

New records of freshwater and land molluscs from Lebanon

(Mollusca: Gastropoda & Bivalvia)

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Abstract: A total of 17 freshwater and 33 land gastropod species as well as 6 small clams from different habitats were found during a study of limnic and terrestrial molluscs in central and northern Lebanon. New records for Lebanon or the Levant countries include *Stagnicola* cf. *berlani* (Bourguignat, 1870) sensu Kruglov, 2005, *Planorbis carinatus* O. F. Müller, 1774, and *Potamopyrgus antipodarum* (J. E. Gray, 1843) as well as the clams *Musculium lacustre* (O. F. Müller, 1774), *Pisidium amnicum* (O. F. Müller, 1774), and *Pisidium tenuilineatum* Stelfox, 1918. Among the land snails, *Orculella mesopotamica riedeli* Hausdorf, 1996, *Buliminus damascensis* (Pallary, 1929), *Turanena benjamitica* (Benson, 1859), *Sphincterochila fimbriata* (Bourguignat, 1852), and *Monacha* cf. *compingtae* (Pallary, 1929) are new for Lebanon.

Key words. Gastropoda, Bivalvia, Lebanon, freshwater molluscs, landsnails, slugs.

Introduction

Our current knowledge of the land snails of Lebanon is based on the work of Georges and Henriette Tohmé (TOHMÉ & TOHMÉ 1988). In their review, the authors also acknowledge – apart from their own findings – the older reports by GERMAIN (1921) and PALLARY (1929, 1939). Since then, only a little information has been added to these works. The greater part of more recent information is concerned with species distribution, taxonomic revisions, and review papers dealing with the molluscan faunas in neighbouring countries (HELLER 1984, HAUSDORF 1996, SCHÜTT 2001).

To date, there is no work summarizing the freshwater molluscs of Lebanon. SCHÜTT (1983) presented results from field excursions by R. KINZELBACH in the 1970s (KINZELBACH 1980), taking into consideration the older works of GERMAIN (1921, 1922) and PALLARY (1939). Focussing on the Orontes river system, SCHÜTT also reported on freshwater gastropods and bivalves from the Litani drainage area as well as from smaller flowing waters which drain directly into the Mediterranean Sea. More recent studies are by KINZELBACH (1986, 1992) concerning selected limnic taxa and by SCHÜTT (1993, SCHÜTT & ŞEŞEN 1993) dealing with prosobranchs, and these complement the earlier findings of the distribution of freshwater mollusca in Lebanon.

Material and methods

Several areas in Northern and Central Lebanon were sampled in 2006. Special emphasis was laid on the Lebanon Mountains and their foothills up to altitudes of 3000 metres as well as on the Bekaa plain. Further sampling points are located at the edge of the Chouf and the northern coast



Fig. 1. Map of Lebanon and sampling localities.

area (Fig. 1). In addition to the author, Kathrin BÖBNECK (Erfurt-Vieselbach), Jörg WEIPERT (Plaue) and Dirk FRENZEL (Sonneberg) took part in the field work.

Freshwater gastropods were collected by hand from hard substrates or were collected with sieves from submerged vegetation. Smaller gastropod and bivalve species were collected with sieves from soft substrates. In addition to visual inspection of the upper soil layers, vegetation and rocks and stones, land snails were also collected utilizing sieve samples. Live animals were fixed with 70% ethanol. Determination is based on shell morphology and, where necessary, on genital preparations. Clams were macerated prior to determination by boiling in 3% sodium hydroxide solution.

Results and discussion

A systematic account of all molluscs collected in Lebanon in 2006 (together with the full species names including author and year of description) is given in the Annex.

Freshwater molluscs (including *Oxyloma cf. elegans*)

The diversity of the mollusc fauna of the small flowing waters and springs which we studied was generally poor. The Palaearctic faunal elements *Galba truncatula*, *Pisidium casertanum* and *P. personatum* inhabit preferentially (but not exclusively) springs and small creeks in the mountains of the Mediterranean as well as of the Lebanon. Among these forms, *Galba truncatula* was reported from the Orontes by SCHÜTT (1983) but is likely to be more widely distributed in Lebanon. The two clam species *Pisidium casertanum* and *P. personatum* were now found in one and two springs, respectively, in the Lebanon Mountains at an altitude of

Table 1. Freshwater molluscs (and *Oxyloma* cf. *elegans*). – 1: Fnaideq (Prov. North Lebanon), woodland Qammouah, spring and effluent, dwindling spring creek, muddy, low water volume, open, 34°28'36''N, 36°14'33''E, 1,550 m a.s.l. (Fig. 7), 26.v.2006; 2: Zgharta (Prov. North Lebanon), right branch of the Nahr Abou Ali above Zgharta, eutrophic, rocky, mean water volume, 34°23'32''N, 35°53'42''E, 80 m a.s.l., 24.v.2006; 3: Ehden (Prov. North Lebanon), Horsh Ehden, small chalk spring marsh at the edge of oak mixed forest, muddy, very low water volume, open, app. 34°18'N, 35°60'E, 1,500 m a.s.l., 25.v.2006; 4: Hadchit (Prov. North Lebanon), Nahr Quadicha, eutrophic, rocky, mean water volume, steep incline, shaded, 34°14'49''N, 35°59'25''E, 1,000 m a.s.l., 30.v.2006; 5: Ain Zepte (Prov. Bekaa), right branch of the Litani, not eutrophic, reconstructed, mean water volume, steep incline, jagged tree-lined, 33°37'38''N, 35°42'58''E, 980 m a.s.l., 31.v.2006; 6: Lahbiye (Prov. Mt. Lebanon), Nahr ed Damour above confluence with Nahr es Safa, slightly eutrophic, gritty-sandy, high water volume, tree-lined, 33°41'50''N, 35°28'45''E, 40 m a.s.l., 31.v.2006; 7: Lahbiye (Prov. Mt. Lebanon), Nahr es Safa near Nahr ed Damour confluence, slightly eutrophic, gritty-sandy, mean water volume, wooden hem, 33°41'50''N, 35°28'45''E, 40 m a.s.l., 31.v.2006; 8: Ras el Assi (Prov. Bekaa), strongly gushing karstic spring and its effluent to the Nahr el Assi, rocky, partly sandy-gritty, locally submerged vegetation, tree-lined, 34°21'06''N, 36°22'36''E, 680 m a.s.l., 29.v.2006. 9: Ras el Assi (Prov. Bekaa), spring creek to Nahr el Assi, strongly overgrown with cane thickets, sandy-gritty, locally muddy, medium water volume, no trees on banks, 34°21'06''N, 36°22'36''E, 680 m a.s.l., 29.v.2006. 10: El Hermel (Prov. Bekaa), Nahr el Assi downstream app. 2 km, rocky, partly sandy-gritty, in reconstructed canal (fish farming), locally sandy-muddy, slightly eutrophic, high water volume, jagged tree-lined, 34°24'36''N, 36°27'06''E, 590 m a.s.l., 29.v.2006; 11: Bab Mareaa (Prov. Bekaa), Lake Quaraaon (dam lake), highly eutrophicated (algal bloom), stony, shallow coast without woods, at drift line, 33°34'41''N, 35°41'27''O, 860 m a.s.l., 31.v.2006; 12: Aammaiq (Prov. Bekaa), extended spring area, many larger ponds with macrophytic vegetation, not eutrophicated, shallow shores with loose or absent wood, muddy-sandy, 33°43'42''N, 35°47'09''O, 870 m a.s.l., 31.v.2006. – open circle = empty shells.

	1	2	3	4	5	6	7	8	9	10	11	12
<i>Theodoxus jordani</i>								●		○		
<i>Melanopsis buccinoidea</i>							●	●	●	●		
<i>Radomaniola gaillardotii</i>								●	●	●		
<i>Potamopyrgus antipodarum</i>					●	●						
<i>Pseudobithynia kathrini</i>									●	●		
<i>Pseudobithynia levantica</i>										●		
<i>Pseudobithynia amiqensis</i>											○	●
<i>Valvata sauleyi</i>										●	○	●
<i>Lymnaea stagnalis</i>												●
<i>Radix auricularia</i>												●
<i>Stagnicola</i> cf. <i>berlani</i>												●
<i>Galba truncatula</i>	●	●										
<i>Physella acuta</i>				●								
<i>Planorbis carinatus</i>												●
<i>Gyraulus piscinarum</i>										●	○	
<i>Gyraulus bekaensis</i>												●
<i>Ancylus fluviatilis</i> s.l.								●		○		
<i>Musculium lacustre</i>										●		●
<i>Pisidium amnicum</i>										●		
<i>Pisidium subtruncatum</i>										●		
<i>Pisidium personatum</i>	●		●						●			
<i>Pisidium casertanum</i>	●								●	●		
<i>Pisidium tenuilineatum</i>									●	●		
<i>Oxyloma</i> cf. <i>elegans</i>									●			

1,500 m a.s.l. Neither species had been reported from Lebanon until now. However, *Pisidium casertanum* is comparatively widely distributed in Syria and was also reported from Israel, the Arabian Peninsula and – together with *P. personatum* – from Northern Africa (KUIPER 1964, SCHÜTT 1983, SCHÜTT et al. 1993, NEUBERT 1998). *Physella acuta* and *Melanopsis buccinoidea* have a Mediterranean distribution. Specimens of the latter species from Nahr es Safa have a completely smooth surface without any ribs and nodes. *Potamopyrgus antipodarum*, which was originally introduced from New Zealand via North America to

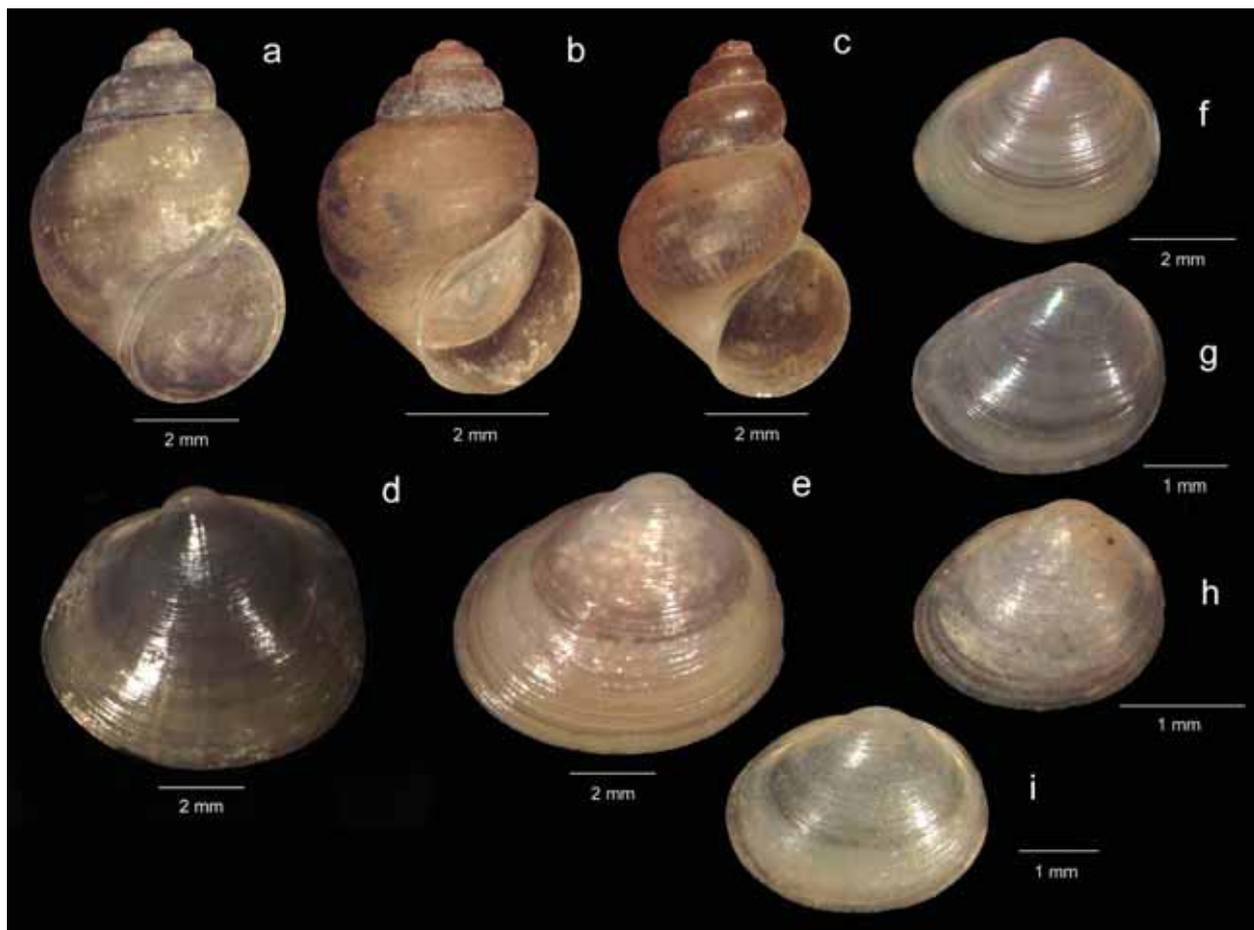


Fig. 2. **a.** *Pseudobithynia amiqensis* (Locality: Bab Mareaa). – **b.** *Pseudobithynia levantica* (Locality: El Hermel). – **c.** *Pseudobithynia kathrini* (Locality: Ras el Assi). – **d.** *Musculium lacustre* (Locality: El Hermel). – **e.** *Pisidium amnicum* (Locality: El Hermel). – **f.** *Pisidium casertanum* (Locality: El Hermel). – **g.** *Pisidium subtruncatum* (Locality: El Hermel). – **h.** *Pisidium tenuilineatum* (Locality: Ras el Assi). – **i.** *Pisidium personatum* (Locality: Fnaideq).

Europe in the 19th century, is now well established in the Mediterranean as well as in large parts of Central Europe. Although this species was not reported until the 1980s from the drainage area of the flowing waters of the Levant, its local occurrence was only a matter of time. To date, the species is presumably more widely distributed, as is suggested by the first reports from a small tributary river of the Litani and from the Nahr ed Damour.

The mollusc fauna of the drainage area of the Orontes and especially of the Syrian part is well known due to the work of SCHÜTT (1983). Accordingly, *Theodoxus jordani* from the Levant is also found in nearly all the larger flowing water systems of Lebanon, which is also suggested by a report of ALOUF (1998). *Melanopsis buccinoidea* and *Radomaniola gaillardotii* (= *Orientalina gaillardotii*, SZAROWSKA 2006) inhabit the headwater of the Nahr el Assi (Fig. 8), including some springs and their effluent waters, in relatively high abundance. Like *Theodoxus jordani*, both species are also present in the drainage area of the Litani (SCHÜTT 1983, 1993). The same study reports *Valvata saulcyi* from the Lebanese headwater of the Nahr el Assi (SCHÜTT 1983). According to the ecological findings of our investigations from 2006, this snail prefers the slow-flowing sections there. Additionally, two species of the Bithyniidae were found at the sampling localities 9 and 10. They were newly described by GLÖER & BÖBNECK (2007a) on the basis of differential comparisons with reported



Fig. 3. **a.** *Planorbis carinatus* (Locality: Aammiq). – **b.** *Gyraulus bekaensis* (Locality: Aammiq). – **c.** *Stagnicola* cf. *berlani* (Locality: Aammiq).

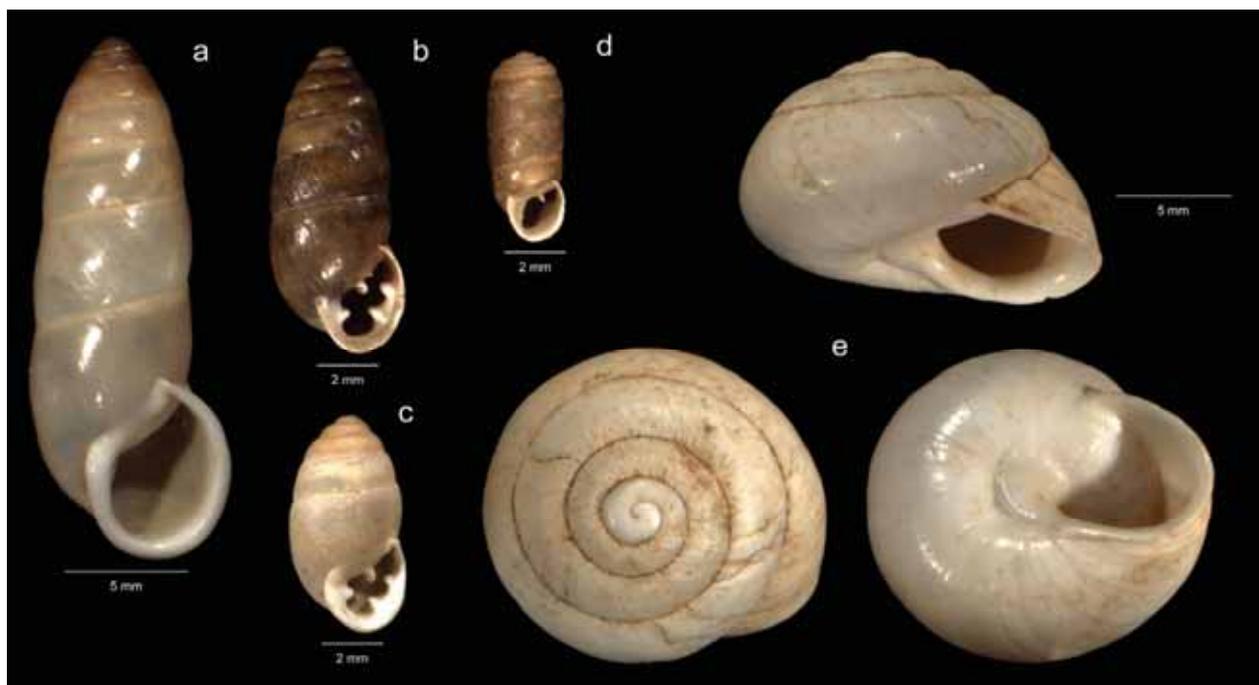


Fig. 4. **a.** *Buliminus damascensis* (Locality: Ras el Assi). – **b.** *Euchondrus* cf. *ledereri* (Locality: Jabal el Mekmel). – **c.** *Euchondrus* spec. (Locality: Nahr Quadicha). – **d.** *Orculella mesopotamica riedeli* (Locality: Ras el Assi). – **e.** *Sphincterochila fimbriata* (Locality: Ras el Assi).



Fig. 5. a (upper row). *Monacha* cf. *compingtae* (Locality: Aammiq). – b (lower row). *Monacha* sp. (Locality: Jabal el Mekmel).

species from the drainage area of the Orontes and the Litani such as *Bithynia badiella* (Küster, 1853) and *Bithynia phialensis* (Conrad, 1852). The headwaters of the Nahr el Assi below El Hermel are therefore inhabited by the species *Pseudobithynia kathrini* (Fig. 2c) and *Pseudobithynia levantica* (Fig. 2b), which live sympatrically on sandy-muddy substrates. Only the former species was found, however, by a cane thicket in a heavily overgrown spring creek, but in great abundance. Planorbid snails were found only sparsely in the course of the present study. For example, *Gyraulus piscinarum* was present in low abundance in the fine sediment of slow-water sections of the tributaries of the main stream of the Nahr el Assi at El Hermel. The occurrence of *Ancylus fluviatilis* s.l. in fast-running sections of the upper Nahr el Assi drainage area is dwindling (SCHÜTT 1983, KINZELBACH 1986). Note, however, that the taxonomy and nomenclature of *Ancylus fluviatilis* is presently under revision. In any case, the Lebanon constitutes the absolute south-east border of the distribution of this western Palearctic taxon. Furthermore, we here report several clam taxa from the drainage area of the upper Nahr el Assi. To the best of our knowledge, this is the first report on the Sphaeriidae from Lebanon. In addition to the species *Pisidium casertanum* and *P. personatum* already mentioned, *P. subtruncatum* and *Musculium lacustre* were found sporadically in the fine sediment of slow-water sections of the tributaries of the main stream. Both species have a Palearctic distribution and were also reported three times by SCHÜTT (1983) for the Syrian parts of the Nahr el Assi. Moreover, *P. subtruncatum* is also reported from Northern Africa (KUIPER 1964). Additionally, we here report for the first time the occurrence of *Pisidium tenuilineatum* in the Levant; we have found one live specimen at each of localities 9 and 10. This very small (valve length: 2 mm) and, hence, easily overlooked species is well known from the European Mediterranean region, the Moroccan Atlas mountains, and sparsely in springs. Our findings of this species now bridge the distribution gap between reports from



Fig. 6a (left). *Stagnicola* cf. *berlani* (Locality: Aammiq): Copulatory organ: left female sex tract, right male sex tract, above cross-section through prostate gland. – Fig. 6b (right). *Oxyloma* cf. *elegans* (Locality: Ras el Assi): Copulatory organ with vagina and bursa copulatrix (left part), penis and vas deferens (right part).

Turkey and two findings from Northern Israel at the southern edge of its known distribution (KUIPER 1972, 1981). Surprisingly, abundant populations of *Pisidium amnicum* were found in the fine sediments at locality 10. This Palaearctic species – the largest of the genus – lives in the Nahr el Assi completely isolated from the rest of its known distribution, which comprises large parts of Europe and Siberia. Until now, *Pisidium amnicum* has not been reported from the Levant and the only confirmed finding from Northern Africa was reported from Egypt (KUIPER 1964).

The land snail *Oxyloma* cf. *elegans*, which is restricted to aquatic habitats, was observed sparsely on the shore as well as in cane thickets at the shore line of a spring creek at Ras el Assi. This Holarctic species has a patchy distribution in Lebanon and is also known from northern parts of Israel (TOHMÉ & TOHMÉ 1988, HELLER 2009). There are no differences in genital morphology between this species and *Oxyloma elegans* (Fig. 6b). However, molecular genetic investigations did not yet give in an unambiguous assignment to this species. It may possibly be a hybrid (SCHNIEBS, in litt.).

The living mollusc fauna of two standing water bodies (both belong to the Litani drainage area in the southern Bekaa plain) were studied. In total, 8 different freshwater snails and a single mussel were observed in the Quaraaon reservoir and the spring area at Aammiq. The latter is characterised by shallow water bodies with cane thicket. It remains unknown whether the strongly eutrophic Lake Quaraaon is still a suitable habitat for the species, which were found only as shells on the drift line. During a faunal survey in 1983, five freshwater snail species were observed alive (MIENIS 1987). The author reported the following taxa: *Valvata saulcyi*, *Physella acuta*, *Radix peregra tenera* (Mousson, 1861), *Bithynia phialensis* (Conrad, 1852), and *Gyraulus ehrenbergi* (Beck, 1837). MIENIS emphasised the presence of spiral bandings and a keel for the *Gyraulus* specimens from Lake Quaraaon. These characteristics are not found in *Gyraulus ehrenbergi* (distributed throughout Africa) or in *G. piscinarum*. It therefore remains unknown which species was actually reported by MIENIS. The *Gyraulus* shells which were found on the drift line during the current investigations were, however,

Table 2. Land gastropods of urban habitats. – 13: Tripoli, city centre, old walls and ruderal areas, 34°26'16''N, 35°50'20''E, ca. 20 m a.s.l., 24.v.2006; 14: Tripoli, Qalaat Sandjil (castle), walls and ruderal vegetation at the ruins, 34°26'01''N, 35°50'39''E, ca. 60 m a.s.l., 28.v.2006; 15: Zgharta (Prov. North Lebanon), walls and ruderal vegetation in the settlement, 34°23'55''N, 35°53'32''E, 110 m a.s.l., 24.v.2006; 16: Enfe (Prov. North Lebanon), ruderal vegetation at abandoned salt works near coast, 34°21'44''N, 35°44'19''E, 30 m a.s.l., 1.vi.2006; 17: Baalbeck (Prov. Bekaa), surroundings of ancient temple, calcareous walls and ruderal vegetation, 34°00'20''N, 36°12'32''E, 1150 m a.s.l., 29.v.2006.

	13	14	15	16	17
<i>Pleurodiscus erdelii</i>				○	
<i>Cristataria dutaillyana</i>		●			
<i>Elia moesta</i>		○			
<i>Oxychilus renaniamus</i>		○			○
<i>Limacus flavus</i>			●		
<i>Monacha syriaca</i>		○			
<i>Platytheba nummus</i>		●			
<i>Cochlicella acuta</i>		○		●	
<i>Xeropicta krynickii</i>		○			○
<i>Eobania vermiculata</i>	●			●	
<i>Cornu aspersum</i>	●	●			

Table 3. Land gastropods of open and half shaded rocky habitats. – 18: El Hermel (Prov. Bekaa), rocky open land at Nahr el Assi ca. 2 km North of El Hermel, ruderaly impacted, 34°24'36''N, 36°27'06''E, 590 m a.s.l., 29.v.2006; 19: Ras el Assi (Prov. Bekaa), rocks calcareous semi-desert with loose vegetation on the slopes of the Nahr el Assi, 34°21'06''N, 36°22'36''O, 680 m a.s.l., 29.v.2006 (Fig. 9); 20: Zgharta (Prov. North Lebanon), dry ruderal vegetation with calcareous stones in side valley of Nahr Abou Ali above the village, 34°23'32''N, 35°53'42''E, 80 m a.s.l., 24.v.2006; 21: Bcharre (Prov. North Lebanon), Jabal el Mekmel ca. 7 km SE of Bcharre, loose calcareous vegetation, 34°12'50''N, 36°04'06''E, 2600 m a.s.l., 27.v.2006 (Fig. 10); 22: Hadchit (Prov. North Lebanon), slopes of the Nahr Quadicha, open calcareous fields, locally with loose vegetation und shrubs, partly ruderaly impacted, 34°14'49''N, 35°59'25''E; 1000-1250 m a.s.l., 30.v.2006; 23: Aammq (Prov. Bekaa), rocky open fields with loose vegetation at the edge of a wetland, ruderaly impacted, 33°43'42''N, 35°47'09''E, 870 m a.s.l., 31.v.2006; 24: Bab Mareaa (Prov. Bekaa), rocky open fields with loose vegetation at Lake Quaraaon, ruderaly impacted, 33°34'41''N, 35°41'27''E, 860 m a.s.l., 31.v.2006; 25: Afqa (Prov. Mount Lebanon), open calcareous fields with loose vegetation on single shrubs near the cave, locally wet, 34°04'00''N, 35°53'46''E, 1160 a.s.l., 1.vi.2006.

	18	19	20	21	22	23	24	25
<i>Orculella mesopotamica riedeli</i>		●						
<i>Orculella sirianocoriensis libanotica</i>								○
<i>Buliminus damascensis</i>		●						
<i>Euchondrus septemdentatus</i>		○			○			
<i>Euchondrus cf. ledereri</i>				●				
<i>Euchondrus spec.</i>					○			
<i>Elia moesta</i>			●					●
<i>Albinaria hedenborgi</i>					●			
<i>Eopolita protensa jebusitica</i>		●						
<i>Oxychilus syriacus</i>								○
<i>Oxychilus renaniamus</i>		○			○			
<i>Limacus flavus</i>								●?
<i>Deroceras berytensis</i>								●
<i>Sphincterochila fimbriata</i>		●						
<i>Monacha syriaca</i>	○	○	●			●	●	
<i>Monacha obstructa</i>						●	○	
<i>Monacha cf. compingtae</i>			○		○	●		○
<i>Monacha spec.</i>				○				
<i>Platytheba nummus</i>					●			
<i>Metafruticicola berytensis</i>								●
<i>Xeropicta krynickii</i>	○	●	●		●	●	●	
<i>Cornu aspersum</i>			●					



Fig. 7. Small spring pond in the forest of Qammouah near Fnaideq, habitat of *Pisidium personatum*, *P. casertanum* and *Galba truncatula*.



Fig. 8. The headwater of the Nahr el Assi, the habitat of highly specialized lotic organisms and endangered by a planned dam construction, habitat of *Theodoxus jordani* and *Melanopsis buccinoidea*.

unambiguously identified as *G. piscinarum*. The most important characters for their determination were the characteristic ribs on the surface of the shells (GLÖER & BÖBNECK 2007b). A common *Gyraulus* form that differs from *G. piscinarum* in the morphology of its genitalia lives in the Aammiq wetland. The shell shows a strong carina but no ribs and has a smaller umbiculus. As none of these characters are known for *G. piscinarum*, it was recently described as a new species, *Gyraulus bekaensis* (GLÖER & BÖBNECK 2007b) (cf. Fig. 3b).

A second, considerably larger taxon of the Planorbidae is also found in the Aammiq wetland, but less abundantly than *Gyraulus bekaensis*. The shells of this group can be readily distinguished from *Planorbis planorbis antiochianus* (Locard, 1883), which is known from Syria, by their sharp median carina. They therefore have a similar morphology to *P. carinatus* from Central European localities and were determined as such (Fig. 3a). *P. carinatus* has a mainly Central European distribution with sparse occurrences in the northern parts of its range and in the Mediterranean. Hence, its presence in Aammiq is rather isolated from its main distribution; however, the species is also reported from the Northern Iran (MANSSORIAN 1994).

Aammiq wetland also provides good conditions for two large members of the Lymnaeidae, *Radix auricularia* and *Lymnaea stagnalis*. Of the former species, we found only juvenile animals. Both species were reported by SCHÜTT (1983) from the Syrian part of the Orontes drainage system. No reports were known, however, from Lebanon until now. Based on the morphology of the genitalia, the *Stagnicola* taxon from Aammiq was preliminarily determined as *S. cf. berlani* (Fig. 3c, 6a). *S. berlani* is distributed from south-east Europe to the Caucasus and has so far not been found in the Levant. It remains, however, unknown whether specimens of “*Stagnicola palustris*” from the Middle East (Syria, Israel) and from Saudi Arabia were correctly identified because their determination was based on shell characters only (SCHÜTT 1983, NEUBERT 1998). An abundant species of the family Bithyniidae from the spring area of Aammiq was originally determined as *Bithynia hamicensis* Pallary, 1939, which was formerly synonymised by SCHÜTT (1983) with *B. phialensis*. The specimens of this taxon are, however, much larger and have more curved whorls than *B. phialensis* (Conrad, 1852) and *B. badiella* (Küster, 1853). Due to differences in the shell morphology in terms of the form of the whorls, this taxon was eventually described as the new species *Pseudobithynia amiqensis* (Fig. 2a), particularly because all of the bithyniid snails in Lebanon which were found in the course of this study were determined as members of the genus *Pseudobithynia* based on the morphology of the genitalia (GLÖER & BÖBNECK 2007a). Thus, the specimens of *Bithynia phialensis* found by MIENIS (1987) in Lake Quaraaon may also belong to the species *P. amiqensis*. In addition to *Musculium lacustre*, which was found in low numbers in the muddy-sandy spring ponds at Aammiq, we also observed specimens of *Valvata saulcyi* at this locality. The latter species was also found in the Nahr el Assi.

Land snails and slugs of urban habitats

An attempt was made to find slugs active during the night in the village of Zgharta. Table 2 lists those species found in urban habitats, although this list is not representative due to incomplete surveys (only locality 14 could be surveyed extensively). The slug *Limacus flavus*, which is distributed in the Mediterranean including the Near East, can live in relatively pristine habitats as well as under anthropogenic conditions. It is, however, not easy to find because of its nocturnal behaviour (HELLER 2009, SCHÜTT 2001). In Zgharta, this species was active at midnight on curbstone and house walls, often feeding on waste and faeces.

The Mediterranean land snails *Cochlicella acuta*, *Eobania vermiculata* and *Cornu aspersum* live in ruderal areas near the coast. The latter two species in particular are considered to be widespread synanthropics in Lebanon (TOHMÉ & TOHMÉ 1988). In ruderal areas at the numerous salt works near Enfe in northern Lebanon, the abundant species *Pleurodiscus erdelii* occurs in addition to the above-mentioned synanthropes. The extensive site of ruins on the hills in the centre of Tripoli (former Crusader castle Qalaat Sandjil) offers optimal conditions for a relatively species-rich land snail community. *Cristataria dutaillyana* and *Platytheba nummus* live with a fairly high abundance on rather wet parts of mural walls with loose interstice vegetation hidden from direct sun rays. Most specimens aestivated in mural gaps, whilst some were placed on the open vertical walls. Both species are scattered over western Syria and Lebanon (PALLARY 1939, NORDSIECK 1971, HAUSDORF 2000). TOHMÉ & TOHMÉ (1988) reported Tripoli as a locality of *Cristataria dutaillyana*. For *Platytheba nummus*, those authors listed valleys directed towards the sea in central Lebanon as the main range.

It remains an open question whether *Oxychilus camelinus* (Bourguignat, 1852) may be among the shell series determined as *O. renanianus* (Pallary, 1939) in Tables 2-4. *O. camelinus* has been described from Baalbeck and is accepted as a distinct species by RIEDEL (1980). HELLER (2009) lists both species for Israel, but he also mentions the difficulties related to species discrimination based on morphological characters. If it should prove to be a single species, *O. renanianus* would be a junior synonym of *O. camelinus*.

Land gastropods of open and half-shaded rocky habitats

One of the two Orculidae collected is widespread, *Orculella sirianocoriensis libanotica*. The distribution area of this taxon extends from Anatolia to Armenia, Syria, Iraq and southern Iran, and in the south to the border region between Israel and Lebanon at Mount Hermon (BAR & MIENIS 1979, HAUSDORF 1996). TOHMÉ & TOHMÉ (1988) list this taxon as *Orcula scyphus* (Frivaldsky, 1848) and provide some localities in Lebanon. Only two new localities can be added: Fnaideq in northern Lebanon (Table 4) and Afqa in the central part of the country. Very small *Orculella* with shell heights of approximately 6 mm could be found near Ras el Assi in the northern Bekaa plain under stones at the bottom of calcareous rocks directed towards Nahr el Assi (Fig. 9). HAUSDORF (in litt.) considered these specimens as belonging to *Orculella mesopotamica riedeli* (Fig. 4d). Until now this subspecies has been noted from the Turkish Hatay only (HAUSDORF 1996). The record of *Buliminus damascensis* (Fig. 4a) is also a first record for the fauna of Lebanon. This member of Buliminidae was first described by PALLARY (1929) from Syria and is of relatively large size – adult specimens can reach shell heights of up to 19 mm. It was found together with *O. mesopotamica riedeli* under stones at the above-mentioned hillside of the Nahr el Assi near Ras el Assi. Belonging to the same family, *Euchondrus septemdentatus* (= *E. borealis* [Mousson, 1874]) is distributed from the southern Taurus, via Syria and Lebanon south to Israel. This species was found during the recent study in the Lebanon Mountains and the Bekaa plain at exposed localities, but most often only dead shells. Two lots of *Euchondrus* from mountainous sites show aberrations in shell shape. At Jabal el Mekmel ca. 7 km southeast of Bcharre at 2600 m a.s.l., I found a *Euchondrus*-morph. This horny-coloured *E. ledereri*-like morph lives completely isolated on calcareous rock with loose vegetation. The shells are considerably higher (up to 12 mm), but the teeth are variable. Four obvious lamellae (2 palatal, 1 parietal, 1 columellar) as well as 1 to 3 weak teeth (2 angular, 1 basal) are visible in the aperture. The



Fig. 9. Rocky habitat vegetation and semi-desert with loose cover near Ras el Assi. Among others, *Buliminus damascensis*, *Orculella mesopotamica riedeli*, *Eopolita protensa jebusitica* and *Sphincterochila fimbriata* occur here.

angular armature is different from that of *Euchondrus septemdentatus* (Fig. 4b, HAUSDORF, in litt.). A completely different shell morphology is present in a population from the Nahr Quadicha below the village of Hadchit. This population lives under stones at the base of exposed calcareous rocks. These elongated egg-shaped snails of ca. 8 mm height resemble *Euchondrus ovularis* (Olivier, 1801). However, they have a reduced apertural armature with 4 strongly developed teeth or lamellae (2 palatal, 1 parietal, 1 columellar) and occasionally a weak basal tooth (Fig. 5b). The taxonomic status of both morphs needs further investigation.

The diversity of Clausiliidae was rather low. Morphs attributed to *Elia moesta* showed the known variability. Morphs from the higher ranges of the Lebanon Mountains could belong to *E. moesta sublaevis* O. Boettger, 1883 or could even represent a hitherto unknown subspecies. They have a finer apical sculpture as compared to the Lebanese lowland morph of *E. moesta* which is the nominal subspecies (NORDSIECK, in litt.). More detailed analyses require more material, particularly from the Lebanon Mountains. As a taxon of specific rank, *E. moesta* is distributed from the Turkish Hatay, Syria, Lebanon south to northern Israel. It is also known from Cyprus (TOHMÉ & TOHMÉ 1988, HELLER 2009, SCHÜTT 2001). *Albinaria hedenborgi* is very abundant on a large and highly exposed calcareous rock, almost free of vegetation, at Nahr Quadicha. This population of the species, considered as *Albinaria tanourinnensis* (Pallary, 1921) by TOHMÉ & TOHMÉ (1988), extends as far as the range-limit known in northern Lebanon.

Two species of *Oxychilus* were found. *O. renanianus* is an unpretentious species which is widely distributed in Lebanon and which can also live synanthropically (TOHMÉ & TOHMÉ



Fig. 10. Only a few species such as *Euchondrus* cf. *ledereri* can survive in the area above 2500 m at the Jabal el Mekmel where loose and less structured rocky vegetation habitats predominate.

1988). During the recent study, only a single damaged shell of *O. syriacus* was found under stones at the base of a rock near Afga in central Lebanon.

The dry-adapted *Eopolita protensa jebusitica* lives in the central and northern parts of Lebanon (TOHMÉ & TOHMÉ 1988). A colony of this species – with many dead and a few live snails – was found near Ras el Assi on the Nahr el Assi slope, mostly under larger stones. Besides *Limacus flavus*, only one more slug was found near the spring of the Adonis River near Afga – an almost dark black morph of *Deroceras berytensis*. This slug lives in the part of the cave where the river originates as well as in the adjacent calcareous rock vegetation with single shrubs and loose vegetation. The range of this species extends from Turkey and Cyprus to Lebanon and most likely also to Israel (WIKTOR 2000, HELLER 2009).

Two species of the family Sphincterochilidae have been mentioned so far from Lebanon. According to TOHMÉ & TOHMÉ (1988), *Sphincterochila cariosa* (Olivier, 1804) and *S. candidissima* (Draparnaud, 1801) can be found there. The latter, however, is a Western Mediterranean species that has not so far been found east of Malta. Therefore the report of this species by TOHMÉ & TOHMÉ from the arid Beqaa Valley is doubtful. The *Sphincterochila* species that was detected in this study from the surroundings of Ras el Assi in the northern Beqaa Valley was identified as *S. fimbriata* (Fig. 4e). Possibly the findings of TOHMÉ & TOHMÉ belong to the same species. *S. fimbriata* has so far been known from Syria, Jordan and Israel (FORCART 1972, HELLER 2009). The collected material contained altogether four species of the genus *Monacha*. Besides *Monacha syriaca* and *M. obstructa*, two species that are widely distributed in the Eastern Mediterranean region and obviously also in Lebanon, a

relatively small, globular-conical form with closed umbilicus was found quite regularly. This form was related by HAUSDORF (in litt.) to *Monacha compingtae* (Fig. 5a), which is known from the Turkish Hatay as well as from northwestern Syria (HAUSDORF 2000). Whether these animals really belong to this taxon or whether they represent an undescribed species has to be investigated in further studies. Empty shells of a fourth form were found on a rocky heath at 2600 m altitude at Jabal el Mekmel, south-east of Bcharre. This form probably represents an undescribed species. The shells are depressed with a conical spire and are slightly shouldered above the periphery. They are 13.5 mm broad and approx. 8 mm high at maximum. The last whorl steeply declines towards the aperture. The aperture is transverse-elliptical with a moderate intense lip. The umbilicus is deep, open and scarcely covered by the columella. The surface of the shell appears irregularly striped to rib-striped (Fig. 5b). Because nothing is known about the anatomy so far, this species will not be described until adult specimens are available (HAUSDORF, in litt.).

Near Afga *Metafruticicola berytensis* could be found on a montane rocky heath with low vegetation. This species is known from the southern Turkey, Syria and Lebanon as far as Mount Hermon in northern Israel (MIENIS 1985, TOHMÉ & TOHMÉ 1988, HELLER 2009, SCHÜTT 2001). One of the most common forms in the open habitats in northern Lebanon was *Xeropicta krynickii*. This gastropod is considered to be very variable, a feature that was confirmed by the present material (HAUSDORF, in litt.). TOHMÉ & TOHMÉ (1988) used the name *X. vestalis joppensis* (Schmidt, 1855) for the Lebanese specimens of this form.

Land gastropods of woody habitats with partly exposed rock vegetation

Areas with relict populations of the Lebanon Cedar (*Cedrus libani*) were preferred in the selection of wood habitats (Table 4, Nr. 26-28). In the woodland of Qammouah, only severely thinned-out woods with different species of broadleaves, firs and a few cedars exist because of the use of this area as grazing land for thousands of years. Here, 8 different land gastropods were found especially around limestone rocks including the previously-mentioned clausiliid species *Cristataria dutaillyana* and *Elia moesta*. Two empty shells of *Turanena benjamitica* were found only at this locality. This species was described from the surroundings of Jerusalem and was found only at few localities in Israel (HELLER 2009). There was no earlier information about this species in Lebanon. *Metafruticicola fourousi* unlike the similar species *M. berytensis*, prefers habitats with trees. This was confirmed by the present results. *M. fourousi* was mainly found at localities dominated by woods, except for one finding at the strongly devastated cedar forests near Bcharre. The known range of the species includes Lebanon and Syria, the Hatay area in southern Turkey and the northern half of Israel (TOHMÉ & TOHMÉ 1988, HELLER 2009, SCHÜTT 2001). In contrast to the forest of Qammouah, the rather dense woods of Ehden are largely protected from grazing. Besides oaks, firs and pines, the largest remaining populations of cedars of Lebanon are the dominating trees here. During a search for molluscs in this area lasting several hours, only 4 species of land gastropods were found. Of special interest is the finding of a *Cristataria* species that was compared with *C. zelebori* by NORDSIECK. This form from Ehden, however, does not have the long dorsal carina and the deep lunellar of the typical *C. zelebori* (NORDSIECK, in litt.).

The most famous and the highest cedar population in Lebanon is located near the town of Bcharre at about 1900 m a.s.l. This area of approximately 7 ha is encircled by a wall and is used as a tourist attraction. Since the most famous winter sports centre of the Lebanon

Table 4. Land gastropods of woody habitats with partly exposed limestone rocks. – 26: Fnaideq (Prov. North Lebanon), Forest Qammouah, woods with partly shaded calcareous rocks, locally wetland vegetation, 34°28'03''N, 36°13'27''E, 1560 m a.s.l., 26.v.2006; 27: Ehden (Prov. North Lebanon), Horsh Ehden, cedar-oak mixed forest on calcareous rocks; 34°18'23''N, 35°59'56''E; 1400 m a.s.l., 25.v.2006; 28: Bcharre (Prov. North Lebanon), Ceders of Lebanon ca. 2 km E of Bcharre, Cedar forest with calcareous rocks, 1900 m a.s.l., 27.v.2006; 29: Hadchit (Prov. North Lebanon), Nahr Quadicha, deciduous mixed forest with calcareous rocky vegetation, partly wet, deciduous mixed forest, 34°14'49''N, 35°59'25''E; 1000-1250 m a.s.l., 30.v.2006; 30: Lahbiye (Prov. Mt. Lebanon), Nahr es Safa near mouth of Nahr ed Damour, woodland at valley slope, ruderaly impacted, 33°41'50''N, 35°28'45''E, 40 m a.s.l., 31.v.2006.

	26	27	28	29	30
<i>Lauria cylindracea</i>				○	
<i>Orculella sirianocoriensis libanotica</i>	○				
<i>Turanena benjamitica</i>	○				
<i>Pene syriacus syriacus</i>		○		●	
<i>Euchondrus septemdentatus</i>	●	○			
<i>Cristataria dutaillyana</i>	●				
<i>Cristataria cf. zelebori</i>		●			
<i>Elia moesta</i>	●			●	
<i>Oxychilus renanianus</i>	○				
<i>Limacus flavus</i>				●	●
<i>Metafruticicola fourousi</i>	●	●		●	●
<i>Helix engaddensis</i>	○		○	●	

Mountains and a main road are close by, the area is under considerable exploitation. The natural ground vegetation is largely destroyed. Designated and paved trails have been installed to counter the resulting erosion. It is nearly impossible to find here an adequate habitat for land snails. Only sporadic empty shells of *Helix engaddensis* could be found. TOHMÉ & TOHMÉ (1988) previously mentioned Bcharre as the locality of this species and gave a wide distribution of *Helix engaddensis* in the north of Lebanon, ranging from the mountains to the Beqaa Valley. Within the scope of the present study, *H. engaddensis* was also observed in the woodland of Qammouah as well as in Nahr Quadicha, but always in proximity to woods. In the upper course of the deeply grooved Nahr Quadicha, major parts of the slopes and the valley ground are covered with dense broad-leaved forests. The local occurrence of springs, for example beneath the small town of Hadchit, results in a distinctly more humid atmosphere than beneath in the valley. Among the land snails collected in this study, *Lauria cylindracea* must be particularly mentioned. A moderately fresh shell of this species was found in sieved material. *Lauria cylindracea* has a wide distribution in Europe which reaches in the east to the Caucasus, potentially even to the western Himalayas. HELLER (2009) and MIENIS (1993) list the sparsely known findings from Israel and Lebanon. On partly shaded lime rocks, a population of *Pene syriacus syriacus* was located. This representative of the Bulimidae ranges from Syria to Mount Hermon (TOHMÉ & TOHMÉ 1988, HELLER 1984 & 2009, SCHÜTT 2001).

Altogether, 17 species of freshwater gastropods, 33 species of land gastropods, and 6 species of small bivalves were found in the course of this study. These include numerous molluscs recorded for the first time from Lebanon, mainly limnic species. Including the species recently described elsewhere in this material, these species are *Pseudobithynia amiqensis*, *Pseudobithynia kathrini*, *P. levantica* and *Gyraulus bekaensis* as well as *Stagnicola cf. berlani*, *Planorbis carinatus* and *Potamopyrgus antipodarum*. In addition, all the species of small bivalves found in 2006, for example *Musculium lacustre*, *Pisidium amnicum* und *P.*

tenuilineatum, were not previously known to occur in Lebanon. Within the land gastropods, especially *Orculella mesopotamica riedeli*, *Buliminus damascensis*, *Turanena benjamitica*, *Sphincterochila fimbriata*, and *Monacha* cf. *compingtae* were not previously known in Lebanon.

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Annex: List of molluscs found in Lebanon in 2006.**Neritidae**01. *Theodoxus jordani* (Sowerby, 1832)**Melanopsidae**02. *Melanopsis buccinoidea* (Olivier, 1801)**Hydrobiidae**03. *Radomaniola gaillardotii* (Bourguignat, 1856)04. *Potamopyrgus antipodarum* (J. E. Gray, 1843)**Bithyniidae**05. *Pseudobithynia amiqensis* Glöer & Bößneck, 2007 (Fig. 2a)06. *Pseudobithynia levantica* Glöer & Bößneck, 2007 (Fig. 2b)07. *Pseudobithynia kathrini* Glöer & Bößneck, 2007 (Fig. 2c)**Valvatidae**08. *Valvata saulcyi* (Bourguignat, 1853)**Lymnaeidae**09. *Lymnaea stagnalis* (Linnaeus, 1758)10. *Radix auricularia* (Linnaeus, 1758)11. *Stagnicola* cf. *berlani* (Bourguignat, 1870) sensu Kruglov, 2005 (Fig. 3c, 6a)12. *Galba truncatula* (O. F. Müller, 1774)**Physidae**13. *Physella acuta* (Draparnaud, 1805)**Planorbidae**14. *Planorbis carinatus* O. F. Müller, 1774 (Fig. 3a)15. *Gyraulus piscinarum* (Bourguignat, 1852)16. *Gyraulus bekaensis* Glöer & Bößneck, 2007 (Fig. 3b)17. *Ancylus fluviatilis* (O. F. Müller, 1774) s.l.**Lauriidae**18. *Lauria cylindracea* (Da Costa, 1778)**Orculidae**19. *Orculella sirianocoriensis libanotica* (Tristram, 1865)20. *Orculella mesopotamica riedeli* Hausdorf, 1996 (Fig. 4d)**Buliminidae**21. *Turanena benjamitica* (Benson, 1859)22. *Pene syriacus syriacus* (L. Pfeiffer, 1864)23. *Buliminus damascensis* (Pallary, 1929) (Fig. 4a)24. *Euchondrus septemdentatus* (Roth, 1839)25. *Euchondrus* cf. *ledereri* (L. Pfeiffer, 1868) (Fig. 4b)26. *Euchondrus* spec. (Fig. 4c)**Pleurodiscidae**27. *Pleurodiscus erdelii* (Roth, 1839)**Clausiliidae**28. *Cristataria dutaillyana* (Bourguignat, 1868)29. *Cristataria* cf. *zelebori* (Rossmässler, 1856)30. *Elia moesta* (Rossmässler, 1839)31. *Albinaria hedenborgi* (L. Pfeiffer, 1849)**Succineidae**32. *Oxyloma* cf. *elegans* (Risso, 1826) (Fig. 6b)**Zonitidae**33. *Eopolita protensa jebusitica* (Roth, 1855)34. *Oxychilus syriacus* (Kobelt, 1879)35. *Oxychilus renanianus* (Pallary, 1939)**Limacidae**36. *Limacus flavus* (Linnaeus, 1758)**Agriolimacidae**37. *Deroceras berytensis* (Bourguignat, 1852)**Sphincterochilidae**38. *Sphincterochila fimbriata* (Bourguignat, 1852) (Fig. 4e)**Hygromiidae**39. *Monacha syriaca* (Ehrenberg, 1831)40. *Monacha obstructa* (L. Pfeiffer, 1842)41. *Monacha* cf. *compingtae* (Pallary, 1929) (Fig. 5a)42. *Monacha* spec. (Fig. 5b)43. *Platytheba nummus* (Ehrenberg, 1831)44. *Metafruticicola fourousi* (Bourguignat, 1863)45. *Metafruticicola berytensis* (L. Pfeiffer, 1841)**Helicidae**46. *Cochlicella acuta* (O. F. Müller, 1774)47. *Xeropicta krynickii* (Krynicky, 1833)48. *Eobania vermiculata* (O. F. Müller, 1774)49. *Cornu aspersum* (O. F. Müller, 1774)50. *Helix engaddensis* (Bourguignat, 1852)**Sphaeriidae**51. *Musculium lacustre* (O. F. Müller, 1774) (Fig. 2d)52. *Pisidium amnicum* (O. F. Müller, 1774) (Fig. 2e)53. *Pisidium casertanum* (Poli, 1791) (Fig. 2f)54. *Pisidium subtruncatum* Malm, 1855 (Fig. 2g)55. *Pisidium tenuilineatum* Stelfox, 1918 (Fig. 2h)56. *Pisidium personatum* Malm, 1855 (Fig. 2i)