MORPHOLOGY, DEVELOPMENTAL BIOLOGY, PARAZITOLOGY

DOI: 10.30906/1026-2296-2023-30-2-112-117

A REVIEW OF CHIGGER MITES (TROMBICULIDAE) ASSOCIATED WITH *Lacerta* SPP. (REPTILIA: LACERTIDAE) FROM CAUCASUS AND ADJACENT TERRITORY

Maria V. Orlova,[1,2] Igor V. Doronin,[3]* Marina A. Doronina,[3] Nikolay V. Anisimov,[4] and Irina G. Dolgova[1]

Submitted August 14, 2022.

Trombiculid mites are known as vectors of larvae of *Ericotrombidium caucasicum* Schluger, 1967, *Lacertacarus latus* Schluger et Vasilieva, 1977, and *Schoengastia* sp. chigger mites (Acariformes: Trombiculidae) were collected from lizards *Lacerta strigata* and *L. agilis* (Reptilia: Lacertidae) in the Caucasus and adjacent territory (Iran). Our record of *Ericotrombidium caucasicum* in Azerbaijan is the first finding of the species in this country. Also, results of *E. caucasicum* on *L. strigata* and *Lacertacarus latus* on *L. agilis* are new host-parasite associations. *Schoengastia* sp. has been reported from *L. strigata* for the first time.

Keywords: Trombiculidae; *Lacerta*; *Ericotrombidium*; *Lacertacarus*; *Multisetosa*; *Neotrombicula*; *Schoengastia*; Caucasus.

INTRODUCTION

The family Trombiculidae Ewing, 1929 sensu Kudryashova (1998) and Shatrov and Kudryashova (2008), comprising 3300 species (Liu et al., 2013), constitutes the most speciose and widely distributed family among terrestrial Parasitengona mites. Larval instars of Trombiculidae (chiggers) are obligatory parasites of vertebrates, mainly mammals. Some cases of chiggers parasitizing invertebrates have also been reported (André, 1943; Audy, 1956; Lakshana, 1966; Lourenço, 1982; Gonçalves-Souza et al., 2014). By contrast to larvae, active postlarval stages (deutonymphs and adults) are free-living predators.

The knowledge of host-parasite associations and of host specificity of trombiculid mites, being especially important in view of medical-veterinary importance of chiggers, is poor. The trombiculids are regarded as vectors of bacteria such as *Anaplasma* sp., *Borrelia* sp., *Orientia* sp., and *Rickettsia* sp.; representatives of trombiculid genera *Leptotrombidium* sp. (in Asia) and *Neotrombicula* sp. (in Europe) are known to transmit bacilli and spirochetes (Fernández-Soto et al., 2001; Frances et al., 2001; Kampen et al., 2004; Miťková et al., 2015).

The parasite fauna of the green lizards, *Lacerta* Linnaeus, 1758 (Reptilia: Lacertidae) is studied highly unevenly. For instance, *L. agilis* Linnaeus, 1758, is one of the most complete and comprehensively studied reptile species in terms of parasitology. Extensive studies of this lizard have been performed within the range covering the territory of the former Soviet Union, first of all, the European part of the country (Sharpilo and Shur, 1976). At the

[1] Department of Mobilization Training of Public Health and Disaster Medicine, Tyumen State Medical University, Tyumen, Russia; e-mail: masha_orlova@mail.ru

[2] Research and Production Laboratory of Engineering Surveys and Environmental Management Technologies, National Research Tomsk State University, Tomsk, Russia.

[3] Laboratory of Herpetology, Zoological Institute of Russian Academy of Sciences, St. Petersburg, Russia; e-mail: ivdoronin@mail.ru

[4] Institute of Environmental and Agricultural Biology (X-BIO), Tyumen State University, Tyumen, Russia.

* Corresponding author.

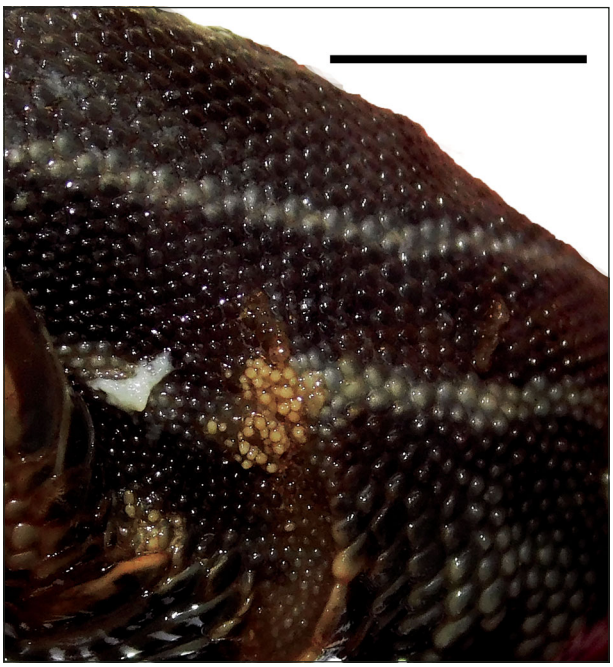

Fig. 1. Chigger mites *Schoengastia* sp. on lizard skin *Lacerta strigata* (collection lot number ZISP 22069), scale bar is 5 mm.

same time, the data on lizard parasites, including chigger mites in the Caucasus, are relatively scarce and fragmentary.

The Caucasus is a mountainous region between the Black and Caspian Seas that forms a natural geographic barrier between Europe and Asia. Currently, the geographic boundaries of the Caucasus ecoregion are accepted under the definitions of the Critical Ecosystem Partnership Fund (CEPF) (www.panda.org/caucasus/cepf) and cover the territories of Armenia, Azerbaijan, Georgia, the North Caucasian part of the Russia, northeastern Turkey, and northwestern Iran. According to CEPF, the Caucasus is one of 25 biodiversity hotspots, biologically highly diverse but also highly vulnerable to environmental degradation (Zazanashvili et al., 2004). These 25 hotspots are selected based on species diversity per area unit: covering only 1.4% of the Earth's land, they accommodate about 44% of all species of vascular plants and 35% of all species in four vertebrate groups (Meyers et al., 2000). Hence, the Caucasus has been globally perceived as a problematic ecoregion with unique flora and fauna inhabited by rare, relic, and endemic species. The region is crucial for preserving our planet's biological diversity.

So, we focused our research on Caucasian territory inhabited by three species belonging to the genus *Lacerta*: *L. agilis*, *L. strigata* Eichwald, 1831, and *L. media* Lantz et Cyrén, 1920. The latter species was found to be free from chiggers.

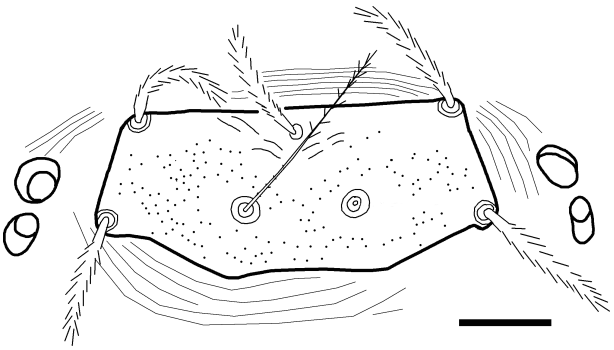

Fig. 2. *Ericotrombidium caucasicum* ex *Lacerta strigata* (collection lot number ZISP 10914), scutum, scale bar is 20 μm.

MATERIAL AND METHODS

Host specimens were collected in the North Caucasian part of Russia, Azerbaijan, Georgia, Turkey, and Iran, fixed in alcohol, and deposited at the Zoological Institute of the Russian Academy of Sciences (ZISP, St. Petersburg, Russia). In 2021 – 2022, we carefully examined 1188 specimens belonging to three species of the genus *Lacerta* including 814, 111, and 263 specimens of *L. agilis*, *L. media*, and *L. strigata*, respectively. Chiggers were attached to their lizard hosts, so potential museum cross contamination was excluded (Fig. 1). Lizards of the genus *Lacerta* were determined according to a key by Bannikov et al. (1977). Morphological identification of chiggers was performed by an MVO method based on a key of Kudryashova (1998) and taxonomic articles by Wen et al. (2012), and Stekolnikov et al. (2019a). Parasite specimens were mounted by NVA on semipermanent microscopic slides in Faure-Berlese's mounting medium and deposited at ZISP. Specimens were examined under a compound microscope (AxioImager A2, Zeiss, Germany). Alphabet designations: L, larva; N, nymph.

RESULTS

A total of 44 chigger mites were found on five specimens of two lizard species. The list of chigger species associated with hosts of the genus *Lacerta* in the Caucasus and adjacent territory is given below.

Genus *Ericotrombidium* Vercammen-Grandjean, 1966
***Ericotrombidium caucasicum* (Schluger, 1967)**
(Fig. 2, Table 1)

Material. 8L ex *L. strigata* from Azerbaijan, Lankaran District, vicinity of Lankaran 38°48′ N 48°49′ E, 3 VI 1911, leg. N. Panov (collection lot number ZISP 10914).

Distribution in the Caucasus. Russia (Stavropol Krai) (as *Leptotrombidium caucasicum* — Schluger, 1967; Kudryashova, 1998), Azerbaijan (this study, new record).

Distribution outside the Caucasus. Ukraine (Kudryashova, 1998), Malta (Stekolnikov et al., 2014), Italy (Stekolnikov et al., 2014), Saudi Arabia (Stekolnikov et al., 2019b).

Lizard hosts. *Darevskia saxicola* (Tertyshnikov, 2002), *L. agilis* (Schluger, 1967; Kudryashova, 1998; Tertyshnikov, 2002), *L. strigata* (this study, new record), *Eremias arguta* (Schluger, 1967; Kudryashova, 1998), *E. velox* (Tertyshnikov, 2002; Zhil'tsova, 2016), *Podarcis filfolensis*, *P. siculus* (Stekolnikov et al., 2014), *Phrynocephalus guttatus*, *Ph. mystaceus*, *Trapelus sanguinolentus* (Tertyshnikov, 2002; Zhil'tsova, 2016).

Other hosts. Rodentia (Stekolnikov et al., 2019b).

Genus *Lacertacarus* Schluger et Vasilieva, 1977
***Lacertacarus latus* Schluger et Vasilieva, 1977**
(Fig. 3)

Material. 5L ex *L. agilis* from Georgia (Abkhazia), Gulripshi District, vicinity of Amtkel Village 43°01′ N 41°19′ E, 29 VII 1973, leg. I. S. Darevsky (collection lot number ZISP 18376).

Distribution in the Caucasus. Russia (Krasnodar Krai) (Schluger and Vasilieva, 1977; Kudryashova, 1998), Georgia (Kudryashova, 1998; this study).

TABLE 1. Standard Measurements of Larvae of *Ericotrombidium caucasicum* (Schluger, 1967)*

Character	Locality					
	The first description. Stavropol krai, Russia and Odessa oblast', Ukraine	Bezopasnoe village, Stavropol krai, Russia (n = 10)	Odessa oblast', Ukraine (n = 2)	Malta (n = 6)	Lipari and Alicudi Islands, Italy (n = 5)	Vicinity of Lankaran, Azerbaijan (n = 5)
AW	—	63 – 70	68, 72	59 – 65	61 – 66	65 – 68
PW	75, 84	72 – 81	75, 82	73 – 76	74 – 78	74 – 79
SB	—	23 – 27	24, 27	24 – 26	23 – 26	24 – 26
ASB	—	25 – 28	24, 27	23 – 25	22 – 27	24 – 26
PSB	—	11 – 13	13, 13	11 – 13	11 – 12	12 – 14
SD	—	36 – 41	37, 40	34 – 37	34 – 38	36 – 40
AP	—	25 – 57	22, 26	21 – 25	22 – 24	23 – 26
AM	26, 34	27 – 31	30, 31	19 – 22	22 – 25	23 – 28
AL	31, 39	32 – 36	36, 38	23 – 29	28 – 31	33 – 37
PL	34, 41	34 – 40	37, 38	30 – 33	31 – 35	35 – 39
Sens	—	54 – 63	66, 70	51 – 54	59 – 59	55 – 60
H	—	32 – 36	34, 34	26 – 29	29 – 30	32 – 34
D	26 – 40	27 – 38	30 – 38	21 – 33	25 – 32	29 – 36
V	23 – 28	23 – 32	24 – 34	20 – 30	23 – 30	25 – 31
pa	196	248 – 279	254 – 268	241 – 250	275 – 286	252 – 270
pm	167	221 – 245	225 – 234	205 – 220	232 – 257	226 – 232
pp	211	257 – 277	250 – 265	225 – 238	263 – 277	254 – 262
References	Schluger, 1967**	Kudryashova, 1998	Vercammen-Grandjean and Langston, 1976	Stekolnikov et al., 2014	Stekolnikov et al., 2014	This study

* Abbreviations: AW, distance between anterolateral scutal setae; PW, distance between posterolateral scutal setae; SB, distance between sensillary bases; 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 between antero- and posterolateral scutal seta on one side; AM, length of anteromedian scutal seta; AL, length of anterolateral scutal setae; PL, length of posterolateral scutal setae; Sens, length of sensilla; H, length of humeral setae; D, length of dorsal idiosomal seta; V, length of ventral idiosomal seta; pa, length of leg I (excluding claws and including coxa); pm, length of leg II (excluding claws and including coxa); pp, length of leg III (excluding claws and including coxa).

** The measurements of the shield and legs from the author are taken differently than is customary in the world literature, so the width of the shield is overestimated by 2 – 3 μm, and the length of the legs is less than the length of the coxae.

Distribution outside the Caucasus. unknown.

Lizard hosts. Lacertini (Schluger and Vasilieva, 1977), *D. derjugini* (as *L. derjugini* — Kudryashova, 1998), *L. agilis* (this study, new record).

Other hosts. Unknown.

Genus *Multisetosa* Hsu et Wen, 1963
Multisetosa major (Schluger, 1955)

Distribution in the Caucasus. Russia (Stavropol Krai) (Kudryashova, 1998).

Distribution outside the Caucasus. Ukraine (as *Sasacarus* (*Multisetosa*) *major* — Gushcha and Sklyar, 1989), Kyrgyzstan (Chirov and Tranbaev, 1992).

Lizard host. *L. agilis* (Kudryashova, 1998).

Other hosts. Rodentia (Gushcha and Sklyar, 1989; Chirov and Tranbaev, 1992).

Genus *Neotrombicula* Hirst, 1925
Neotrombicula (*Polymasticula*) *tragardhiana* (Feider, 1953)

Distribution in the Caucasus. Russia (Dagestan, Stavropol Krai) (Stekolnikov and Daniel, 2012), Azerbaijan, Armenia (Kudryashova, 1998).

Distribution outside the Caucasus. Crimea, Kyrgyzstan, Tajikistan (Kudryashova, 1998), Uzbekistan (Stekolnikov and Daniel, 2012), Turkey (Kudryashova, 1998; Stekolnikov and Daniel, 2012), Romania (Kudryashova, 1998).

Lizard hosts. *P. tauricus* (as *L. taurica*), *L. agilis*, *L. strigata*, *D. raddei* (as *L. saxicola*) (Kudryashova, 1998).

Other hosts. Insectivora, Rodentia (Kudryashova, 1998).

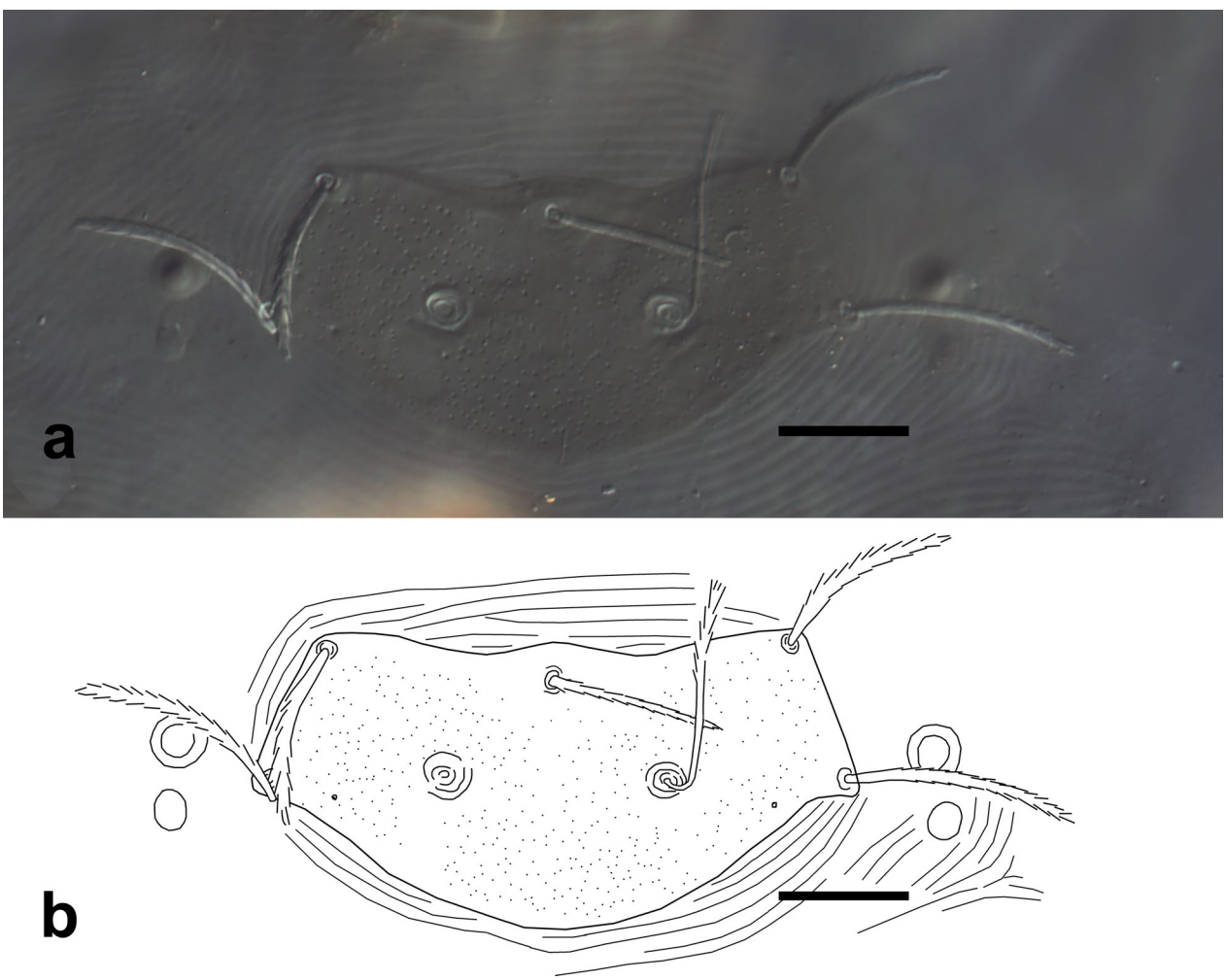

Fig. 3. *Lacertacarus latus* ex *Lacerta agilis* (collection lot number ZISP 18376), scutum: A, photograph; B, drawing; scale bar is 20 μm.

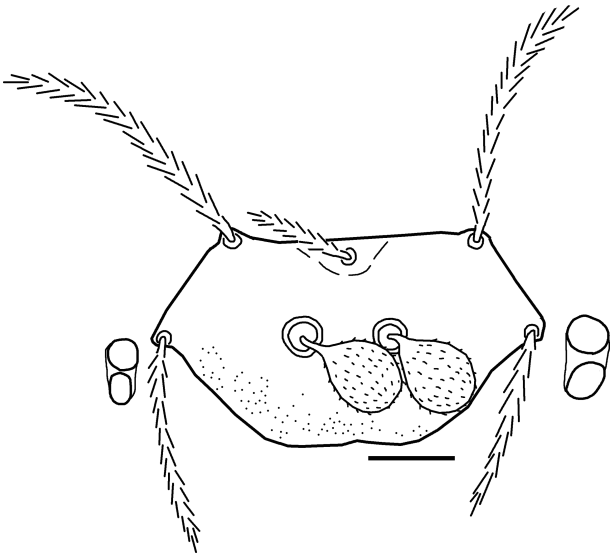

Fig. 4. *Schoengastia* sp. ex *Lacerta strigata* (collection lot number ZISP 22069), scutum, scale bar is 20 μm.

Genus *Schoengastia* Oudemans, 1910
Schoengastia sp. (Fig. 4)

Material. 31 L ex *L. strigata* from Iran, Mazandaran, vicinity of Babolser (= Meshkhede-Ser, Meshedeser) 36°41′ N 52°41′ E, 5 VII 1942, Soviet epidemiological and parasitological expeditions to Iran in 1941 – 1943 (collection lot number ZISP 22069).

Note. Species of the genus *Schoengastia* parasitize many vertebrates (Marsupialia, Reptilia, Aves, Mammalia) (Nadchatram et al., 1980). This is the first record of the genus *Schoengastia* on lizards of genus *Lacerta*. A single species *Schoengastia* (*Priomesochela*) *persica* Wen, Saboori et Akrami, 2012 has been recorded from Iran before. Diagnosis of our specimens does not coincide with described species of genus *Schoengastia* and, highly likely, these individuals belong to a new species.

As a result, we had reveled representatives of five genera and four known chigger species associated with the genus *Lacerta* in the Caucasus and adjacent territory. The finding of *Schoengastia* sp. is of a particular interest, and, in our opinion, further comprehensive research is needed to study the fauna of reptile ectoparasites in the examined region

Acknowledgments. This study was supported by the Russian Science Foundation (grant number 22-24-00079) (for Igor V. Doronin and Marina A. Doronina).

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