

Contributions to the fauna of reptilian chiggers (Acari: Trombiculidae) from the Central Mediterranean, with a description of one new species

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A new species of chigger mite, *Lacertacarus sardiniensis* sp. nov., is described from a lizard *Podarcis tiliguerta* (Gmelin) collected in Sardinia. One species, *Ericotrombidium caucasicum* (Schluger, 1967), previously known from Southern Russia and Southern Ukraine, is recorded for the first time on the lizards *Podarcis filfolensis* (Bedriaga) and *Podarcis siculus* (Rafinesque-Schmaltz), and on Malta, Lipari Island and Alicudi Island (Aeolian Islands, Sicily, Italy).

<http://zoobank.org/urn:lsid:zoobank.org:pub:CD41E85B-1801-4FA3-BC42-28F5F1AC14C1>

Keywords: Trombiculidae; chiggers; *Lacertacarus*; *Ericotrombidium*; lizards; *Podarcis*; Mediterranean; Malta; Sardinia; Italy

Introduction

Host selectivity in trombiculids depends mainly on a coincidence of habitats in chiggers and their hosts (Daniel 1961). This selectivity results in the existence of chigger species and genera parasitizing exclusively or principally bats, birds, lizards or amphibians (Kudryashova 1998). Because lizards are characteristic element of the Mediterranean fauna, investigation of their chiggers is an important part of trombiculid studies in the region. However, collections of chiggers from reptiles are not as frequent as from small mammals. Our materials found on lizards inhabiting several islands of Mediterranean Sea provide therefore a significant addition to the faunistics of these mites.

Materials and methods

Collection

Lizards were hand-collected and checked for parasites without any damage to the animal. Parasites were removed with a pin and immediately preserved in 85% ethanol.

Morphology

Most of the mite specimens collected were mounted on microscope slides in Faure–Berlese medium and examined with the use of a microscope MBI-3 (LOMO plc, St. Petersburg, Russia) supplied with phase-contrast optics. Measurements (in micrometres) were made with an ocular micrometer, and morphological drawings were made using a camera lucida. The terminology follows the standards generally accepted in chigger taxonomy (Goff et al. 1982; Kudryashova 1998; Stekolnikov 2013). In the scheme of

the dorsal idiosomal setae arrangement (Figure 5), tentative bounds between rows of setae are outlined by dotted lines. The double circles in the figures of the legs (Figures 11–13) represent the bases of unspecialized tactile setae; single circles correspond to the unspecialized setae situated on the opposite side of the leg.

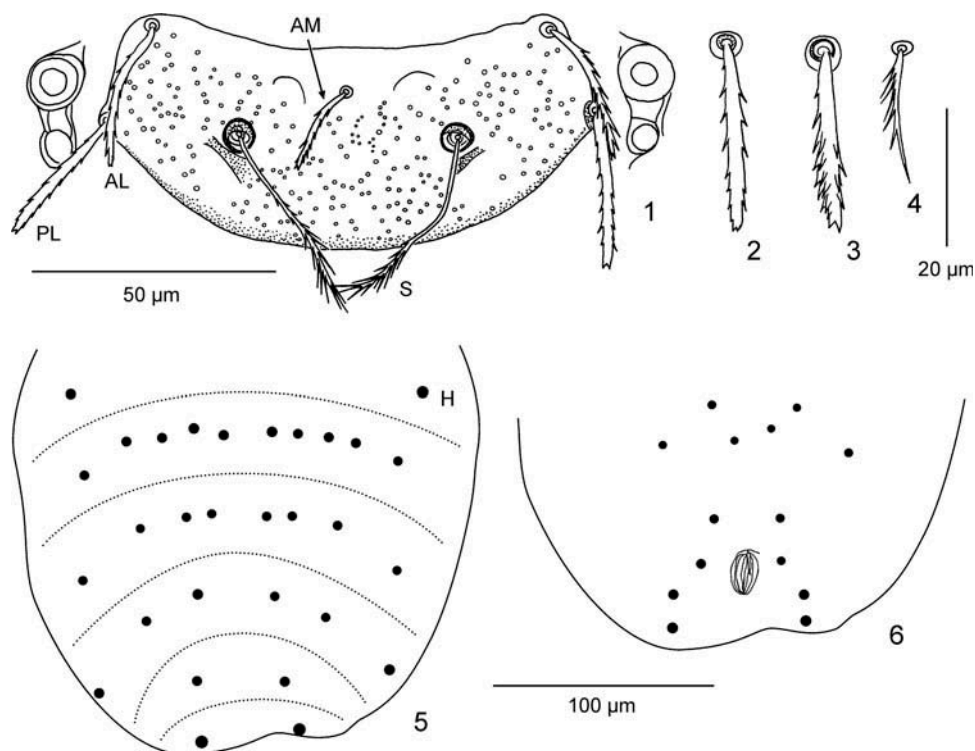
Two specimens (one of each species) were cleared in lactic acid and mounted on microscope slides in glycerol. Photographs of these specimens were taken with an Olympus BD40 microscope equipped with an Olympus 20× phase-contrast lens (Olympus Corporation, Tokyo, Japan) and digital microscope camera. Images were enhanced in Photoshop CS6 (Adobe Systems Inc., San Jose, CA, US) and have been deposited in Morphbank (2014).

Specimens' deposition

Two specimens photographed for Morphbank have been deposited in the private collection of Walter P. Pfliegler (WPP). Other specimens, including type series of the new species, have been deposited in Zoological Institute, St. Petersburg, Russia (ZIN).

Statistical evaluation

We estimated the morphometric differences between samples of examined species by individual standard variables with the use of Wilcoxon Mann–Whitney rank sum test and calculation of exact two-sided *p*-values. This technique belongs to nonparametric statistical methods and can be used in the case of very small sample sizes (Hollander and Wolfe 1999). It applies a rank transformation to a variable and then tests the null hypothesis implying equality of



Figures 1–6. *Lacertacarus sardiniensis*, **sp. nov.** 1. Scutum and eyes. 2. Dorsal idiosomal seta of the first row. 3. Dorsal idiosomal seta of the fourth row. 4. Ventral (preanal) idiosomal seta. 5. Arrangement of dorsal idiosomal setae. 6. Arrangement of ventral idiosomal setae. Scale bars: 1, 50 µm; 2–4, 20 µm; 5, 6, 100 µm. Abbreviations: AL, anterolateral scutal seta; AM, anteromedian scutal seta; H, humeral seta; PL, posterolateral scutal seta; S, sensillum.

sample medians in two groups characterized by this variable. Calculations were performed in the package “coin” ver. 1.0–23 (Hothorn et al. 2006, 2008) implemented in the “R” software environment ver. 3.1.0 (R Core Team 2014).

Genus *Lacertacarus* Schluger et Vasilieva, 1977

Schluger and Vasilieva, 1977: p. 265; Kudryashova, 1998: p. 243; Kalúz, 2011: p. 16.

Type species

Trombicula callosa Schluger, 1966 (by original designation).

Species included

Lacertacarus callosus (Schluger, 1966), *Lacertacarus graecus* Kalúz, 2011, *Lacertacarus latus* Schluger et Vasilieva, 1977, *Lacertacarus sardiniensis* **sp. nov.**, *Lacertacarus similis* Schluger et Vasilieva, 1977, *Lacertacarus turcicus* Kalúz, 2011.

Diagnosis

SIF = 7BS-N-3(2)-2(3)111.(0–2)0(1)00; fPp = B/B(N)/NNB; fsp = 7.7.7; fCx = 1.1.1; fSt = 2.2. Palp tarsus with seven branched setae, nude subterminala (eupathidium) and

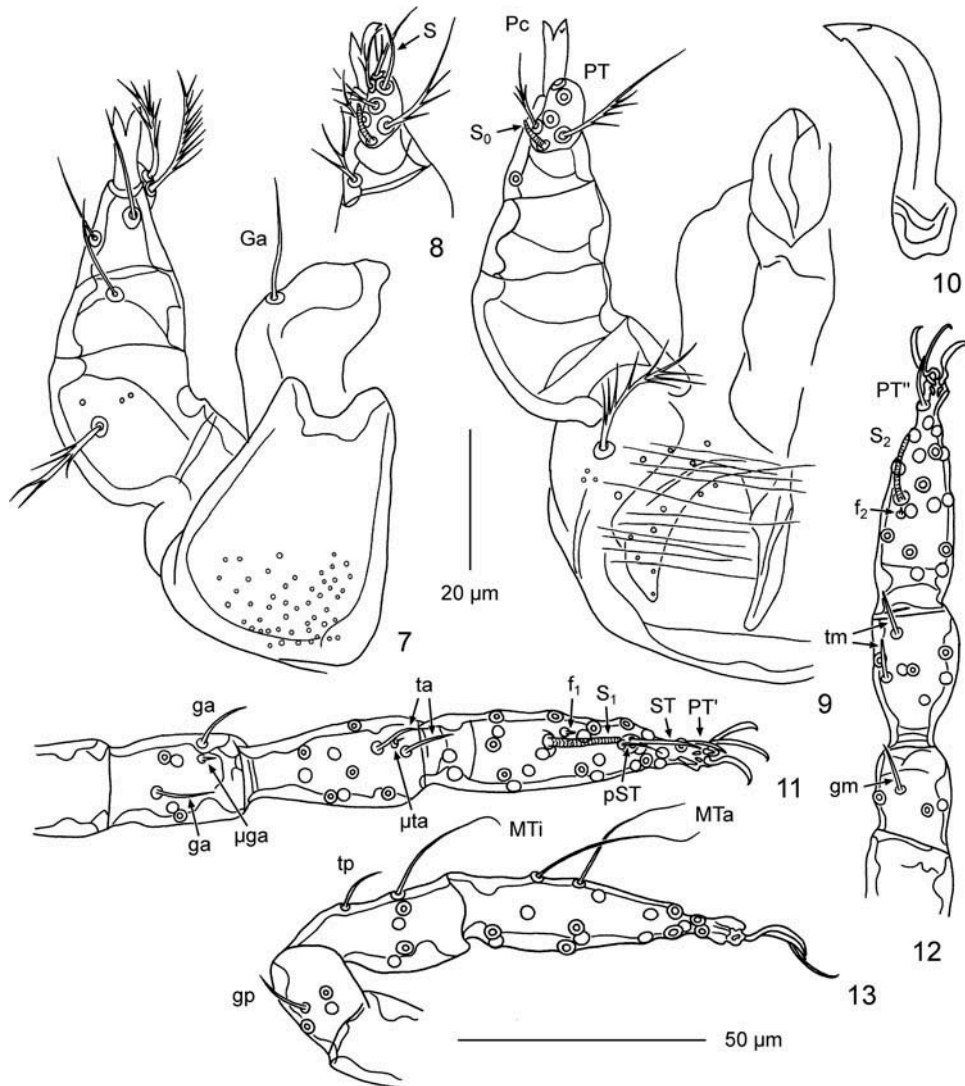
basal tarsala (solenidium); galeal seta nude; palpal claw three-pronged (in *L. sardiniensis* **sp. nov.** probably two-pronged); cheliceral blade with tricuspid cap; palpal femoral seta branched; palpal genual seta branched or nude; dorsal and lateral palpal tibial setae nude, ventral palpal tibial seta branched. Scutum much wider than long, in shape of crescent, with puncta; two pairs of eyes; flagelliform sensilla with short branches in distal half; distance between sensillary bases larger than distance from sensillary base to posterolateral seta. Dorsal idiosomal setae usually slightly inflated, lanceolate, covered with short squamose barbs. Legs seven-segmented; leg coxae unisetose; microtarsala I (famulus) distal to tarsala I (solenidium); two or three genualae I (solenidia); usually one mastitarsala on leg III; in *L. turcicus* mastitarsala absent; in *L. sardiniensis* **sp. nov.** two mastitarsalae and mastitibiala present.

Remarks

The genus is similar to *Neotrombicula* Hirst, 1925 and differs from it mainly by the scutum, which is much wider than long, in the shape of crescent in *Lacertacarus* and subpentagonal in *Neotrombicula*.

Hosts

Lizards (Reptilia, Squamata, Lacertidae). One species (*L. callosus*) was also found on *Erinaceus europaeus* L. Hosts for *L. graecus* and *L. turcicus* are unknown.



Figures 7–13. *Lacertacarus sardiniensis*, sp. nov. 7. Dorsal aspect of gnathosoma. 8. Ventral aspect of palpal tibia and tarsus. 9. Ventral aspect of gnathosoma. 10. Cheliceral blade. 11. Leg I, dorsal view, genu-tarsus. 12. Leg II, dorsal view, genu-tarsus. 13. Leg III, antero-posterolateral view, genu-tarsus. Scale bars: 7–10, 20 µm; 11–13, 50 µm. Abbreviations: f_1 , microtarsala I; f_2 , microtarsala II; Ga, galeala; ga, genuala I; gm, genuala II; gp, genuala III; MTa, mastitarsalae; MTi, mastitibiala; Pc, palpal claw; PT, palpal tarsus; PT', pretarsala I; PT'', pretarsala II; pST, parasubterminala; S, palpal subterminala; S_0 , palpal tarsala; S_1 , leg tarsala I; S_2 , leg tarsala II; ST, leg subterminala; ta, tibiala I; tm, tibiala II; tp, tibiala III; μ ga, microgenuala; μ ta, microtibiala.

Distribution

Caucasus, Transcaucasia, Asia Minor, Southern Europe. By states: Russia (Krasnodar Krai), Georgia, Azerbaijan, Armenia, Turkey (Hatay Province), Greece. Here this genus is recorded in Italy (Sardinia) for the first time.

Lacertacarus sardiniensis sp. nov. (Figures 1–13, Table 1)

Diagnosis

SIF = 7BS-N-2(3?)-2111.2100; fPp = B/N/NNB; fCx = 1.1.1; fSt = 2.2; fSc: PL > AL > AM; Ip = 655–677; fD = 2H-(8–10)-8(7)-6-2-(2–4); fV = 6-2-2-2-2; DS = 29–31; VS = 13–14; NDV = 42–45.

LARVA

Idiosoma (Figures 1–6). Eyes 2 + 2. One pair of humeral setae; 27–29 dorsal idiosomal setae covered with short squamose barbs, arranged 10-8-6-2-2 with little variation, in holotype 9-8-6-2-2; four sternal setae, six to seven anterior ventral and six to eight posterior ventral setae, clearly separated from anterior ventral ones; total number of idiosomal setae excluding coxal and sternal 42–45.

Gnathosoma (Figures 7–10). Cheliceral blade with tricuspid tip; cheliceral base moderately covered with puncta in proximal part; gnathobase with transverse striations and sparse puncta; palpal femur with few puncta; gnathobase with one pair of branched setae; galeala nude; palpal claw with two prongs visible; seta on palpal femur branched; seta on palpal genu nude; dorsal and lateral palpal tibial

Table 1. *Lacertacarus sardiniensis* sp. nov., standard measurements of the type series.

Variable	Holotype	Range	Mean	Sample size
AW	81	76–86	80	7
PW	99	96–103	100	7
SB	44	44–49	46	7
ASB	25	23–25	25	7
PSB	23	21–25	23	7
SD	48	44–50	48	7
P-PL	27	23–31	27	7
AP	20	19–23	21	7
AM	18	17–22	19	5
AL	29	28–32	30	7
PL	31	31–34	32	5
S	42	42–44	43	3
H	33	31–36	33	7
D _{min}	25	24–27	25	6
D _{max}	32	30–35	32	6
V _{min}	17	16–22	18	6
V _{max}	29	29–35	31	6
pa	239	234–247	242	6
pm	200	200–209	205	4
pp	216	216–225	220	4
Ip	655	655–677	669	4
DS	29	29–31	30	7
VS	14	13–14	14	7
NDV	43	42–45	43	7
TaIIIL	58	58–58	58	4
TaIIIW	14	13–14	14	4

Abbreviations: AW, distance between anterolateral scutal setae; PW, distance between posterolateral scutal setae; SB, distance between sensilla; ASB, distance from the level of sensillary bases to extreme anterior margin of scutum; PSB, distance from the level of sensillary bases to extreme posterior margin of scutum; SD, length of scutum (ASB + PSB); P-PL, distance from the level of posterolateral scutal setae to extreme posterior margin of scutum; AP, distance from anterolateral to posterolateral scutal setae on one side; AM, length of anteromedian seta of scutum; AL, length of anterolateral setae of scutum; PL, length of posterolateral setae of scutum; S, length of sensilla; H, length of humeral setae; D_{min}, length of the shortest dorsal idiosomal seta; D_{max}, length of the longest dorsal idiosomal seta; V_{min}, length of the shortest ventral idiosomal seta; V_{max}, length of the longest ventral idiosomal seta; pa, length of leg I; pm, length of leg II; pp, length of leg III; Ip, total length of legs I–III; DS, number of dorsal idiosomal and humeral setae; VS, number of ventral idiosomal setae (excluding coxal and sternal setae); NDV, number of idiosomal setae (DS + VS); TaIIIL, length of leg tarsus III; TaIIIW, width of leg tarsus III.

setae nude, ventral palpal tibial seta branched; palpal tarsus with seven branched setae, nude subterminala and tarsala.

Scutum (Figure 1). Much wider than long, in the shape of crescent, with concave anterior and convex posterior margins, moderately punctated; AM base far posterior to level of ALs; SB posterior to level of PLs (P-PL – PSB = 2–8; mean value 4.3); PL ≥ AL > AM; flagelliform sensilla with 12–15 rather short branches in distal half.

Legs (Figures 11–13). All seven-segmented, with pair of subequal claws and claw-like empodium. Leg I: coxa with one non-specialized branched tactile seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, two genualae, microgenuala; tibia 8B, two tibialae, microtibiala; tarsus

22B, tarsala 14 long, microtarsala distal to tarsala, subterminala, parasubterminala, pretarsala. Leg II: coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B, genuala; tibia 6B, two tibialae; tarsus 16B, tarsala 13 long, thin, with slightly inflated apex, microtarsala proximal to tarsala, pretarsala. Leg III: coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala; tibia 5B (rarely 4B), tibiala, mastitibiala distal to tibiala; tarsus 14B, two mastitarsalae.

Host

Podarcis tiliguerta (Gmelin) (Reptilia, Squamata, Lacertidae).

Type material

Holotype larva (ZIN, slide no. 8550, T-Tr-65): Italy, Sardinia, Capo al Vente, near Bosa (40°19'38" N, 8°26'12" E), ex *P. tiliguerta*, 30 April 2013, coll. A. Sciberras and W. Pfliegler. Paratypes (ZIN, slides nos. 8548, 8549, 8551–8554): six larvae with the same data.

Additional material

One larva (private collection of W. Pfliegler, slide no. A6885) with the same data. Photomicrograph is deposited in Morphbank, no. 850709 (Morphbank 2014).

Etymology

The species epithet refers to the island of Sardinia, where the type locality is situated.

Remarks

The new species differs from all other *Lacertacarus* species in the presence of two mastitarsalae and one mastitibiala. Other species have a single mastitarsala only (*L. turcicus* has no mastitarsala) and have no mastitibiala. Among related taxa, presence of additional mastitarsalae and (or) mastitibiala is characteristic for the subgenera *Neotrombicula* (*Digenulea*) Vercammen-Grandjean, 1960, *Neotrombicula* (*Polymasticula*) Vercammen-Grandjean et Kolebinova, 1985 (Kudryashova 1998) and one species of *Kepkatrombicula* Kudryashova et Stekolnikov, 2010 (Shatrov and Stekolnikov 2011).

By other traits, the new species is most similar to *L. similis* and differs from it in a lesser number of idiosomal setae (fD = 2H-10-8-6-2-2 vs. 2H-10-8-6-6-2-2, DS = 29–31 vs. 36, VS = 13–14 vs. 14–16, NDV = 42–45 vs. 50–52) and shorter legs (Ip = 655–677 vs. 745).

We have been unsuccessful in finding the third prong of the palpal claw (which is characteristic of all other *Lacertacarus*) in the new species. However, we could not state its absence with confidence, because this structure is poorly visible in many chigger mites.

The transverse striations of the gnathobase were not observed in other *Lacertacarus* species, but these structures are hardly visible and therefore could have been missed by the researchers who studied this genus previously.

Genus *Ericotrombidium* Vercammen-Grandjean, 1966

Vercammen-Grandjean, 1966: 286 [*Leptotrombidium* subg.; a new name to replace *Leptotrombidium* (*Cotrombidium*)]; Vercammen-Grandjean and Langston, 1976: p. 737 (*Leptotrombidium* subg.); Kudryashova and Abo-Taka, 1986: p. 97.

Type species

Leptotrombidium galliardi Vercammen-Grandjean et Taufflieb, 1959 (by original designation).

Ericotrombidium caucasicum (Schluger, 1967) (Table 2)

Leptotrombidium (*Ericotrombidium*) *caucasicum* Schluger, 1967: p. 45, fig. 5 [Russia, Stavropol Krai, Bezopasnoye; syntypes in Zoological Museum of Moscow University]; Vercammen-Grandjean and Langston, 1976: p. 762, pl. 231 [*Leptotrombidium* (*Ericotrombidium*)]; Kudryashova and Abo-Taka, 1986: p. 98, fig. 2 (*Ericotrombidium*); Kudryashova, 1998: p. 126, fig. 87 (*Ericotrombidium*).

Diagnosis

SIF = 7BS-B-3-2111.0000; fPp = B/N/NNB; fCx = 1.1.1; fSt = 2.2; fSc: PL > AL > AM; Ip = 677–815; fD = 2H-8(9)-6(7)-6(7)-4-2-(2-6); DS = 28–34; VS = 20–33; NDV = 48–63 [according to Kudryashova (1998) and original data].

Hosts

Lacerta agilis L., *Eremias arguta* (Pallas). Here, this species is for the first time recorded on *Podarcis filfolensis*

Table 2. *Ericotrombidium caucasicum*, standard measurements.

Variable	Malta			Lipari and Alicudi Islands			p-value
	Range	Mean	Sample size	Range	Mean	Sample size	
AW	59–65	63	6	61–66	63	5	1
PW	73–76	75	6	74–78	76	5	0.32
SB	24–26	25	6	23–26	24	5	0.42
ASB	23–25	24	6	22–27	25	5	0.24
PSB	11–13	12	6	11–12	11	5	0.27
SD	34–37	36	6	34–38	36	5	0.58
P-PL	7–13	11	6	11–14	12	5	0.63
AP	21–25	23	6	22–24	23	5	0.54
AM	19–22	20	5	22–25	23	5	0.032*
AL	23–29	25	6	28–31	29	5	0.015*
PL	30–33	32	6	31–35	33	5	0.067
S	51–54	53	2	59–59	59	1	0.67
H	26–29	28	6	29–30	29	4	0.052
D _{min}	21–25	23	6	25–27	26	5	0.0087*
D _{max}	30–33	32	6	32–32	32	5	0.33
V _{min}	20–24	21	5	23–23	23	5	0.13
V _{max}	23–30	27	5	27–30	28	5	0.36
pa	241–250	247	6	275–286	281	5	0.0022*
pm	205–220	213	5	232–257	244	5	0.0079*
pp	225–238	231	5	263–277	269	4	0.016*
Ip	677–704	691	5	776–815	796	4	0.016*
DS	30–31	31	6	28–31	30	5	0.44
VS	20–27	22	6	20–23	21	5	0.76
NDV	50–58	52	6	48–54	51	5	0.90
TaIII L	58–63	60	6	67–72	69	4	0.0095*
TaIII W	12–13	13	6	12–13	13	4	1

Notes: The exact two-sided *p*-values of the Wilcoxon Mann–Whitney rank sum test for the difference between two samples are given. Values lesser than 0.05 are indicated by *.

Abbreviations: AW, distance between anterolateral scutal setae; PW, distance between posterolateral scutal setae; SB, distance between sensilla; ASB, distance from the level of sensillary bases to extreme anterior margin of scutum; PSB, distance from the level of sensillary bases to extreme posterior margin of scutum; SD, length of scutum (ASB + PSB); P-PL, distance from the level of posterolateral scutal setae to extreme posterior margin of scutum; AP, distance from anterolateral to posterolateral scutal setae on one side; AM, length of anteromedian seta of scutum; AL, length of anterolateral setae of scutum; PL, length of posterolateral setae of scutum; S, length of sensilla; H, length of humeral setae; D_{min}, length of the shortest dorsal idiosomal seta; D_{max}, length of the longest dorsal idiosomal seta; V_{min}, length of the shortest ventral idiosomal seta; V_{max}, length of the longest ventral idiosomal seta; pa, length of leg I; pm, length of leg II; pp, length of leg III; Ip, total length of legs I–III; DS, number of dorsal idiosomal and humeral setae; VS, number of ventral idiosomal setae (excluding coxal and sternal setae); NDV, number of idiosomal setae (DS + VS); TaIII L, length of leg tarsus III; TaIII W, width of leg tarsus III.

(Bedriaga) and *P. siculus* (Rafinesque-Schmaltz) (Reptilia, Squamata, Lacertidae).

Distribution

Russia (Stavropol Krai), Ukraine (Odessa Oblast). Here, this species is for the first time recorded on Malta and on two other Mediterranean islands, Lipari and Alicudi (Italy).

Material examined

13 larvae (12 larvae in ZIN, slides nos. 8555–8566; one larva in private collection of W. Pfliegler, slide no. A7026): Malta, Maltese Archipelago, Small Blue Lagoon Rock (Il-Ħaġra Ta' Bejn il-Kmiemen iż-Żgħira) and Large Blue Lagoon Rock (Il-Ħaġra Ta' Bejn il-Kmiemen iż-Kbira) (satellite islets of Comino Island), ex *P. filfolensis*, 23 October 2011, coll. A. Sciberras; one larva (ZIN, slide no. 8567): Lipari Island, ex *P. siculus*, 30 September 2011, coll. A. Sciberras; five larvae (ZIN, slides nos. 8568–8572): Alicudi Island, ex *P. siculus*, 28 September 2011, coll. A. Sciberras. Photomicrograph of the specimen no. A7026 is deposited in Morphbank, no. 850714 (Morphbank 2014).

Intraspecific variance

Specimens from the Aeolian Islands (Lipari and Alicudi) differ from the material collected on Malta in their longer legs (measurements pa, pm, pp, lp and taIII) and longer setae (AM, AL and D_{min}) (Table 2). For the differences in PL and H, *p*-values are close to the threshold 0.05. Moreover, solenidia on the legs I and II are longer in the material from the Aeolian Islands than in the specimens collected on Malta: S₁ = 21–22 vs. 12–14 and S₂ = 15–16 vs. 13–14.

Specimens collected on the Mediterranean islands differ from the type series of *E. caucasicum* (according to Kudryashova 1998) in the lesser number of idiosomal setae (NDV = 48–58 vs. 57–63) and shorter setae (AM = 19–25, AL = 23–31, PL = 30–35 and H = 26–30 vs. 26–34, 31–39, 34–41 and 32–36, respectively).

Discussion

Among the chiggers parasitizing reptilian hosts in the Mediterranean region, representatives of the subfamily Leeuwenhoekiinae should be mentioned first. The following species were described from Reptilia in Turkey and North Africa: *Matacarus agamae* (Taufflieb, 1960), *Matacarus demrei* (Kepka, 1962) and *Matacarus maroccanus* (Taufflieb 1958). The chigger fauna considered in the work of Taufflieb (1958) includes also two species from the tribe Schoengastiini, *Neoschoengastia pastoriana* Taufflieb, 1958 and *Schoutedenichia geckobia* Taufflieb,

1958 both described from *Tarentola mauritanica* (L.) (Reptilia, Squamata, Gekkonidae) collected in Morocco.

The genus *Lacertacarus* is the most characteristic element of the reptilian chigger fauna in the Western Palearctic. Supposedly all of its species parasitize lizards and only occasionally can be found on other vertebrates. Three species of the genus belong to the Mediterranean fauna: *L. turcicus*, *L. graecus* and *L. sardiniensis* **sp. nov.** Finding one of its species in Sardinia significantly enlarges the geographic range of the genus. Probably, the range extends to other parts of the Mediterranean Basin too. Occurrence of *Lacertacarus* in North Africa and Southern Spain is highly possible.

Revisions of the genus *Ericotrombidium* (Vercammen-Grandjean and Langston 1976; Kudryashova and Abo-Taka 1986) include data on some species parasitizing Reptilia in Southern Europe [e.g., *Ericotrombidium hasei* (Feider, 1958), *E. caucasicum* and *Ericotrombidium hasgelum* Kudryashova, 1986, in Kudryashova and Abo-Taka 1986]. One species described from North Africa, *Ericotrombidium tarentolae* (Vercammen-Grandjean et Langston, 1976), and *E. caucasicum* reported here from Malta, Lipari Island and Alicudi Island belong to the Mediterranean fauna.

Statistically significant morphometric differences between *E. caucasicum* samples from Malta and the Aeolian Islands (see above description and Table 2) is a remarkable example of geographic variance that could be a first step towards speciation under the model of island biogeography. Future collecting efforts on and around Sicily, which is situated between Malta and the Aeolian Islands, may probably help to understand the relationship between these morphological forms in more detail. Since chigger mites are temporary parasites with rather low host selectivity, their coevolution with lizards is improbable. However, considering the evolutionary history of hosts can give some basis for hypotheses of faunogenesis in chiggers. Thus, during the Pleistocene, island populations of Central Mediterranean *Podarcis* spp. became interconnected to some extent and separated again (e.g. Salvi et al. 2014 and references therein). This may have led to the dispersal of their parasites (including chiggers) as well.

Both species reported in this work have some features characteristic of reptilian chiggers: the slightly inflated apex of the solenidium (tarsala) situated on leg tarsus II (S₂) and the presence of transverse striations on the gnathobase. These hardly visible striations were not previously described in species of *Lacertacarus* and *Ericotrombidium*, but they are known in many *Eutrombicula* Ewing, 1938 parasitizing Reptilia in the New World (Daniel and Stekol'nikov 2004).

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