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Research

Chigger Mites (Acariformes: Trombiculidae) of Chiloé Island, Chile, With Descriptions of Two New Species and New Data on the Genus *Herpetacarus*

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Abstract

Three species of chigger mites are recorded in our collections from four species of cricetid rodents on Chiloé Island (southern Chile, Los Lagos Region), an area endemic to scrub typhus (*Orientia* sp.). Two species are described as new—*Herpetacarus (Abonnencia) eloisae* sp. nov. and *Quadraseta chiloensis* sp. nov. One species, *Paratrombicula goffi* Stekolnikov and González-Acuña 2012, is for the first time recorded on a mammal host (one species of cricetid rodent), and its distribution is extended to the Los Lagos Region of Chile. The genus *Proschoengastia* Vercammen-Grandjean, 1967 is synonymized with the subgenus *Herpetacarus (Abonnencia)* Vercammen-Grandjean, 1960, and four new combinations are established: *Herpetacarus (Abonnencia) herniosa* (Brennan and Jones, 1961), comb. nov., *Herpetacarus (Abonnencia) insolita* (Brennan and Jones, 1961), comb. nov., *Herpetacarus (Abonnencia) macrochaeta* (Brennan and Jones, 1961), comb. nov., and *Herpetacarus (Abonnencia) antarctica* (Stekolnikov and Gonzalez-Acuña, 2015), comb. nov.

Key words: chigger, parasite, rodent, taxonomy, South America

Mite larvae of the family Trombiculidae Ewing, 1944, which are commonly known as chiggers, are usual temporary ectoparasites of terrestrial vertebrates. Infestations can cause pruritic skin reactions (trombiculiasis) in animals and humans (Mullen and OConnor 2009, Walter et al. 2009). Apart from their role as ectoparasites, trombiculid mites are known as important but neglected vectors of *Orientia tsutsugamushi* causing scrub typhus, a potentially serious rickettsial infection in the Asia-Pacific region (Elliott et al. 2019, Weitzel et al. 2020). They also have been hypothesized to be vectors or at least reservoirs of *Borrelia* spp., *Bartonella* spp., and Hantaan virus (Kampen et al. 2004, Literak et al. 2008, Kabeya et al. 2010, Yu and Tesh 2014).

The family (in broad sense, i.e., including Leeuwenhoekiinae Womersley, 1944, Trombiculinae Ewing, 1929, and Walchiinae Ewing, 1946 as subfamilies) consists of about 200 genera with more than 3,500 species (Zhang et al. 2011). Up to now, 14 chigger genera with 23 species have been recorded in Chile, mainly from reptiles, but the real number might be far higher (Silva-de la Fuente et al. 2015, Stekolnikov and González-Acuña 2015, Espinoza-Carniglia et al. 2016).

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Recently, human scrub typhus cases caused by a novel species, *Candidatus* Orientia chiloensis have been discovered in the Los Lagos Region including Chiloé Island in southern Chile (Balcells et al. 2011; Weitzel et al. 2016, 2019; Abarca et al. 2020). However, at the time of a recent revision, no data were available on chiggers of this region (Stekolnikov and González-Acuña 2015). During two field studies on Chiloé Island, Los Lagos Region, in 2018 and 2020, we captured rodents to analyze the prevalence of chigger mites and positivity of chigger pools for *Orientia* species DNA. During the studies, three chigger species, *Herpetacarus* sp., *Quadraseta* sp., and *Paratrombicula* sp., were recorded on six rodent species (Acosta-Jamett et al. 2020). The aim of the present study was to identify exactly all these chiggers, two of which were found to represent new species. In addition, this work includes an analysis of the literature on the taxonomy of *Herpetacarus* Vercammen-Grandjean, 1960, resulting in the establishment of a new synonym.

Materials and Methods

Larval stages of mites, which were used for morphological examination, were collected from rodent species *Abrothrix olivacea* (Waterhouse), *Abrothrix sanborni* (Osgood), *Geoxus valdivianus* (Philippi), and *Oligoryzomys longicaudatus* (Bennett) (Rodentia: Cricetidae) trapped on Chiloé Island in southern Chile during January and February 2018 and February 2020. Study sites were selected within our ongoing clinical-epidemiological surveillance project of scrub typhus (Abarca et al. 2018, Weitzel et al. 2018). Details on the methodology and collection localities have been published elsewhere (Acosta-Jamett et al. 2020). In brief, rodents were trapped with Sherman-like traps in various sites of northern Chiloé and thoroughly examined for the presence of ectoparasites by the naked eye. Mite specimens were fixed in 96% ethanol, cleared in Nesbitt's solution, and then mounted on microscope slides using Berlese's medium (Walter and Krantz 2009). The slides were examined under a Leica DM2500 compound microscope (Leica Microsystems GmbH, Wetzlar, Germany) using differential interference contrast (DIC). Microphotographs were taken by means of a Leica DMC 4500 digital camera, morphological drawings were prepared using a drawing tube.

Measurements were made by two authors: A. Stekolnikov measured the specimens of *Herpetacarus (Abonnencia) eloisae* sp. nov., the holotype and one paratype (ZIN 16434) of *Quadraseta chiloensis* sp. nov. using a MBI-3 microscope (LOMO plc, St. Petersburg, Russia) with phase contrast optics; M. C. Silva-de la Fuente measured paratypes of *Q. chiloensis* sp. nov. using a BestScope (BS-2030T) microscope with phase contrast optics; microphotographs were taken with an Olympus SP-57OUZ digital camera. These two sets of measurements are included separately in the table, since they could be biased relative to each other due to peculiar properties in the mode of measuring performed by two researchers (Stekolnikov et al. 2019).

The terminology used in our descriptions follows Goff et al. (1982) and Stekolnikov (2018). A brief diagnosis consisting of diagnostic formulas, which are useful for chigger taxonomists, precedes each species description. We use the following formulas:

SIF (synthetic identification formula) including the following characters: number of branched setae on palpal tarsus; presence of nude subterminala (eupathidium, ζ) on palpal tarsus (S); condition of galeal seta (N—nude, B—branched, f— forked); number of prongs of palpal claw; number of genualae I (σ); number of genualae II (σ); number of genualae III (σ); number of tibialae III (φ); number of mastitarsalae III; number of mastitibialae III; number of mastigenualae III or additional genualae III; number of mastifemoralae III. fsp—leg segmentation formula, the numbers of apparent segments of each pair of legs; fCx—coxal setation formula, the numbers of setae on leg coxae I–III; fSt—sternal setal formula, the numbers of anterior (between coxae I) and posterior (between coxae III) sternal setae; fPp—palpal setation formula including condition (N—nude, B—branched, b—having one branch or cilium) of palpal femoral seta, palpal genual seta, and three palpal tibial setae (dorsal, lateral, and ventral); fSc—scutal formula, including relative lengths of scutal setae [AM—anteromedian seta (*vi*); AL—anterolateral setae (*ve*); PL—posterolateral setae (*se*)]; fD—arrangement of dorsal idiosomal setae by rows (H—humeral setae); Ip—sum of lengths of legs I, II, and III (including coxae); DS—number of dorsal idiosomal and humeral setae; VS—number of ventral idiosomal setae (excluding coxal and sternal).

Other abbreviations used in the tables of measurements are as follows: AW—distance between ALs; PW—distance between PLs; 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 PLs to extreme posterior margin of scutum; AP—distance from AL to PL on one side; S—length and width of sensilla (*si*); H—length of humeral setae; D_{min}—minimal length of dorsal idiosomal setae; D_{max}—maximal length of dorsal idiosomal setae; V_{min}—minimal length of ventral idiosomal setae; V_{max}—maximal length of ventral idiosomal setae; pa—length of leg I (including coxa); pm—length of leg II (including coxa); pp—length of leg III (including coxa); TaIIIL—length of leg tarsus III; TaIIIW—width of leg tarsus III; PT'—length of pretarsala I (ζ); ST—length of subterminala (ζ); pST—length of parasubterminala (z); S_1—length of leg tarsala I (ω); f_1—length of microtarsala I (ε); ta—length of tibialae I (φ); μta—length of microtibiala I (κ); ga—length of genualae I (σ); μga—length of microgenuala I (κ); PT"—length of pretarsala II (ζ); S_2—length of leg tarsala II (ω); f_2—length of microtarsala II (ε); tm—length of tibialae II (φ); gm—length of genuala II (σ); tp—length of tibiala III (φ); gp—length of genuala III (σ).

Type specimens will be deposited in Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia (ZIN), Museo de Zoología Universidad de Concepción, Concepción, Chile (MZUC), Colección del Departamento de Ciencia Animal, Universidad de Concepción, Chillán, Chile (CDCA), and Natural History Museum, London, United Kingdom (NHM), as indicated below.

Nomenclature

This article and the nomenclatural act(s) it contains have been registered in Zoobank (www.zoobank.org), the official register of the International Commission on Zoological Nomenclature. The LSID (Life Science Identifier) number of the publication is: urn:lsid:zoobank.org:pub:5273599B-70DB-403F-B118-8D671E8501A4.

Results

Family Trombiculidae Ewing, 1929

Subfamily Trombiculinae Ewing, 1929

Tribe Schoengastiini Vercammen-Grandjean, 1960

Genus *Herpetacarus* Vercammen-Grandjean, 1960

Herpetacarus Vercammen-Grandjean, 1960: Plate; 1965: 85; 1966: 631; 1968: 90; Fernandes and Kulkarni 2003: 366; Stekolnikov 2018: 59; Jacinavicius et al. 2019: 1138; Stekolnikov and Matthee 2019: 435.

Ornithacarus Vercammen-Grandjean, 1960: Plate.

Arisocerus Brennan, 1970a: 32; Brennan and Goff 1977: 556; Goff and Gettinger 1989: 557.

Lukoschuskaaia Kolebinova and Vercammen-Grandjean, 1980: 56 (as a subgenus of *Herpetacarus*).

Proschoengastia Vercammen-Grandjean, 1967: 130 (as a subgenus of *Schoengastia*), syn. nov.; Stekolnikov and Gonzalez-Acuña 2015: 27.

Type Species: *Ascoschoengastia causicola* Jadin and Vercammen-Grandjean, 1952, by original designation.

Diagnosis (Larva)

SIF = 6BS, 7B, 7BS-N(B)-3-(1–8)111.0(1)0(1)00; fsp = 7.7.7; Ip = 620–1051. Cheliceral blade with tricuspid cap; galeal setae nude, rarely branched; palpal claw 3-pronged; palpal tarsus with six or seven branched setae, nude subterminala present or absent. Scutum trapezoidal, wider than long, with convex or biconvex posterior margin, sometimes striated on its posterior half or margins, with one AM, two AL, and two PL setae; sensilla globose to fusiform, covered with setules, sensillary bases often situated far apart. Eyes 2 + 2. Legs 7-segmented, 1–8 genualae I, genualae II and III present, tibiala III present, mastitarsala and mastitibiala sometimes present.

According to the revision of Vercammen-Grandjean (1966), *Herpetacarus* consists of three subgenera—nominative, with seven branched setae and subterminala on palpal tarsus, *Abonnencia* Vercammen-Grandjean, 1960, with seven branched setae on palpal tarsus, without subterminala, and *Cricacarus* Vercammen-Grandjean, 1966, with six branched setae and subterminala on palpal tarsus. Later a monotypic subgenus *Lukoschuskaaia* Kolebinova and Vercammen-Grandjean, 1980 was described for a species *H. (L.) makokoui* Kolebinova and Vercammen-Grandjean, 1980, which has extra setae on lateral scutal margins. That subgenus was synonymized with *Herpetacarus (Herpetacarus)* by Stekolnikov (2018). The genus *Arisocerus*, which included two South American species, was synonymized with *Herpetacarus* by Jacinavicius et al. (2019); both its species fit the diagnosis of *Herpetacarus (Herpetacarus)*.

The subgenus *Schoengastia (Proschoengastia)*, with the type species *Euschoengastia herniosa* Brennan and Jones, 1961, was described by Vercammen-Grandjean (1967) for two South American species. That subgenus was raised to generic level by Stekolnikov and Gonzalez-Acuña (2015) who also described an additional species from Chile and transferred one species from the genus *Trombicula* Berlese, 1905. Since the diagnosis of *Proschoengastia* does not differ from that of *Herpetacarus (Abonnencia)*, we synonymize here the former genus with the latter subgenus and thus establish the following new combinations: *Herpetacarus (Abonnencia) herniosa* (Brennan and Jones, 1961), comb. nov., *Herpetacarus (Abonnencia) insolita* (Brennan and Jones, 1961), comb. nov., *Herpetacarus (Abonnencia) macrochaeta* (Brennan and Jones, 1961), comb. nov., and *Herpetacarus (Abonnencia) antarctica* (Stekolnikov and Gonzalez-Acuña, 2015), comb. nov.

Previously, we examined type series of three African species of *Herpetacarus (Abonnencia)*—*H. (A.) decasetosus* Stekolnikov and Matthee, 2019, *H. (A.) octosetosus* Stekolnikov and Matthee, 2019, and *H. (A.) otomyius* (Radford, 1942) (Stekolnikov and Matthee 2019)—and also a type series of *Proschoengastia antarctica* Stekolnikov and Gonzalez-Acuña, 2015 (Stekolnikov and Gonzalez-Acuña 2015); our examination confirms that the latter species belongs to the same genus and subgenus as the three former, by its habitus and all diagnostic traits.

Species of *Herpetacarus* were mostly described from Africa (Stekolnikov 2018, Stekolnikov and Matthee 2019) and China (Li et al. 1997); two species are known from India (Fernandes and Kulkarni 2003), one from Japan, one from Malaysia, one from Australia, one from Papua New Guinea (Vercammen-Grandjean 1966), and two from Thailand (Nadchatram and Kethley 1974). In South America, in addition to two species formerly included in *Arisocerus* and four species formerly included in *Proschoengastia*, one species from the nominative subgenus, *H. (H.) dalmati* (Brennan, 1951), was described from Guatemala and *H. (A.) nasuae* (Boshell and Kerr, 1942) was described from Colombia (Vercammen-Grandjean 1966).

The current classification of *Herpetacarus* seems artificial, since it is based on a single trait (the chaetome of palpal tarsus), while other characters, namely the shape of scutum, shape of sensilla, relative distance between sensilla, number of genualae I, and number of mastisetae on leg III, are highly variable within the genus. A new revision of *Herpetacarus* is thus desirable.

We do not follow the opinion of Jacinavicius et al. (2019), who consider three subgenera of *Herpetacarus* (nominative, *Abonnencia*, and *Cricacarus*) as separate genera. They based their classification on the statement that the setation of palpal tarsus is usually constant within chigger genera. However, there are rather many examples showing that this trait is variable within distinct genera; thus, in *Schoutedenichia* Jadin and Vercammen-Grandjean, 1954 the formula of palpal tarsal setae can be 3B (three branched setae), 4B, 5B, and 4BS (four branched setae and subterminala) (Vercammen-Grandjean 1958, Stekolnikov 2018); *Walchia* Ewing, 1931 has 4B or 5B; *Schoengastiella* Hirst, 1915 has 4B, 4BS or 5B (Vercammen-Grandjean 1968); *Trombicula* Berlese, 1905 (*sensu stricto*) has 5B, 6B, or 7B (Daniel and Stekolnikov 2006).

Herpetacarus (Abonnencia) eloisae Stekolnikov and Silva-de la Fuente, sp. nov.

(Figs. 1A, B, 2, 3)

(urn:lsid:zoobank.org:act:45CEC14A-FF5C-4A00-A5B5-79335E130A12)

Diagnostic Formulas

SIF = 7B-N-3-2111.0000; fsp = 7.7.7; fCx = 1.1.1; fSt = 2.2; fPp = B/B/BN(b)B; fSc: PL > AL > AM; Ip = 813–906; DS = 62; VS = 43; NDV = 105. Measurements given in Table 1.

Description (Larva)

Idiosoma (Figs. 1A, 2B–F). Eyes 2 + 2, on ocular plate. One pair of barbed humeral setae, 62 barbed dorsal idiosomal setae, fD in holotype 2H-12-11-11-9-8-7-2; four sternal setae; 43 ventral setae; total number of idiosomal setae excluding coxal and sternal 105. *Gnathosoma* (Figs. 3A, B). Cheliceral blade with tricuspid cap; cheliceral base, palpal femur, and gnathobase covered with small puncta; gnathobase with one pair of branched setae; galeala nude; palpal claw with three prongs; palpal femoral seta heavily branched, palpal genual seta branched, dorsal and ventral palpal tibial setae branched, lateral palpal tibial seta nude or having one cilium; palpal tarsus with seven branched setae and basal tarsala. *Scutum* (Figs. 1A, B, 2A). Nearly

Table 1. Measurements (µm) and numbers of setae (DS, VS, NDV) of *Herpetacarus eloisae* sp. nov. (n = 10)

Variable	Range	Mean	Holotype
AW	72–81	77	77
PW	92–97	94	95
SB	29–33	31	29
ASB	32–36	33	34
PSB	25–29	27	29
SD	57–63	61	63
P-PL	19–23	21	22
AP	35–40	38	39
AM	34–40	36	34
AL	59–77	68	68
PL	71–81	76	71
S	36–45	41	41
H	52–63	59	56
D_{min}	33–47	39	34
D_{max}	50–59	54	52
V_{min}	25–33	29	30
V_{max}	37–47	43	41
pa	295–340	313	295
pm	252–293	269	268
pp	292–326	309	311
Ip	844–959	891	874
PT’	15–18	17	15–17
ST	27–30	29	27
pST	11–16	13	11
S_1	14–17	16	14
f_1	2–2	2	2
ta	12–17	14	14–15
µta	2–4	3	2
ga	17–22	19	19–22
µga	3–3	3	3
PT”	16–18	17	17
S_2	13–14	14	14
f_2	2–2	2	—
tm	11–14	13	12–14
gm	15–18	16	18
tp	14–15	14	14
gp	14–17	15	17
DS	47–62	56	62
VS	41–55	46	43
NDV	98–105	102	105

trapezoidal, with rather dense small puncta, anterior margin sinuous, posterior margin broadly rounded; AM situated posterior to level of ALs; SB situated anterior to level of PLs (PSB–P-PL = 7) and slightly closer to each other than to lateral scutal margins; PL > AL > AM; all scutal setae similar to humeral setae; sensilla clavate, asymmetrically inflated, more protuberant side of their bulb covered with much larger setules than less protuberant side. *Legs* (Figs. 3C–E). All legs 7-segmented, with one pair of claws and claw-like empodium. Leg I: coxa with one nonspecialized branched seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, two genualae, microgenuala; tibia 8B, two tibialae, microtibiala; tarsus 22B, tarsala, microtarsala distal to tarsala, subterminala, parasubterminala, pretarsala. Leg II: coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala; tibia 6B, two tibialae; tarsus 16B, tarsala, microtarsala proximal to tarsala, pretarsala. Leg III: coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala; tibia 6B, tibiala; tarsus 15B.

Hosts

Abrothrix olivacea, *A. sanborni*, and *Geoxus valdivianus* (Rodentia: Cricetidae).

Type Material

Holotype: Larva (ZIN 16433, T-Tr.-93) ex *A. sanborni*, Chile: Los Lagos Region, Chiloé Island, 18-I-2018, coll. Gerardo Acosta and Esperanza Beltrami. Paratypes: 12 larvae (ZIN 16424–16432) ex *G. valdivianus* (one larva), *A. sanborni* (three larvae), and *A. olivacea* (eight larvae), 14-I-2018–8-II.2018, other data same. Holotype will be deposited in ZIN; paratypes will be deposited in ZIN, MZUC, CDCA, and NHM.

Additional Material

Nineteen larvae ex *G. valdivianus* (five larvae), *A. olivacea* (nine larvae; MZUC-UCCC 46313–46323 and CDCA 334–336), and *A. sanborni* (five larvae; CDCA 337–341), Chile: Los Lagos Region, Chiloé Island, January and February 2018, coll. Gerardo Acosta and Esperanza Beltrami.

Etymology

The species was named after Eloísa Díaz Insunza (1866–1950) who was the first Chilean female medical student and first woman working as a medical doctor in South America.

Differential Diagnosis

Herpetacarus eloisae sp. nov. is similar to *H. herniosa* (Brennan and Jones, 1961), comb. nov., described from *Lagidium peruanum* Meyen (Rodentia: Chinchillidae) in Peru, by the setation of gnathosoma and legs, but differs in wider scutum (AW = 77–82, PW = 95–100, PW/SD = 1.5 vs 53, 84, and 1.3, respectively), shorter scutal setae (AM = 33–39, AL = 54–72, and PL = 71–87, vs 50, 95, and 106, respectively), much more numerous idiosomal setae (fD = 2H-12-11-11-9-8-7-2 vs 2H-8-6-6-4-2-2, DS = 62 vs 30, VS = 43 vs about 30), and in the presence of asymmetrically inflated sensilla.

Genus *Quadraseta* Brennan, 1970

Quadraseta Brennan, 1970b: 1695; Goff and Brennan 1977: 501; Goff and Gettinger 1989: 557; Jacinavicius et al. 2018: 442.

Type Species: *Euschoengastia pazca* Brennan and Jones, 1964, by original designation.

Diagnosis (Larva)

SIF = 4B-N(B)-3-2(3)111.0000; fsp = 7.7.7; fCx = 1.1.1; fSt = 2.2. Cheliceral blade with tricuspid cap; galeal setae nude or branched; palpal claw 3-pronged; palpal tarsus with four branched setae and basal tarsala. Scutum sparsely punctate, subrectangular, with sinuous anterior margin and almost straight, slightly convex or bilobate posterior margin, with one AM, two AL, and two PL setae (PLs longest scutal setae); sensilla clavate to capitate, covered with setules. Eyes 2 + 2. Legs 7-segmented, 2 or 3 genualae I, genualae II and III present, tibiala III present, subterminala, parasubterminala, pretarsalae I and II present, mastisetae on leg III absent.

Quadraseta chiloensis Stekolnikov and Silva-de la Fuente, sp. nov.

(Figs. 1C–F, 4–6)

(urn:lsid:zoobank.org:act:FD97C279-415A-4E9A-9852-EEDF4217B991)

Diagnostic Formulas

SIF = 4B-B-3-2111.0000; fsp = 7.7.7; fCx = 1.1.1; fSt = 2.2; fPp = B/B/BBB; fSc: PL > AL > AM; fD = 2H-(8–11)-8(7)-8-6(7)+(5–9);

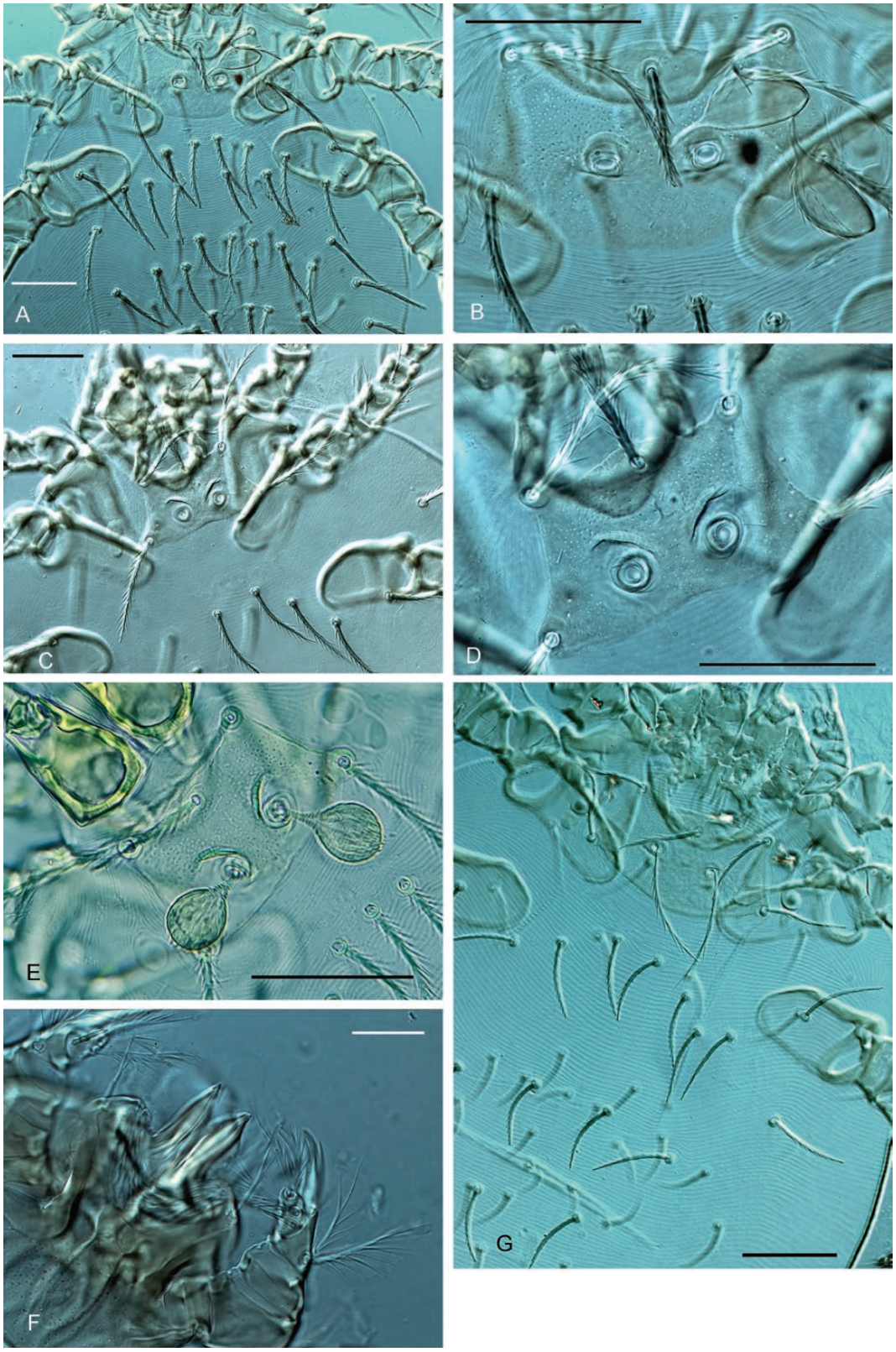

Fig. 1. *Herpetacarus (Abonnencia) eloisae* sp. nov., holotype (A, B), *Quadraseta chiloensis* sp. nov., holotype (C, D) and paratypes (E, F), and *Paratrombicula goffi* Stekolnikov and González-Acuña, 2012, specimen from Chiloé Island (G). (A, C, G) Anterior part of idiosoma, dorsal aspect. (B, D, E) Scutum. (F) Gnathosoma, ventral aspect. Scale bars: 50 μm (A–E, G), 20 μm (F).

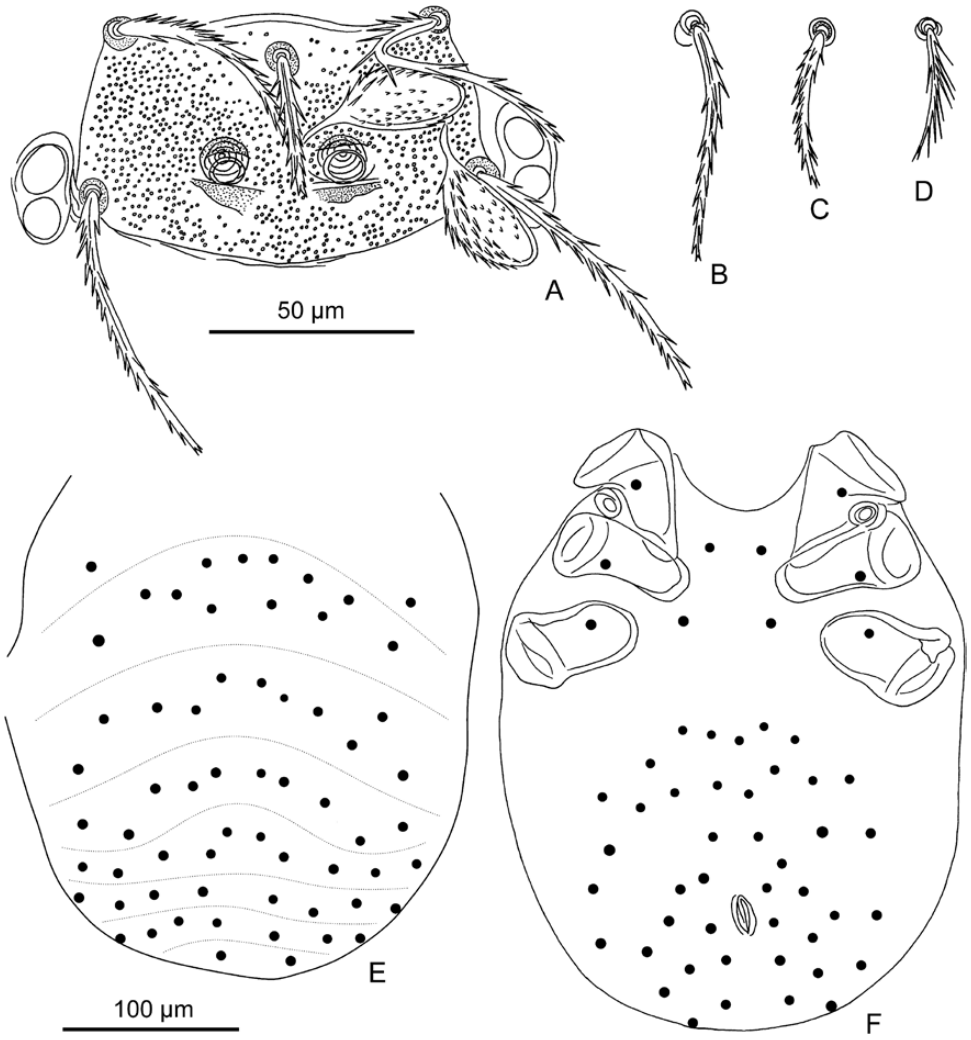

Fig. 2. *Herpetacarus (Abonnencia) eloisae* sp. nov., holotype. (A) Scutum and eyes. (B) Humeral seta. (C) Dorsal idiosomal seta of second row. (D) Preanal ventral idiosomal seta. (E) Arrangement of dorsal idiosomal setae (scheme). (F) Idiosoma, ventral aspect (scheme). Scale bars: 50 µm (A–D), 100 µm (E, F).

Ip = 873–977; DS = 37–44; VS = 35–53; NDV = 72–94. Measurements given in Table 2.

Description (Larva)

Idiosoma (Figs. 1C, 4, 5A–C). Eyes 2 + 2, on ocular plate. One pair of humeral setae and 35–42 dorsal idiosomal setae, fD in holotype 2H-9-8-8-6-6; 4 sternal setae; 35–53 ventral setae; total number of idiosomal setae excluding coxal and sternal 72–94. All setae densely covered with long barbs. *Gnathosoma* (Figs. 1F, 5E, F). Cheliceral blade with tricuspid cap; cheliceral base, palpal femur and genu sparsely covered with small puncta; gnathobase densely covered with small puncta; gnathobase with 1 pair of branched setae; galeala with two to three branches, in holotype nude on one side; palpal claw with three prongs; palpal femoral, genual, and three tibial setae heavily branched; palpal tarsus with 4 heavily branched setae and basal tarsala. *Scutum* (Figs. 1C–E, 5D). Nearly trapezoidal, with rather dense small puncta, anterior margin sinuous, posterior margin slightly bilobate; AM situated slightly posterior to level of ALs; SB situated anterior to level of PLs (PSB–P-PL = 7) and at same distance from each other as to lateral scutal margins; PL > AL > AM; all scutal setae similar to dorsal idiosomal setae; sensilla subcapitate, covered with setules from stems. *Legs* (Fig. 6). All legs 7-segmented, with one pair of claws and claw-like empodium. Leg I: coxa with one nonspecialized branched seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, two genualae, microgenuala; tibia 8B, two tibialae, microtibiala; tarsus 22B, tarsala, microtarsala proximal 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 much thinner than tarsala I, microtarsala proximal to tarsala, pretarsala. Leg III: coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala; tibia 6B, tibiala; tarsus 15B.

Hosts

Abrothrix olivacea, *Geoxus valdivianus*, and *Oligoryzomys longicaudatus*.

Type Material

Holotype: Larva (ZIN 16434, T-Tr.-94) ex *A. olivacea*, Chile: Los Lagos Region, Chiloé Island, 2-II-2018, coll. Gerardo Acosta and Esperanza Beltrami. Paratypes: one larva on the same slide as holotype; one larva (CDCA 344) ex *G. valdivianus*, four larvae (CDCA 345–347) ex *A. olivacea*, and four larvae (CDCA 348–351) ex

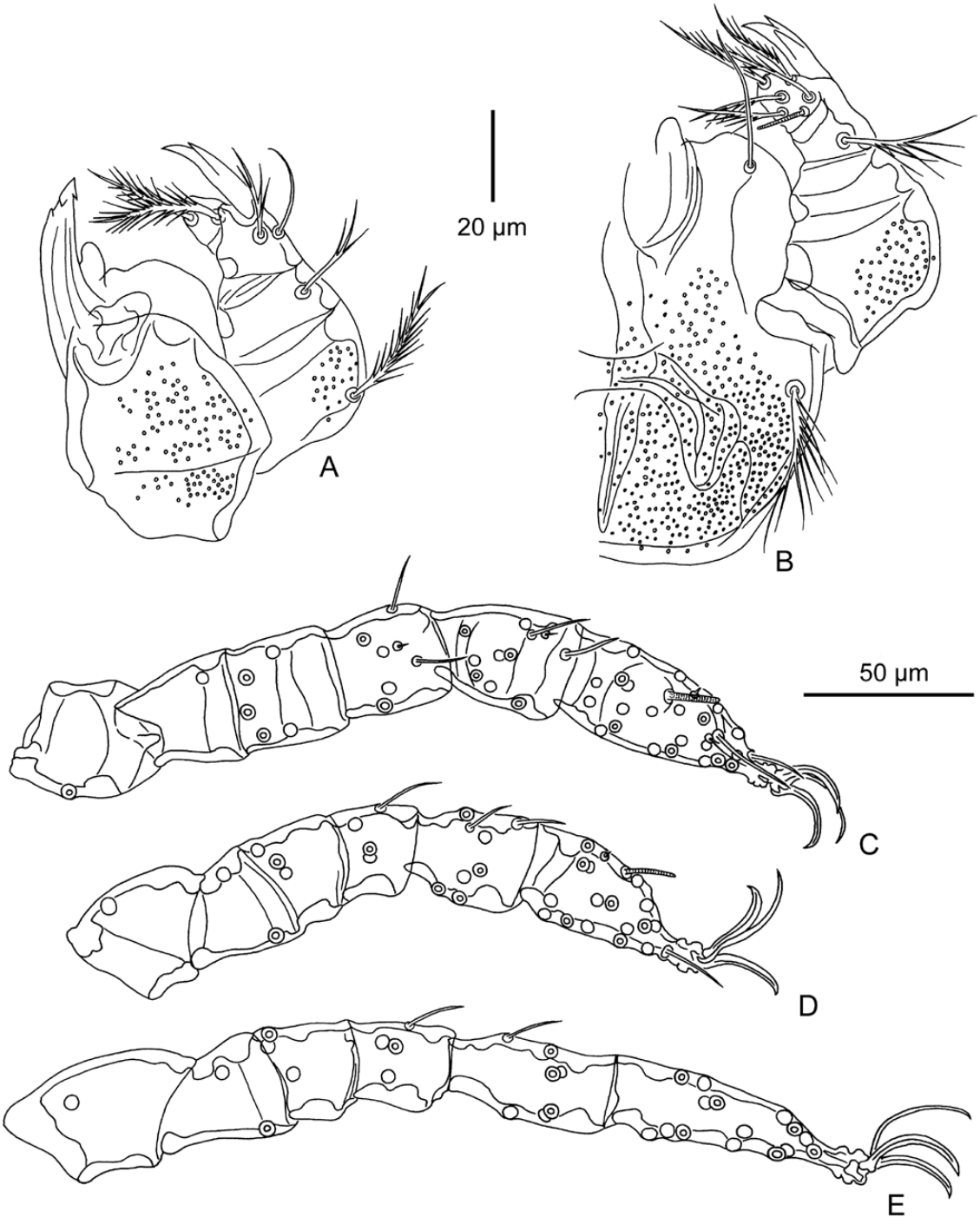

Fig. 3. *Herpetacarus (Abonnencia) eloisae* sp. nov., holotype. (A) Dorsal aspect of gnathosoma. (B) Ventral aspect of gnathosoma. (C) Free part of leg I (trochanter–tarsus). (D) Free part of leg II (trochanter–tarsus). (E) Free part of leg III (trochanter–tarsus). Scale bars: 20 µm (A, B), 50 µm (C–E).

O. longicaudatus, Chile: Los Lagos Region, Chiloé Island, February 2020, coll. M. Carolina Silva de la Fuente, Felipe Peña and Nicol Lizama. Holotype will be deposited in ZIN, paratypes will be deposited in ZIN, MZUC, CDCA, and NHM.

Etymology

The species name refers to the type locality (Chiloé Island).

Differential Diagnosis

The new species is similar by setation of gnathosoma, legs, and idiosoma to *Q. azulae* (Brennan and Jones, 1964) described from an unidentified 'opossum' and 'mouse' in the Buenos Aires Province of Argentina, but differs in greater absolute and relative distance between sensillary bases (SB = 20–32 vs 12, SB/PW = 0.3 vs 0.2), in larger scutum (AW = 50–61, PW = 75–92, ASB = 28–40, SD = 40–53, and AP = 40–45 vs 47, 61, 24, 35, and 26, respectively), and in much longer setae (AM = 40–50, AL = 65–77, PL = 69–78, H = 65–70 vs 26, 42, 37, and 35, respectively; PL > AL vs AL > PL). The new species is also similar to *Q. trapezoides* (Brennan and Jones, 1964) described from an unidentified 'fox' in Argentina (Buenos Aires Province), but differs from it in the branched genuala versus nude, wider scutum (AW = 50–61, PW = 75–92, and PW/SD = 1.7 vs 44,

Table 2. Measurements (μm) and numbers of setae (DS, VS, NDV) of *Quadraseta chiloensis* sp. nov.

	Holotype	Paratype (ZIN 16434)	Other paratypes (n = 8)	
Variable			Range	Mean
AW	60	61	50–55	54
PW	84	92	75–80	78
SB	27	32	20–25	22
ASB	36	40	28–33	29
PSB	14	13	13–15	13
SD	50	53	40–48	43
P-PL	7	9	5–10	6
AP	41	42	40–45	42
AM	43	41	40–50	43
AL	77	69	65–73	69
PL	76	69	70–78	73
S	—	—	33–40	36
H	69	67	65–70	68
D_{min}	56	54	58–63	61
D_{max}	70	72	63–78	71
V_{min}	29	32	28–38	31
V_{max}	59	65	50–63	58
pa	322	340	300–313	306
pm	286	293	255–270	266
pp	331	344	305–320	313
Ip	939	977	873–900	884
TaIIIL	94	92	80–88	84
TaIIIW	18	18	15–18	16
S_1	18	18	18–20	18
f_1	—	2	3–3	3
ST	25	27	25–28	26
pST	9	10	10–15	13
PT’	17	18	18–18	18
ga	21	18–20	18–23	21
μga	5	—	5–5	5
ta	14	15–16	13–15	14
μta	4	4	5–5	5
S_2	19	18	18–20	18
f_2	—	2	3–3	3
PT”	16	17	13–18	15
gm	14	15	15–15	15
tm	13	14	13–13	13
gp	18	16	15–18	17
tp	17	15–17	15–18	17
DS	39	37	37–44	41
VS	46	35	43–53	48
NDV	85	72	85–94	88

61, and 1.3, respectively) and in much longer setae (AM = 40–50, AL = 65–77, PL = 69–78, H = 65–70 vs 25, 46, 31, and 42, respectively; PL > AL vs AL > PL).

Tribe Trombiculini Vercammen-Grandjean, 1960

Genus *Paratrombicula* Goff and Whitaker, 1984

Paratrombicula Goff and Whitaker, 1984: 329; Stekolnikov and González-Acuña 2012: 106, 2015: 18.

Type Species: *Paratrombicula enciscoensis* Goff and Whitaker, 1984, by original designation.

Diagnosis (Larva)

SIF = 7B-N(b)-3-1(2)111.0000; fPp = B/B/BNB, B/B/BBB; fsp = 7.7.7; fCx = 1.1.1; fSt = 2.2. Cheliceral blade with tricuspid cap; galeal setae nude or having one small cilium; palpal claw 3-pronged; lateral seta of palpal tibia nude or branched; other palpal setae branched; palpal tarsus with seven branched setae and basal tarsala. Scutum punctate, nearly pentagonal, with rounded posterior margin, with one AM, two AL, and two PL setae; flagelliform sensilla densely covered with short branches in distal part and small cilia in proximal part. Eyes 2 + 2. Legs 7-segmented; microtarsala I usually proximal to tarsala [distal in *P. plaumanni* (Brennan and Jones, 1964)]; single genuala I (in *P. goffi* Stekolnikov and González-Acuña, 2012, 2 genualae I sometimes present), genualae II and III present, tibiala III

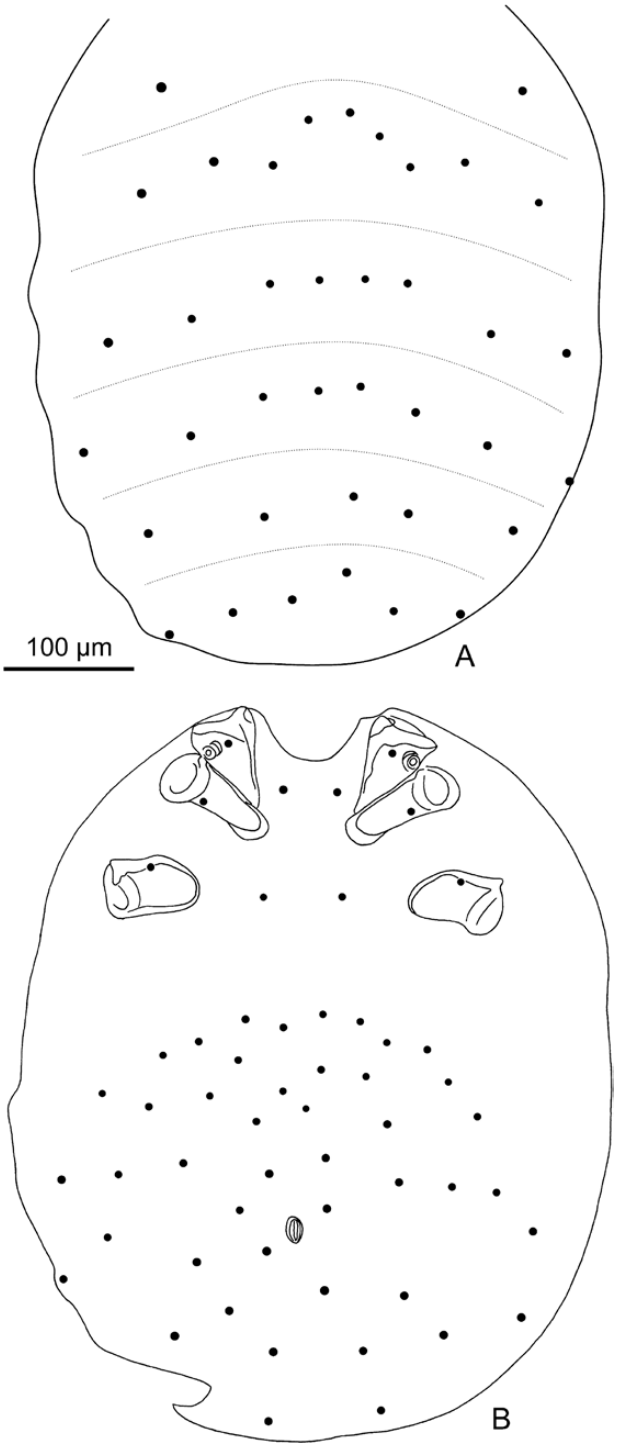

Fig. 4. *Quadraseta chiloensis* sp. nov., holotype. (A) Arrangement of dorsal idiosomal setae (scheme). (B) Idiosoma, ventral aspect (scheme).

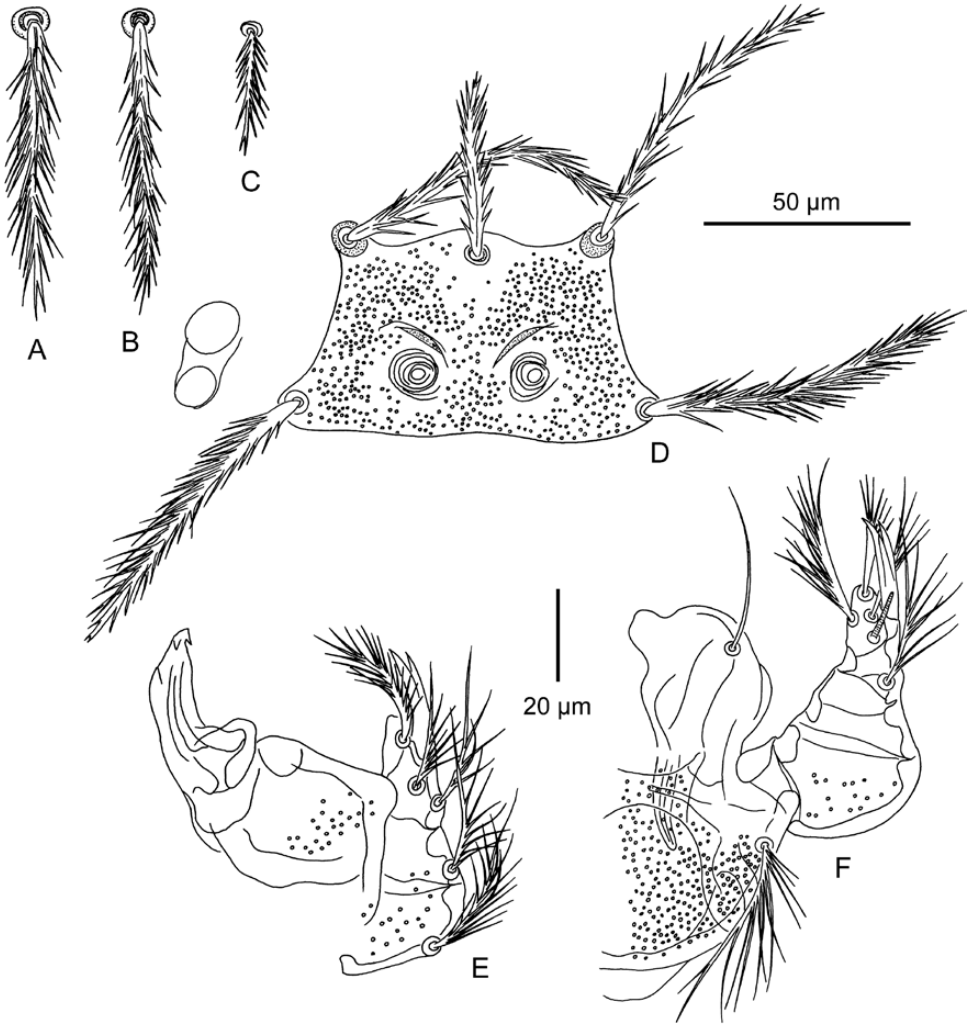

Fig. 5. *Quadraseta chiloensis* sp. nov., holotype. (A) Humeral seta. (B) Dorsal idiosomal seta of second row. (C) Preanal ventral idiosomal seta. (D) Scutum and eyes (right eyes not figured). (E) Dorsal aspect of gnathosoma. (F) Ventral aspect of gnathosoma. Scale bars: 50 μm (A–D), 20 μm (E, F).

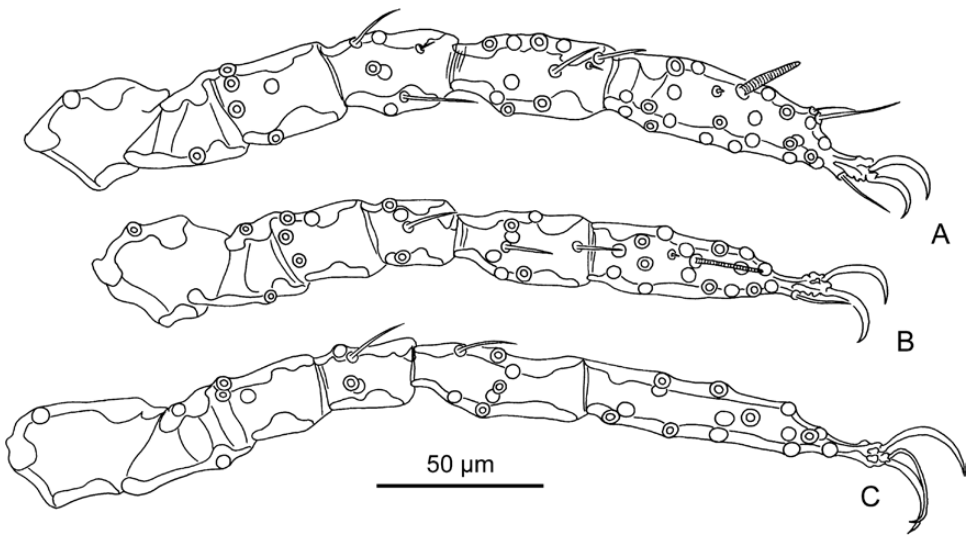

Fig. 6. *Quadraseta chiloensis* sp. nov., holotype. (A) Free part of leg I (trochanter–tarsus; empodium missed). (B) Free part of leg II (trochanter–tarsus; empodium missed). (C) Free part of leg III (trochanter–tarsus).

present, subterminala, parasubterminala, pretarsalae I and II present, mastisetae on leg III absent.

Paratrombicula goffi Stekolnikov and González-Acuña, 2012

(Fig. 1G)

Diagnostic Formulas (Corrected According to New Data)

SIF = 7B-N-3-1(2)111.0000; fsp = 7.7.7; fCx = 1.1.1; fSt = 2.2; fPp = B/B/BN(B)B; fSc: AL = PL = AM; fD = 2H-8-6-6-4-4-(0–2); Ip = 725–805; DS = 28–32; VS = 20–28; NDV = 50–60.

Hosts

Liolaemus lemniscatus Gravenhorst, *L. chillanensis* Müller and Hellmich (Reptilia: Squamata: Iguanidae) (Stekolnikov and González-Acuña 2012), *Abrothrix olivacea* (this study).

Distribution

Chile, O'Higgins Region and Biobío Region (Stekolnikov and González-Acuña 2012), Los Lagos Region (this study).

Type Material Examined

Holotype: Larva (ZIN 7696, T-Tr.-55) ex *L. lemniscatus*, CHILE, O'Higgins Region, Sierras de Bellavista, 9-XII-2006. Eleven paratypes larvae (ZIN 7695, 7697–7699, 7713, 7733, 7738–7742) ex *L. lemniscatus* and *L. chillanensis*, CHILE, O'Higgins Region, Sierras de Bellavista, 9-XII-2006; Biobío Region, Nevados de Chillan Mts, Shangri-la mountain refuge, 11-I-2006; Waldorf mountain refuge, 15-I-2006.

Additional Material Examined

Three larvae (ZIN 16435, CDCA 342, 343) ex *A. olivacea*, CHILE, Los Lagos Region, Chiloé Island, 2-II-2018, coll. Gerardo Acosta and Esperanza Beltrami.

Discussion

Knowledge on the trombiculids parasitizing mammal hosts in Chile is limited. Up to now, chigger mites described from Chilean mammals included four species known only from their type series—*Chilacarus martini* Webb, Bennett and Loomis, 1986 from a long-haired akodont *Abrothrix longipilis* (Waterhouse) (Rodentia: Cricetidae), *Paraguacarus santiagoensis* Goff and Webb, 1989 from a common degu *Octodon degus* (Molina) (Rodentia: Octodontidae), *Herpetacarus (Abonnencia) antarctica* (Stekolnikov and Gonzalez-Acuña, 2015) from an American mink *Neovison vison* (Schreber) (Carnivora: Mustelidae), and *Dewuacarus lemuensis* Silva-de la Fuente, 2015 from a Picumche pericote *Loxodontomys pikumche* Spotorno, Cofre, Vilina, Marquet and Walker (Rodentia: Cricetidae). Our work adds three more species to this number. The total number of Chilean chiggers is thus increased to 15 genera, with *Quadraseta* and *Herpetacarus* recorded in Chile for the first time and *Proschoengastia* synonymized with *Herpetacarus*, and 25 species. The number of genera and species can increase in the future due to the lack of studies of chiggers parasitizing birds, bats, and amphibians in Chile.

Only one species, *Whartonacarus chaetosus* (Brennan and Jones, 1961) is also known outside the country up to now (Stekolnikov and González-Acuña 2015). Moreover, 5 of the 15 Chilean chigger genera are monotypic and can be endemic as well. The high level of endemism may be caused by the geographical situation of Chile as a narrow strip limited by the Pacific Ocean in the west and the Andean mountain chain in the east (Santibáñez et al. 2008).

The recent discovery of scrub typhus in southern Chile has raised questions on possible vectors and reservoirs of this emerging infection (Weitzel et al. 2016). All of the known vectors of *Orientia tsutsugamushi* in the Asia-Pacific region belong to the genus *Leptotrombidium* Nagayo, Miyagawa, Mitamura et Imamura, 1916 (Strickman 2001, Kim and Walker 2011, Santibáñez et al. 2015). Species of other genera, such as *Euschoengastia koreaensis* Jameson and Toshioka, 1954, *Neotrombicula japonica* (Tanaka, Kaiwa, Teramura and Kagaya, 1930), *Schoengastia hanmyaensis* Suzuki, 1976, and *Schoengastiella ligula* Radford, 1946, have been suggested as vectors in certain regions, but this remains controversial (Tilak et al. 2011, Santibáñez et al. 2015). However, since *Leptotrombidium* does not occur in the Neotropical region (Stekolnikov 2013), possible trombiculid vectors of scrub typhus in Chile should undoubtedly belong to a distinct genus or genera.

Although all demonstrated vector species in Asia-Pacific may parasitize various mammals and birds, rodents seem to be the critical determinants of the maintenance of scrub typhus in Asia (Coleman et al. 2003). Because no rodent-associated trombiculids had been reported from the Chilean focus of scrub typhus previously, other possible vectors, such as terrestrial leeches, have been discussed (Balcells et al. 2011). This study presents three potential vector candidates, *Herpetacarus (Abonnencia) eloisae* sp. nov., *Quadraseta chiloensis* sp. nov., and *Paratrombicula goffi*. Our previous data showed that *Herpetacarus* sp. was the most abundant chigger in the study area, which was found on all six examined rodent species, in five of six study sites, and on 93% of infested hosts, while *Quadraseta* sp. and *Paratrombicula* sp. were collected from only two rodent species each and in one study site. At the same time, some mite pools (from taxonomically unidentified samples) taken in the sites where only *Herpetacarus* sp. was recorded were found to be positive for *Orientia* sp. (Acosta-Jamett et al. 2020), which suggests that *H. eloisae* sp. nov. might be a vector or reservoir of scrub typhus on Chiloé. However, further research is necessary to verify this hypothesis.

Acknowledgments

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