publication of data gained in subterranean habitats helps to fill a gap. The state of knowledge of gastropods differs however between various subterranean habitats. While several gastropod species of the Balkan Peninsula were described or reported from caves (e.g. GITTENBERGER 1978, 1985, 2008, KUŠČER 1932, NEGREA & BOITAN 2001, RIEDEL 1992, 1996, SCHÜTT 1968, 1970, STURANY 1904, SUBAI & SZEKERES 1999, WAGNER 1914) only a few studies concern the subterranean environment and the MSS. One reason for the poorer knowledge of the MSS fauna may be the much more difficult access to this habitat compared with many caves. Moreover the role of the MSS was probably underestimated in the past because many species were occasionally collected under stones at the soil surface or empty shells were found at the surface.
RIEDEL (1996) summarizes the knowledge of subterranean species of Zonitidae s.l. and stressed that many species of this group live permanently in deep soil, un-

der rock boulders or in rock fissures. In his paper, RIEDEL (l.c.) mentioned 38 subterranean species of Zonitidae s.l. from Greece, three of which were recorded in our investigation (*M. ionica*, *S. samius* and *M. glabra*). RIEDEL & SUBAI (1978) assume that *M. ionica* is a "semisubterranean" species, specimens from the type locality were collected in interstices between loose boulders, under stones and rarely in duff between roots of *Olea*. The genera *Zonites* and *Allaegopis* are regarded as MSS dwellers by RIEDEL (1996), but at the same time the author termed representatives of *Allaegopis* and *Aegopinella* "trogloxenous" (found only occasionally in caves or subterranean passages). In contrast, species of *Aegopinella* are subterranean in the sense of NEGREA (1975). A further genus of Zonitidae s.l. with many MSS dwelling species on the Balkan Peninsula is *Vitrea* (DELI & SUBAI 2011). RIEDEL (1996) listed six subterranean species of *Vitrea* from Greece which were not recorded in our traps however.

But not only Zonitidae and related taxa may be regarded as MSS dwellers. At least the recorded representatives of Clausiliidae, Helicidae and Helicodontidae may also spend longer periods of their life in subterranean habitats or live in caves respectively. On the other hand *Pomatias elegans* or *Poiretia compressa* are well known as living on the soil surface and would retreat to deeper layers in the rock boulder only during hot and dry periods.

However, one should avoid a classification of the recorded species as "subterranean" and "trogloxenous" taxa, because the long period of trap placement does not allow one to distinguish whether species retreated from the dry soil surface or stayed longer (or permanently) in the depth. According to RIEDEL (1996) the main adaptation to a cave environment is an increasing paler, thinner and fragiler, often translucent shell of the snail. Several of the snails recorded in the present study meet these characters (three *Mediterranea* species, *S. samius*), though such shells could be found at the soil surface too. Some species with a harder shell, e.g. the undescribed *Josephinella* sp., may live in the subterranean habitat as well, because only empty shells were found at the surface so far.

Considering the total catch the enormous size of most trapped species is conspicuous. Small sized taxa like species of the genus *Vitrea* or of the family Argnidae were not recorded at all in the traps, though their representatives may live in subterranean habitats (DELI & SUBAI 2011, SUBAI 2008, 2011). Therefore we must conclude that not all snail taxa may be trapped adequately with this method.

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