

The genus *Pseudobithynia* in Lebanon, with a redescription of three species and additional notes on its ecology

(Mollusca: Bithyniidae)

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Abstract. New material of Bithyniidae from Lebanon comprised topotypes of *Paludina badiella* Küster, 1853, *Bithynia saulcyi* Bourguignat, 1853, and *Bithynia hamicensis* Pallary, 1939, which are redescribed, and for which, for the first time, penis morphology is depicted. We found that *P. amiqensis* Glöer & Böbneck, 2007 is conspecific with *P. hamicensis* (Pallary, 1939) (**syn. n.**).

Key words. *Pseudobithynia*, *Paludina badiella*, *Bithynia hamicensis*, *Bithynia saulcyi*, redescription, Lebanon, Middle East.

Introduction

Pseudobithynia is a genus similar to *Bithynia*, but without a penial appendix. GERMAIN (1921: 5 ff.) reported as many as 13 taxa of Bithyniidae from Lebanon and Syria. Even so, this family is still not well investigated because there is no clear concept of the species that occur in this region. GERMAIN (1922: plate 21, fig. 18-24) depicted *Bithynia hawadieriana* Bourguignat, 1853, and *B. sidoniensis* Mousson, 1861, which look very distinct, while SCHÜTT (1983: 29) believed that these taxa are synonyms of *B. phialensis* (Conrad, 1852) and continued to adhere to his two species concept for this region, with the two species *B. phialensis* and *B. badiella* (Küster, 1853), respectively. Recently, GLÖER & BÖBNECK (2007) added three new species to the faunal list of Lebanon, *Pseudobithynia kathrini*, *P. levantica*, and *P. amiqensis*.

SCHÜTT (1983) studied the rich material collected in the Orontes and neighbouring river systems by the Institute of Zoology of the University of Mainz between 1975 and 1980 (R. KINZELBACH), but could not provide evidence for the occurrence of *Pseudobithynia*. As no wet material exists in the Senckenberg collection, where the materials were deposited by SCHÜTT, more precise anatomical studies are not possible (JANSSEN, in litt.). From the neighbouring continental Africa no *Bithynia* species lacking a penial appendix is known (MANDAHL-BARTH 1968, BROWN 1994, VAN DAMME 1984). BÖBNECK (GLÖER & BÖBNECK 2007) as well as A. DIA could only find *Pseudobithynia* species in Lebanon, and no *Bithynia* species. So it is still unclear which species SCHÜTT (1983: 33, Fig. 3B) was actually studying when he depicted the penis morphology of "*Bithynia badiella*", especially as he did not indicate the sampling site.

The aim of this paper is to improve knowledge of the molluscan biodiversity of Lebanon, and to redescribe some *Pseudobithynia* species based on our new material.

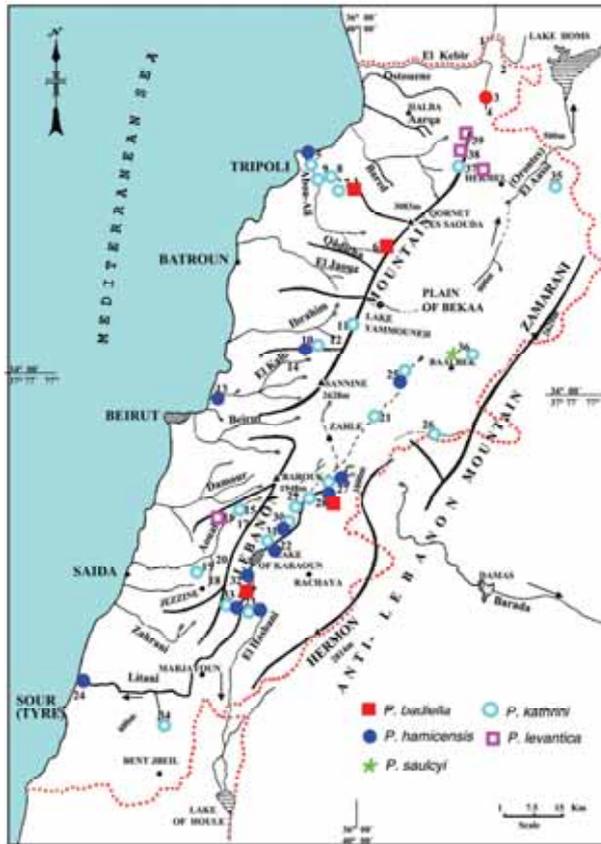


Fig. 1. The sampling sites of *Pseudobithynia* spp. in Lebanon. The numbers refer to Table 1.

Material and methods

Altogether 20 river systems were surveyed (springs, brooks, rivers, ponds and lakes) and 200 sampling sites were studied in Lebanon between 1979 and 2009 by Aref DIA. *Pseudobithynia* species could be found at 39 stations in seven river systems.

The material was collected from the banks of the water bodies with a Surber sampler and a kick net, and was preserved in ethanol (75%). The dissections of the genital organs and measurements and the shells were carried out using a stereo microscope (Zeiss). The photographs were made with a digital camera system (Leica R8). The material is deposited in the collection of the National Council for Scientific Research, Beirut, Lebanon.

Hydrological data were provided by the National Office of Litani (gauges: Limnigraphie), as m^3/s . Dissolved oxygen was determined with the Winkler Method and using the kit "HACH" titration (Winkler-Azide with PAO, EL/2000 DR model). Dissolved oxygen content was measured in the field.

To identify the *Pseudobithynia* spp. from Lebanon, we used topotypes and compared these with original photos of the syntypes, which were taken by Eike NEUBERT.

Table 1. Collecting stations. Localities are listed and numbered per river basin (S = station).

S	Sampling site/ taxa	Alt.	Coordinates	date
I. Basin of El Kebir (surface 1000 km², length 60 km)				
S1	Aarida, at bridge El Assouad, near village El Aarida / <i>P. sp. juv.</i>	254	34°39'N 36°18'E	25.10.2009
S2	Nsara, little spring-brook in Ouadi Audine/ <i>P. sp. juv.</i>	1440	34°31'N 36°18'E	25.08.2009
S3	Magl el Bal, little spring-brook in Ouadi Audine/ <i>P. hamicensis</i>	1330	34°30'N 36°18'E	13.03.2008
S4	Es Safa spring, at bridge Ouadi Khaled/ <i>P. sp. juv.</i>	380	34°37'N 36°24'E	31.08.2009
II. Basin of Abou Aali, (surface 484 km², length 42 km)				
S5	Abou Aali at Abou Samra, near Citadel Saint Gilles, Tripoli / <i>P. kathrini, P. hamicensis</i>	30	34°25'N 35°50'E	18.10.2000 16.06.1993
S6	Qadicha, a stream at power plant, near village Bcherré/ <i>P. badiella</i>	1400	34°15'N 36°00'E	10.03.1996 19.11.1995
S7	Rachaaïne spring, near village Rachaaïne/ <i>P. badiella, P. kathrini</i>	136	34°23'N 35°55'E	09.07.1995 10.03.1996 24.12.1995
S8	Rachaaïne a stream at Tahoïne El Merdâchiyé / <i>P. kathrini</i>	80	34°23'N 35°54'E	27.04.2002
S9	Rachaaïne a stream at bridge Zgharta (village) / <i>P. kathrini</i>	60	34°23'N 35°54'E	18.10.2001
III. Basin of Ibrahim (surface 330 km², length 30 km)				
S10	Ibrahim at Janné, near village Janné / <i>P. kathrini, P. hamicensis, P. cf. levantica</i>	730	34°04'N 35°49'E	23.06.2002 03.11.2002 09.03.2002
S11	Aakoura spring (Aaqoura), near village Aakoura / <i>P. kathrini, P. cf. levantica</i>	1400	34°07'N 35°54'E	29.07.1995
S12	Below Afqa spring, near village El Ghâbât / <i>P. sp. juv.</i>	1020	34°04'N 35°52'E	15.01.1995 15.04.1995
IV. Basin of El Kalb (surface 260 Km², length 30 Km)				
S13	El Kalb at estuary of the river / <i>P. hamicensis, P. sp. juv.</i>	12	33°57'N 35°36'E	09.05.2007
S14	El Kalb at Hrajel, near village Hrajel / <i>P. sp. juv.</i>	1190	34°00'N 35°47'E	29.04.2006
V. Basin of Aouali (Awali)				
S15	Aouali at Jisr el Misri, near village Barouk / <i>P. kathrini</i>	1050	33°42'N 35°40'E	10.11.1979
S16	Aouali at Jisr Batloun, near village Barouk / <i>P. sp. juv., P. cf. levantica</i>	980	33°41'N 35°39'E	20.10.1979 13.03.1979
S17	Aouali at jisr Jdeidet el Chouf/ <i>P. sp. (juv.)</i>	710	33°39'N 35°36'E	08.12.1979
Tributary (Nahr Aaray Jezzine/Waterfall Jezzine)				
S18	Nabaa Jezzine a spring-brook near village Jezzine / <i>P. sp. (juv.)</i>	950	33°32'N 35°35'E	18.08.1979
S19	Nahr Aaray a stream, near village Jezzine / <i>P. kathrini</i>	900	33°32'N 35°34'E	23.04.1979
S20	Nahr Aaray below village Jezzine (Oûadi Jezzine) / <i>P. cf. levantica</i>	690	33°33'N 35°34'E	27.07.1979
VI. Basin of Litani (surface 2170 km², length 170 km)				
S21	Litani at Rayak bridge/ <i>P. kathrini</i>	900	33°50'N 36°00'E	04.07.1995
S22	Litani at Joub Jannine, near village Joub Jannine / <i>P. hamicensis</i>	800	33°38'N 35°16'E	10.10.1991
S23	Litani below Ain Zarka spring, near power plant Markaba / <i>P. kathrini, P. hamicensis</i>	550	33°32'N 35°41'E	29.4.2005 02.07.2005 11.11.2005
S24	Litani above Kasmiyé (Qasmiyeh) near village Kasmiyé / <i>P. hamicensis</i>	5	33°20'N 35°15'E	03.12.1988 24.12.1988 24.02.1989 29.01.1989
S25	Haouch-Bay (Hawch Bay) spring, near village Chmistar / <i>P. kathrini, P. hamicensis</i>	1000	33°56'N 36°03'E	10.10.1995 03.05.2000
S26	Yahfoufa, a stream at village Janta / <i>P. kathrini</i>	1000	33°51'N 36°06'E	07.10.1987 24.05.2000
S27	Anjar spring, near village Anjar / <i>P. kathrini, P. hamicensis</i>	1000	33°44'N 35°56'E	17.10.1991
S28	Ghazyel, a stream near village Estable / <i>P. badiella, P. hamicensis</i>	870	33°45'N 35°56'E	30.05.1995
S29	Kab-Elias (koub-Eliass), a stream above village Kab-Elias / <i>P. kathrini</i>	1000	33°47'N 35°49'E	10.10.1991
S30	Ammiq springs and pond / <i>P. hamicensis, P. kathrini</i>	850	33°43'N 35°47'E	06.05.2004 27.05.1995 06.5.2004
S31	Khraizat spring, near village Saghbine/ <i>P. kathrini</i>	1000	33°36'N 35°41'E	14.05.2003
S32	Tayouné spring, near village Saghbine / <i>P. badiella, P. hamicensis</i>	1000	33°36'N 35°41'E	14.05.2003 14.05.2003
S33	Daya'a spring, near village Machgara / <i>P. kathrini</i>	1000	33°32'N 35°39'E	14.05.2003
S34	Hjair spring (Ouadi Hujcir), near Ghandouriyé + Qantra vill./ <i>P. kathrini</i>	230	33°15'N 35°27'E	03.03.2005

VII. Basin of Orontes (surface 1870 km ² , length 46 km)				
S35	Orontes below Chwaghir village (Chouaghir) / <i>P. kathrini</i>	570	34°24'N 36°26'E	25.08.1984 28.04.1985
S36	Ras el-Ain Baalbeck, springs and pond / <i>P. saulcyi</i> , <i>P. kathrini</i>	1000	34°00'N 36°12'E	18.01.2009 30.04.1995
S37	El Haour at Marjhine, springs and pond, near village El Hermel / <i>P. levantica</i> , <i>P. kathrini</i>	1730	34°22'N 36°13'E	20.05.20012 0.05.2010 09.10.2001
S38	El Jammässia at Marjhine, springs and pond, near vill. El Hermel / <i>P. levantica</i>	1720	34°22'N 36°13'E	20.05.2001
S39	El Jamiaa at Marjhine, springs and pond, near village El Hermel / <i>P. levantica</i>	1720	34°23'N 36°14'E	21.10.2004

Results

Pseudobithynia spp. were found at 39 out of 200 sampling sites (Table 1, Fig. 1). These samples comprised five species: *P. hamicensis* (Pallary, 1939) (12 stations), *P. kathrini* Glöer & Bößneck, 2007 (21 stations), *P. levantica* Glöer & Bößneck, 2007 (3 stations), *P. badiella* (Küster, 1853) (4 stations), and *P. saulcyi* (Bourguignat, 1853) (1 station). In addition, we found that *P. amiqensis* Glöer & Bößneck, 2007 is conspecific with *P. hamicensis* Pallary, 1939 and is thus a junior synonym of the latter species. Not all specimens could be determined to species level, because juvenile *Pseudobithynia* spp. are not always characteristic enough for identification.

It was found that three species of *Pseudobithynia* occur in the river basins of Abou Ali, Litani, and Orontes (Table 2). Two species are hemi-stenothermous and three species are eurythermous (Table 3).

Pseudobithynia Glöer & Pešić, 2006

Type species: *Pseudobithynia irana* Glöer & Pešić, 2006

Diagnosis: The shells are globular to conical or elongated conical. The operculum is calcareous, and the penis has neither a penial appendix nor a flagellum.

Pseudobithynia badiella (Küster, 1853)

Paludina badiella KÜSTER, 1853 (p. 62, figs. 25-28); Beirut.

Neotype: NEUBERT (1998: 347, Fig. 32). – Material: S6, S7, S28, S32.

Description: The small yellowish-brown coloured shell is spherical and has 3.5 fast growing whorls, which are slightly rounded and flattened at the top, separated by a clear suture (Figs 2.1, 2.4). The body whorl is dominant. The surface is silky, opaque and finely striated. The umbilicus is slit-like to closed, and the operculum is yellowish (Fig. 2.2). Shell height 3.0-3.5 mm, width 3.0-3.5 mm. The penis is broad at the base and pointed at the tip, and the penial appendix is absent (Fig. 2.3). – Diagnosis: The shells of *P. badiella* are globular and the body whorl is flattened at the suture.

Distribution: The species was found only in the coastal rivers of the western slope of Mont Liban and the headwater of the Orontes and Litani rivers (eastern slope of Mont Liban), at two sampling sites each. It could be found in the creanal and rhithral of rivers (Fig. 3) at water temperatures of 6-22°C and at altitudes of 130-1400 m.



Fig. 2. *Pseudobithynia badiella* (S7). 1: Shell (male), 2: operculum, 3: head with penis, 4: with operculum (female).



Fig. 3. Habitat of *Pseudobithynia badiella*. 1- 4: S7 (Rachaaïne spring, near village Rachaaïne).

Pseudobithynia hamicensis (Pallary, 1939)

Bithynia hamicensis PALLARY, 1939 (p. 75, pl. IV, figs. 37-40). Ammiq.

Pseudobithynia amiqensis Glöer & Bößneck, 2007, **n. syn.**

Material: S3, S5, S10, S13, S22, S23, S24, S25, S27, S28, S30 (topotypes), S32.

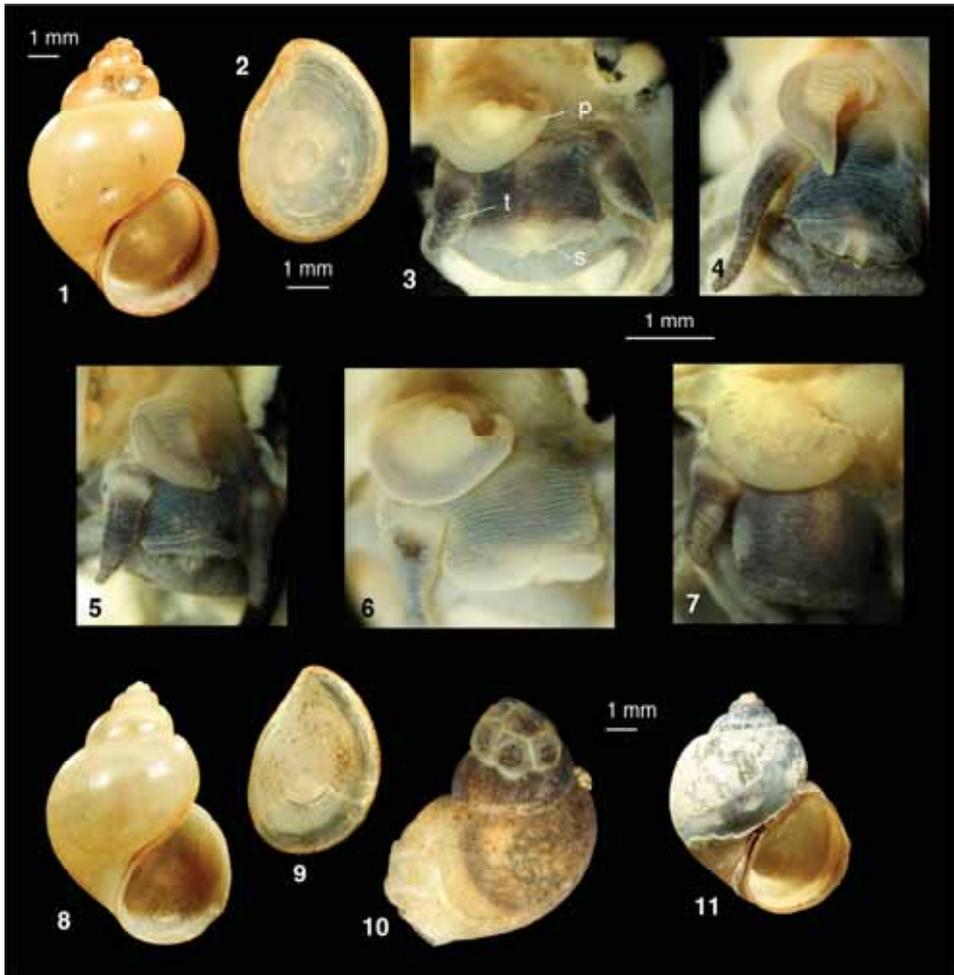


Fig. 4. *Pseudobithynia hamicensis*. 1: Shell (male, S5), 2: operculum, 3-7: penis in situ, 8: shell (female, S24), 9: operculum, 10: shell with eggs, 11: shell (female, S22) – p = penis, s = snout, t = tentacle.

Description: The conical silky shell is horn-coloured and consists of 5-5.5 whorls, which are slightly rounded and separated by a clear suture (Fig. 4.1). The umbilicus is slit-like to closed. The oval aperture is angled at the top, and its outer edge is thickened with a white lip. The edge of the aperture, as seen from the side, is sinuate. The nucleus of the operculum is central (Figs 4.2, 4.9). Females are broader (Figs 4.8, 4.11). Shell: ♂ 10.3 mm high, 6.7 mm wide; ♀ 9.3 mm high and 6.9 mm wide, resulting in a mean ratio of H:B=1.5 (♂), 1.3 (♀) respectively; the ratio of aperture height to shell height is 0.41 (♂) and 0.48 (♀). The juveniles are globular. The mantle is dark-coloured with fine white unsharp spots. The penis is simple, with folds in the middle part, broad at its base and attenuated at the distal end (Figs 4.3-4.7). – **Diagnosis:** The outer margin of the aperture of *P. hamicensis* is thickened, the



Fig. 5. Sampling sites of *Pseudobithynia hamicensis*. 1: S5 (Abou Aali at Abou Samra, near Citadel Saint Gilles, Tripoli), 2: S24 (Litani above Kasmiyé (Qasmiyeh) near village Kasmiyé), 3: S22 (Litani at Joub Jannine, near village Joub Jannine), 4: S27 (Anjar spring, near village Anjar).



Fig. 6. *Pseudobithynia saulcyi*. 1: Shell (male, S36), 2: operculum, 3: penis in situ. – e = eye, p = penis, s = snout, t = tentacle.

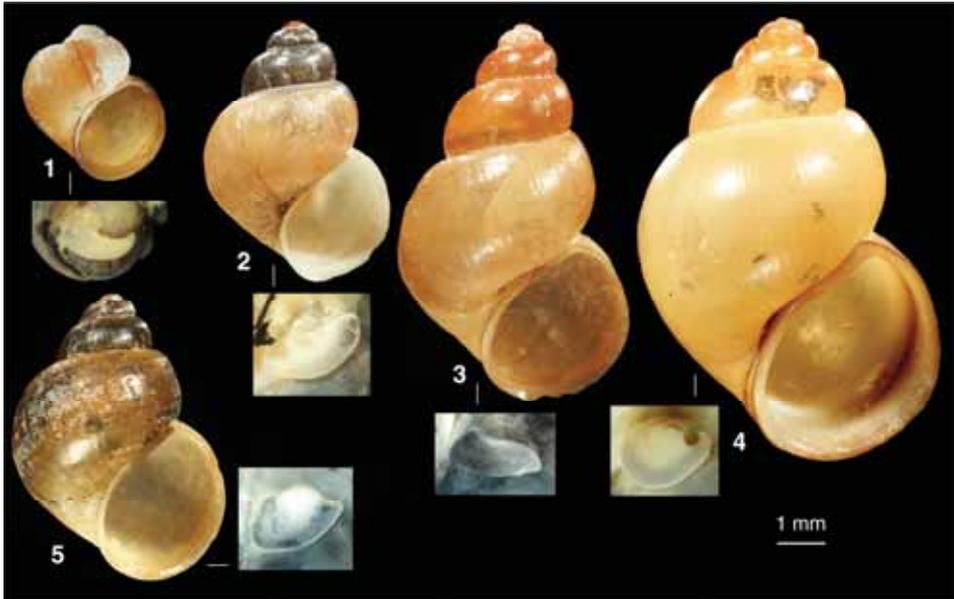


Fig. 7. Bithyniidae of Lebanon. 1: *Pseudobithynia badiella*, 2: *P. saulcyi*, 3: *P. kathrini*, 4: *Pseudobithynia hamicensis*, 5: *P. levantica*.

umbilicus is closed, while the umbilicus is slit-like in *P. kathrini*, and the outer margin of the aperture is sharp in that species. The penis of *P. hamicensis* has a swelling in its middle part, whilst there is no swelling in *P. kathrini*.

Distribution: The species occurs in both coastal and inland area (El Kebir, Abou Ali, Ibrahim, El Kalb, Litani), and is, in addition to *P. kathrini*, the most widespread *Pseudobithynia* species in Lebanon. It occurs at elevations from 5 to 1330 m a.s.l. It is eurythermous (11–26°C) and eurytopic (main river, tributaries, springs and pond) (Fig. 5). The eggs are laid on the shells of other specimens (Fig. 4.10).

Remarks: Because of the high variability of the shells of this species, GLÖER & BÖBNECK (2007) did not recognise that *P. hamicensis* (Pallary) and *P. amiqensis* Glöer & Böbneck, 2007 are conspecific. We compared our samples with a photo of a syntype, which allowed us to identify *P. hamicensis* beyond doubt.

Pseudobithynia saulcyi (Bourguignat, 1853)

Bithynia saulcyi BOURGUIGNAT, 1853 (p. 63). Baalbek.

Material: S36 (topotype).

Description: The silky shell is conical, brownish horn-coloured, with 4.5 slightly rounded whorls (Fig. 6.1). The suture is deep. The body whorl is prominent, and the umbilicus is closed. The aperture is oval and angled at the top, with a sharp margin. The operculum is concave at the central nucleus (Fig. 6.2). The mantle is black. Shell 5.8 mm high, 4.1 mm wide, ratio of H:B=1.4. The penis is simple, broad at the base and blunt at the distal end

Table 2. Number of *Pseudobithynia* spp. recorded per river system in The Lebanon.

	El Kebir	Abou Aali	Ibrahim	El Kalb	Aouali (Awali)	Litani	Orontes
<i>P. badiella</i>		+				+	
<i>P. hamicensis</i>	+	+	+	+		+	
<i>P. kathrini</i>		+	+		+	+	+
<i>P. levantica</i>							+
<i>P. saulcyi</i>							+
No. of species	1	3	2	1	1	3	3

(Fig. 6.3). – Diagnosis: Shell conical, umbilicus closed, margin of the aperture thin and sharp, penis simple.

Distribution: It was found only in the headwater of the Orontes (eastern slope of Mont Liban) at one sampling site (Ras el-Ain Baalbeck). The spring of Ras el-Ain Baalbeck (S27) is part of a karstic area in a chain of the Anti-Lebanon mountains in the east (inland province, or Bekaa with a submediterranean to arid climate). Currently, its flow is reduced by pumping and is only rarely 1 m³/s. This main resurgence is marked by dense macrophytes: *Ranunculus sphaerospermus* and *Myriophyllum spicatum*. On the banks we find grasses (Graminaceae) and sedges (Cyperaceae), and on the water surface filamentous algae in particular. At our sampling site, the water temperature was 9-16°C, dissolved O₂ levels at or near saturation (80-90%), and the substrate consisting of silt and sand rich in decaying plant debris; the depth varied between 10 and 40 cm.

Remarks: According to BOURGUIGNAT (1853: 63), *B. saulcyi* is subconical ventricose with a black-greenish epidermis. The surface bears black ribs. The measurements of the original description are: shell height 6 mm, width 3.5 mm. We could not find this black-greenish epidermis and the black ribs, nor were they evident on the holotype.

Identification key to the Bithyniidae of Lebanon

- 1 Shell small, height 3-3.5 mm, globular, margin of the aperture thick, penis simple without swelling *P. badiella*
- Shell larger, conical 2
- 2 Shell >8 mm high, outer margin of the aperture thickened, penis with a swelling *P. hamicensis*
- Shell <8 mm high, penis with a swelling or simple 3
- 3 Shell height 7-8 mm, slim conical, margin of the aperture sharp, umbilicus slit-like, penis simple *P. kathrini*
- Shell smaller, umbilicus closed 4
- 4 Shell height 6 mm, conical, umbilicus closed, margin of the aperture thin and sharp, penis simple *P. saulcyi*
- Shell height 5-6 mm, conical, penis with a swelling..... *P. levantica*

Table 3. Zonation (as range of temperature, and range of elevation) of *Pseudobithynia* spp. in Lebanese rivers (coastal = coastal rivers of the western slope of Mont Lebanon; inland = headwater of Orontes and Litani rivers (eastern slope of Mont Lebanon)).

	Water temperature (°C, min.-max)		Zonation	Altitude	Distribution
<i>P. levantica</i>	9-18	hemi- stenothermous	crenal and rhithral	600-1730	inland (Orontes river basin)
<i>P. kathrini</i>	8-28	eurythermous	eurytope but prefers crenal-rhithral	30-1730	coastal + inland
<i>P. hamicensis</i>	11-26	eurythermous	eurytope but prefers crenal-rhithral	5-1330	coastal + inland
<i>P. sauleyi</i>	9-16	hemi- stenothermous	crenal	1000-1100	inland (Orontes river basin)
<i>P. badiella</i>	6-22	eurythermous	crenal and rhithral	130-1400	coastal + inland

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