

First record of *Pemphigus saliciradicis* (Börner, 1950) (Hemiptera: Aphididae) on roots of the grape vine, *Vitis vinifera* (Vitaceae) from Transcaucasia

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Apterous and alate viviparous females of the aphid *Pemphigus saliciradicis* (Börner, 1950) collected for the first time on roots of the grape vine (*Vitis vinifera*, Vitaceae) near Tbilisi (Georgia) in 1968 are redescribed and illustrated. A key to the alatae of the genus *Pemphigus* Hartig species distributed in Transcaucasia is given.

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1. Introduction

The genus *Pemphigus* Hartig, 1839 is represented by more than 70 species in the world (Remaudiere & Remaudiere 1997, Blackman & Eastop 2006). Up to now, nine species of this genus including *Pemphigus borealis* Tullgren, *P. bursarius* (L.), *P. fuscicornis* (Koch), *P. immunis* Buckton, *P. populi* Courcey, *P. populinigrae* (Schrank), *P. protospirae* Lichtenstein, *P. spyrothecae* Passerini and *P. vesicarius* Passerini have been recorded in Transcaucasia (Uvarov 1918, Jijilashvili 1948, Razmadze 1961, Arutiunian 1967, Dzhibladze 1975, 1982, Alieva 1980, Barjadze & Kvavadze 2005). *Pemphigus saliciradicis* (Börner) was added to this species list after the present restudy of specimens collected by G. Dekanoidze on roots of grape vine in the suburb of Tbilisi.

P. saliciradicis (Börner 1950) (Aphididae: Eriosomatinae) normally lives on roots of *Salix* spp. (Salicaceae) in Europe, Asia and North America (Börner 1950, Hille Ris Lambers 1952,

Stroyan 1964, Lange 1965, Aoki 1975, Blackman & Eastop 1994). *P. saliciradicis* is here recorded for the first time from Transcaucasia. Apterous and alate viviparous females are reported for the first time on the roots of grape, *Vitis vinifera*. Specimens studied here were originally collected in April 1968 near Tbilisi in Georgia (Dekanoidze 1968) and provisionally identified as "*Pemphigus* sp." by Dr. A. Dzhibladze. Subsequent attempts to recollect *P. saliciradicis* in Georgian vineyards since 2006 have been unsuccessful.

2. Material and methods

Specimens of *P. saliciradicis*, from roots of *V. vinifera* (Vitaceae) were studied. All specimens were from the collection of the Georgian Institute of Zoology. Two slides with air penetration were successfully remounted in Canada balsam on six slides. Thirteen characters – BL, Ant., H.Ti., HTII, PT, Ant. I, II, III, IV, V, VIb were measured,

including those of the rostrum and its apical segments “URS” (= RIV+V). These abbreviations are explained in the tables.

Sixty nine root-feeding apterous exules of *Pemphigus bursarius*, *P. immunis*, *P. populi-nigrae*, *P. saliciradicis* (from *Salix* and *Vitis*) and *P. vesicarius* were included in the morphometric analysis. Six continuous characters were selected for analyses, while other characters were measured and subsequently rejected because of high correlation with other characters. Principal Components Analysis (SPSS program package) was carried out on all specimens using the final 6 variables to determine the main components of variation in the morphological data and show differences or similarities between root living *Pemphigus* species. The differences between the apterous exules of the aphid taxa were tested using ANOVA and Tukey's *a posteriori* tests. Ranges of selected characters are shown in Table 3, but the results of Tukey's tests are for means.

3. Redescription of *Pemphigus saliciradicis* (Börner, 1950) (Table 1, 2; Figs 1a–d, 2a–e)

3.1. Material examined

Alata vivipara females. Nr. 1. Label (in Cyrillic): “na korniakh vinograd [= on the roots of vine] *G. Dekanoidze* L0361”, (without date nor locality), identified as “*Pemphigus* sp.” by Dr. A. Dzhibladze. Nr. 2 (same label than Nr. 1.).

15 apterous viviparous females. With the label, “na korniakh vinograd [on the roots of wine] Avchala 8.IV.68” (locality of the Tbilisi suburb, Georgia).

These specimens deposited in the MNHN (Nr. 017231); in the Institute of Zoology of Georgia (IZG), in the BMNH London and in the MNHN Paris (Nr. 017232).

3.2. Apterous viviparae

Field characters: live specimens yellowish with blackish antennae, head and legs; body wax-covered with wax flocks extending posteriorly (Dekanoidze 1968). Recognition characters: head with a pigmented discal plate (length 0.29–

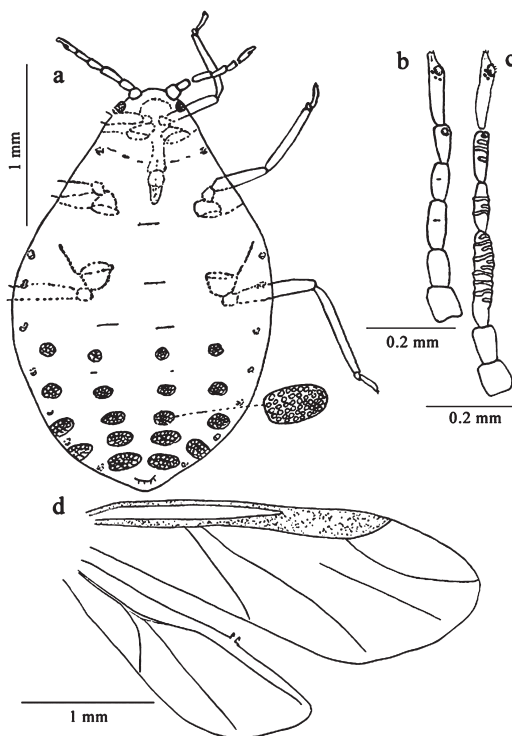


Fig 1. *Pemphigus saliciradicis* (Börner, 1950), aptera vivipara female. – a. Body. – b. Antenna; alata vivipara female. – c. Antenna. – d. Forewing. (According to Dzhibladze 1975).

0.33 mm, frontal and basal width 0.15 and 0.26 mm respectively), medial suture pale; antennae and legs evenly dark; cauda, anal and subgenital plates slightly pigmented. Vertex with short setae, ca. 15 μ m, without wax gland plates, densely covered with minute wax pores. Eyes very dark, separated from the discal plate, with 3 ommatidia and sometimes with 6–20 additional smaller facets. Antenna 6-segmented, 1.2–1.4 X rostr. length, sometimes Ant. III and Ant. IV imperfectly separated; Ant. III short and very variable, 1.03–1.52 X Ant. II, only 1.8–2.9 times longer than its median diameter, 0.66–0.88 X VI b and 0.90–1.25 X URS; Ant. IV always shorter than Ant. V, about as short as Ant. I; length of Ant. V 2.6–3.7 times longer than its narrow basal diameter which is half (0.45–0.54) of the subapical one; PT 0.28–0.37 times shorter than VI b. Antennal setae short 8–11 μ m: Ant. I with 3 setae; Ant. II – 6–9; Ant. III – 3–4; Ant. IV – 2–3; Ant. V – 3; VI b – 2; PT – 5 setae. Primary rhinaria small, with a crown of numerous setae. Rostr. not reaching mesocoxae;

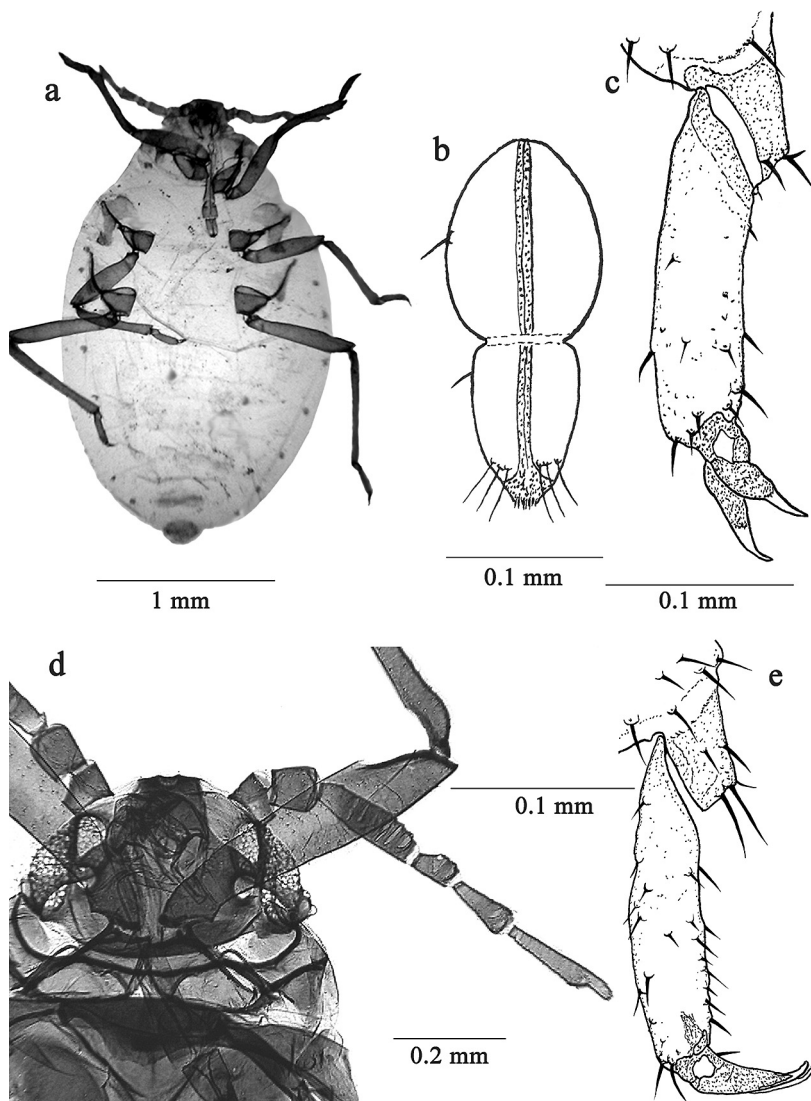


Fig 2. *P. saliciradicis* (Bömer, 1950), aptera vivipara female.
 – a. Body. – b. III-V segments of rostrum.
 – c. Fore tarsus; alata vivipara female.
 – d. Head and antenna.
 – e. Fore tarsus.

URS short, subcylindrical 0.6–0.7 on its basal part, with 0–1 (rarely 2) accessory setae which are very short (8–10 μm); a narrow apical zone of R IV is distinctly pale.

Thorax without wax plates. Metatibia 0.19–0.26 X BL, with short setae c.a. 15 μm i.e. 1/3 of the diameter of tibia in the middle. First tarsal segment with 2 strong, straight apical setae (19–20 μm) and, on the fore leg, an additional finer, shorter and curved seta (11–12 μm) between them. Empodial setae very short (6–8 μm).

Abdomen with 4 wax plates on each tergite III

to VI, those on III and IV subcircular, smaller than those on V and VI and, on tergite VII, 2 much larger ones; each plate with 1 (rarely 2) fine setae of 27–32 μm long; these plates are quite pale and distinct mainly by their border. Tergite VIII with 6 setae – 40 μm long, cauda with 2–3 setae – 30 μm long. Anal plate with 8–12 setae; the 3 gonapophyses hardly developed, respectively with 8–9, 2–2, 8–9 very short setae; genital plate with 10–12 anterior, 4–5 median, and 10–12 posterior setae. Other characteristics are given in Table 1.

Table 1. Biometric data (means in mm) of vine root living *Pemphigus saliciradicis* females; Al.: alata vivipara, Ap.: aptera vivipara.

	Ant. segments												
	BL	Ant.	Rostr.	H.Ti.	I	II	III	IV	V	VIb	PT	URS	HTII
Al.	3.05	0.82	0.40	0.86	0.069	0.090	0.219	0.101	0.129	0.162	0.053	0.107	0.195
Al.	3.08	0.78	0.45	0.79	0.066	0.082	0.206	0.096	0.123	0.159	0.052	0.101	0.208
Ap.	2.42	0.61	0.52	0.57	0.058	0.093	0.110	0.060	0.077	0.151	0.047	0.107	0.175
Ap.	2.62	0.65	0.45	0.61	0.071	0.096	0.118	0.069	0.093	0.159	0.044	0.107	0.192
Ap.	2.80	0.70	0.50	0.72	0.074	0.096	0.137	0.063	0.104	0.170	0.052	0.118	0.195
Ap.	2.47	0.67	0.49	0.61	0.079	0.090	0.137	0.063	0.085	0.156	0.047	0.110	0.184
Ap.	2.51	0.64	0.50	0.57	0.082	0.096	0.118	0.069	0.082	0.140	0.052	0.101	0.181
Ap.	2.58	0.60	0.48	0.50	0.063	0.093	0.096	0.071	0.082	0.140	0.052	0.107	0.186
Ap.	2.37	0.57	0.48	0.50	0.069	0.082	0.090	0.063	0.082	0.137	0.049	0.099	0.167
Ap.	2.37	0.60	0.47	0.55	0.063	0.101	0.110	0.056	0.071	0.148	0.055	0.110	0.170
Ap.	2.47	0.61	0.51	0.58	0.053	0.093	0.099	0.071	0.088	0.151	0.044	0.110	0.173
Ap.	2.72	0.66	0.54	0.62	0.071	0.104	0.118	0.069	0.096	0.159	0.047	0.110	0.186
Ap.	2.51	0.63	0.53	0.61	0.069	0.090	0.112	0.056	0.093	0.150	0.049	0.112	0.178
Ap.	2.69	0.71	0.53	0.70	0.074	0.104	0.145	0.055	0.121	0.162	0.047	0.104	0.197
Ap.	2.76	0.65	0.51	0.64	0.077	0.096	0.123	0.039	0.096	0.162	0.049	0.110	0.178
Ap.	2.46	0.60	0.46	0.53	0.069	0.096	0.099	0.056	0.082	0.151	0.052	0.104	0.170
Ap.	2.29	0.61	0.49	0.54	0.071	0.096	0.110	0.066	0.074	0.145	0.047	0.104	0.170

Abbreviations: BL: body length; Ant.: Antenna; VIb: base of VI antennal segment; PT: processus terminalis; Rostr.: rostrum; URS: (= RIV+V) apical segment of rostrum; H.Ti.: hind tibia; HTII: second segment of hind tarsus

3.3. Alate viviparae

Recognition characters: head, antenna, rostr. (except a short pale subapical zone), meso-, metanotum and stomatic plates dark; legs a little paler; cauda, anal and genital plates barely pigmented. Head without wax gland plates, vertex with about 18 short setae (10–15 μ m). Antenna 6-segmented; Ant. III 3.4–3.9 times longer than its maximal diameter, about 2 times Ant. IV, subequal to Ant. VI (VIb+PT), with an obvious tooth near the base, i.e. before the first rhinarium; Ant. IV only 1.8–1.9 X its maximum diameter; Ant. V 2.0–2.4 its maximum diameter but 5.6–5.9 X its basal diameter; PT 0.33 times shorter than VI b.

Sec. rhin., oblong oval to nearly narrow, occupying no more than half of the circumference of the segment; antennal chaetotaxy: 4–5 setae on Ant. I, 17–18 on Ant. II, 6–8 on Ant. III, 2–3 on Ant. IV, 3–5 on Ant. V, 2 on VI b, and 5 on PT. Rostr. short, only 0.13–0.15 X BL, similar to aptera; URS 0.49–0.55 X HTII, about 1.7 times longer than its basal width, with 2 short accessory setae.

Thorax with 2 small wax gland plates on the

base of the mesonotum. First tarsal joint chaetotaxy: anterior leg, 3+2, medium and posterior legs, 2+2; second tarsal joint with about 10 ventral setae. Wings with pale veins except the subcostal vein which is darker and enlarged on the posterior part of the pterostigma; distance from base of radial sector to the apex of pterostigma = 0.4 \times the distance from tip of pterostigma to tip of Rs; base of Cu1 and that of Cu2 well distant; on the posterior wing, the two oblique veins are not basally connected.

Abdomen with wax gland plates on tergites III–VII; their distribution is not very distinct and possibly different from that observed in aptera (2 or 3 pairs? on some of the tergites III–VI, 1 or 2 pairs? on tergite VII). Cauda with 3 setae, anal plate with 6 setae, gonapophyses, and genital plate as in aptera. Measurements and ratios of apterous and alatae viviparous females are given in the Table 1 & 2.

3.4. Embryo in alate

BL about 0.6–0.7 mm. Antenna 4-segmented, with 2 apical setae on Ant. III and 2 setae below

Table 2. Comparisons of alatae exules of *P. saliciradicis* living on *V. vinifera* and nearby *Salix* sp. roots (Aoki 1975). For measured traits, ranges (mm) are shown. Bold type shows differences (on the basis of non-overlapping ranges) of measurements and ratios between the taxa.

No. of specimens	2	3
Locality	Georgia: Tbilisi, Avchala	Japan: Jōzankei, Hokkaidō
Date	unknown	3.X.1973
On roots of	<i>Vitis</i>	unknown (near <i>Salix</i> sp. roots)
BL	3.05–3.08	2.16–2.36
Ant.	0.78–0.82	0.58–0.65
Ant. III	0.21–0.22	0.18–0.21
Ant. Vb or VIb	0.16	0.15–0.17
PT	0.052–0.053	0.040
URS	0.10–0.11	0.10–0.11
HTII	0.20–0.21	0.21–0.22
Number of sec. rhin. on Ant. III, IV, V	III–8–10; IV–2–5; V–1–3	III–6–8; IV–2–5; V–0–1
Ratios:		
Ant./BL	0.25–0.27	0.26–0.28
Ant. III/BL	0.07	0.08–0.09
PT/Ant. VIb	0.33	0.24–0.25

Abbreviations: Ant. IV and V: IV and V antennal segments; other abbreviations are explained in Table 1 and 3.

the primary rhinarium of Ant. IV. Length of largest setae on antenna and leg: 26–35 μm; empodial setae: 9–13 μm, i.e. 4–5 times shorter than the claws. URS without distinct accessory setae (?); its subapical part is about as wide as the proximal. Embryo has stylet.

4. Comparison of *P. saliciradicis* on *Vitis* and *Salix* and with other species

For root-feeding aptera exules, there are significant differences among the taxa in the means of all traits tested (BL, Ant., Ant. III, Rostr., URS and HTII), $F_{5,63} > 13.6$, $P < 0.0001$ for all (for pairwise differences see Table 3). Ratios of Ant./BL, Rostr./BL, Rostr./Ant., URS/BL, URS: length/Width, URS/HT2, URS/Ant. Vb or VIb between aptera exules of *P. saliciradicis* (Börner) (both *Vitis* and *Salix*-feeding ones) and four other *Pemphigus* species are also given in Table 3.

All apterous specimens of *Pemphigus populinigrae* and *P. vesicarius* are grouped separately from each other and other species specimens, while specimens of *P. bursarius* and *P. immunis* have some overlaps. Specimens of *Salix* and *Vitis* root feeding *P. saliciradicis* are grouped together separately from other species and also overlapping, indicating their similarity (Fig. 3).

Additionally, alate exules of *P. saliciradicis*

collected on the roots of an undetermined plant from Japan (Aoki 1975) and the *Vitis* root feeding *Pemphigus* sp. were compared (Table 2). Differences in measurements and ratios between *Vitis*

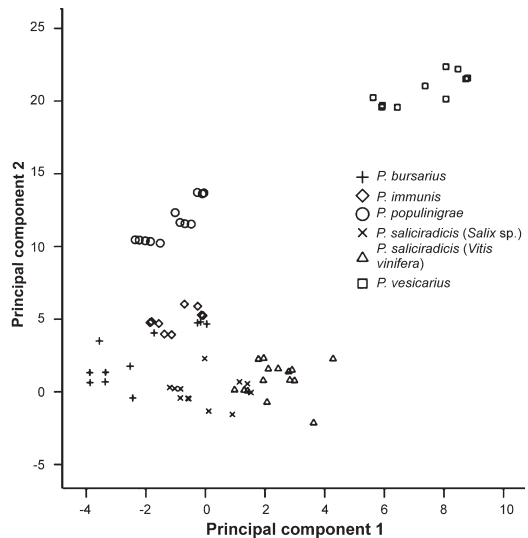


Fig 3. Principal component ordination of the specimens of *P. bursarius*, *P. immunis*, *P. populinigrae*, *P. saliciradicis* and *P. vesicarius* based on the analysis of the six morphological variables (BL, Antenna, Ant. III, Rostr., URS, HTII) onto the first and second principal axes.

Table 3. Ranges of selected traits of root living aptera exules of *P. saliciradicis* (*P. salic.*) on *Vitis* and *Salix*, and four other root living *Pemphigus* species: *P. bursarius* (*P. burs.*), *P. immunitis* (*P. imm.*), *P. populinigrae* (*P. pop.*) and *P. vesicarius* (*P. ves.*). Means sharing no letters are significantly different (Tukey's test, $P < 0.05$) for the tested variables (BL, Ant., Ant.III, Rostr., URS and HTII). Bold type shows differences (on the basis of non-overlapping ranges) of ratios between *P. saliciradicis* (Börner) (vine and *Salix* sp. feeding ones) and four other *Pemphigus* species.

	<i>P. salic.</i> (on <i>Vitis</i>)	<i>P. salic.</i> (on <i>Salix</i> sp.)	<i>P. burs.</i>	<i>P. imm.</i>	<i>P. pop.</i>	<i>P. ves.</i>
Number of specimens	15	12	11	9	12	10
Locality	Georgia	Iran	France	Italy	Spain	France
Date	08.IV.1968	24.VI.1955	21.VIII.1953 10.XI.1953 03.VII.1998	21.X.1963	17.VIII.1970 04.VII.1985	07.IX.2000
On roots of:	<i>V. vinifera</i>	<i>Salix</i> sp.	<i>C. sp.</i> <i>T. sp.</i> <i>L. sp.</i>	<i>E. pithuisa</i>	<i>G. sp.</i> <i>F. spath.</i>	<i>C. arbor.</i>
BL (mm)	2.3–2.8 ^a	1.7–2.5 ^b	1.3–2.1 ^c	1.4–1.9 ^c	1.3–2.0 ^c	2.8–3.4 ^d
Antenna (mm)	0.57–0.71 ^a	0.45–0.59 ^b	0.24–0.43 ^c	0.39–0.46 ^d	0.31–0.40 ^{cd}	0.51–0.63 ^b
Ant.III (mm)	0.09–0.15 ^{ade}	0.08–0.14 ^{acd}	0.04–0.09 ^b	0.06–0.11 ^{bc}	0.07–0.12 ^{dc}	0.10–0.16 ^e
Rostr. (mm)	0.45–0.54 ^a	0.42–0.53 ^b	0.31–0.51 ^{cf}	0.43–0.49 ^{bf}	0.35–0.43 ^{cg}	0.87–1.03 ^d
URS (mm)	0.10–0.12 ^a	0.09–0.10 ^b	0.08–0.11 ^b	0.10–0.11 ^a	0.12–0.14 ^c	0.19–0.21 ^d
HTII (mm)	0.17–0.20 ^a	0.14–0.17 ^b	0.10–0.14 ^c	0.11–0.13 ^c	0.09–0.10 ^d	0.17–0.21 ^a
Ant./BL	0.23–0.27	0.19–0.26	0.18–0.24	0.21–0.28	0.19–0.25	0.15–0.22
Rostr./BL	0.17–0.21	0.20–.24	0.21–0.26	0.23–0.30	0.21–0.26	0.26–0.34
Rostr./Ant.	0.69–0.85	0.86–1.02	1.0–1.3	1.0–1.1	1.0–1.2	1.5–1.8
URS/BL	0.04–0.05	0.04–0.05	0.05–0.06	0.06–0.07	0.07–0.09	0.06–0.07
URS: Length/Width	1.6–1.9	1.3–1.7	2.1–2.4	2.1–2.3	2.2–2.7	3.4–4.2
URS/HTII	0.53–0.65	0.56–0.70	0.75–1.02	0.84–0.98	1.2–1.4	1.0–1.2
URS/Ant. Vb or Vlb	0.64–0.75	0.70–0.89	0.84–1.06	0.85–1.03	1.2–1.5	1.5–1.8

Abbreviations: Ant. III: III antennal segment; Ant. Vb: base of V antennal segment. Host plant: *V. vinifera*: *Vitis vinifera*; *C. sp.*: *Cichorium* sp.; *E. pithuisa*: *Euphorbia pithuisa*; *G. sp.*: *Gnaphalium* sp.; *C. arbor.*: *Colutea arborescens*; *T. sp.*: *Taraxacum* sp.; *L. sp.*: *Lactuca* sp.; *F. spath.*: *Filago spathulata*. Other abbreviations are explained in Table 1.

and *Salix* roots feeding apterous and alate exules of *P. saliciradicis* may be caused by influence of different environmental conditions and host plant's chemical substances. The only way to strictly confirm that specimens of *P. saliciradicis* originating from *Salix* spp. and *Vitis* belong to a single taxon, is host transfer experiments of exules from *Salix* roots to *Vitis* roots and vice versa. There are clear differences between *Vitis*-inhabiting and the 'normal' *Salix* specimens (see Table 3), possibly indicates a new species, but as the *Vitis* taxon has been found only once, more of those are needed to reconsider possible separation of this form as a new species. A final decision awaits the collection of further samples.

5. Key to the alatae of the genus *Pemphigus* Hartig species distributed in Transcaucasia

1. Aphid living on roots 2
 - Aphid living on aerial parts 3
2. Alatae with sec. rhin. on Ant. III – 8-10, Ant. IV-2-5, Ant. V – 1-3. On roots of *Vitis vinifera* *P. saliciradicis* (Börner)
 - Alatae with sec. rhin. on Ant. III – 5-8, Ant. IV – 1-3, Ant. V -0. On roots of *Beta vulgaris* and *Beta vulgaris saccharifera* *P. fuscicornis* (Koch)
3. Gall produced on leaf petioles or leaf surface 4
 - Gall produced on twigs or branches 9
4. Siphuncular pores absent 5
 - Siphunculus present as small pores 7
5. Galls produced on the mid-rib of the leaves 6
 - Galls produced by spiral twisting of petiole.

On *Populus nigra* and *P. pyramidalis*

P. spyrothecae Passerini

6. Galls globular on upper side of leaves. First tarsal segments almost always with 2 hairs, rarely with 3. HT II 0.17–0.21 mm long. On *Populus nigra* and *P. pyramidalis*

P. populi Courchet

- Galls have irregular structure with numerous tubular outgrowth. First tarsal segments usually with 3–4 hairs. HT II 0.20–0.25 mm long. On *Populus nigra* and *P. pyramidalis*

P. vesicarius Passerini

7. Galls produced on petiole. Alatae with sec. rhin. on Ant. III–8-17, Ant. IV–2-8, Ant. V–2-5, Ant. VIb–2-8

- Galls pouch shaped, on upper side of mid-rib of leaves. Alatae with sec. rhin. on Ant. III–12-18, Ant. IV–3-7, Ant. V–4-7, Ant. VIb–4-7. On *Populus nigra* and *P. pyramidalis*

P. populinigrae (Schrank)

8. Galls similar to galls of *P. spyrothecae*, but thinner and with more spirals. Most proximal sec. rhin. on Ant. III distal to tooth. On *Populus nigra* and *P. pyramidalis*

P. protospirae Lichtenstein

- Galls purse-shaped. Most proximal sec. rhin. (1 or 2) on Ant. III basal to tooth. On *Populus nigra* and *P. pyramidalis*

P. bursarius (L.)

9. Galls hazelnut-sized, elliptical. Alatae with sec. rhin. on Ant. III–13-19, Ant. IV–4-5, Ant. V–6-9, Ant. VIb 6-10. On *Populus pyramidalis*

P. borealis Tullgren

- Galls quite large, walnut like. Alatae with sec. rhin. on Ant. III–7-9, Ant. IV–2-4, Ant. V–0-1, Ant. VIb 0. On *Populus nigra* and *P. pyramidalis*

P. immunis Buckton

6. Discussion

The Georgian entomologist, G. Dekanoidze (1968) found dense colonies of *Pemphigus* sp. consisting only of apterous viviparous females on the main and secondary roots of *Vitis* in early April 1968. They caused damage and death to 75% of secondary roots and they occurred on the roots to the depth of 40 cm. According to Dekanoidze (1968), this species lives only on roots of vine, overwintering there, and begin feeding and

reproducing early spring. However, such assertion implies that the population of *P. saliciradicis* is anholocyclic (lives on the secondary host during the whole year and reproduces only parthenogenetically, i.e. the sexual generation is lost) on *Vitis* roots, as population of this species on roots of *Salix* spp.

All attempts to recollect *Pemphigus* species on roots of vine since 2006 have been unsuccessful. Based on this unsuccessful search, I think this species is not a new species for science, but it is *P. saliciradicis* – occasionally occurring on vine roots. But this species may be found on vine roots again in future and it can become potentially problematic pest in grape production.

There are other records of root-feeding Eriosomatinae on *Vitis*, such as a colony of *Prociophilus oleae* which was recorded only one time on roots of vine (Stroyan & Barbagalo 1982), and a colony of *Geoica lucifuga* (apterous females and larvae) was collected only one time (Nevsky 1929). It is clear that these vine root feeding species (*P. oleae* and *G. lucifuga*) have an ability to settle on the new host species.

Conversely, because of the wide range of distribution of *P. saliciradicis* (Asia, Europe and North America) and on the other hand, high percentage of grapes' secondary roots damage (75%) (based on single data-point) this species could be potentially problematic in grape production.

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