Two new species of Apoloniinae (Acari: Trombiculoidea: Leeuwenhoekiidae) from African small mammals, with a key to the species of the world

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Key words: Acari, Africa, Apoloniinae, chiggers, Leeuwenhoekiidae, new species, Trombiculoidea

Abstract. The genus *Liuela* Wang et Bai, 1992 is transferred from Trombiculidae to Apoloniinae and a new species *Liuela monosetosa* sp. n. described from specimens taken in Morocco from the hosts *Gerbillus* sp. and *Meriones libycus* Lichtenstein. A new species of *Straelensia* Vercammen-Grandjean et Kolebinova, 1968, *Straelensia variocula* sp. n. is described from specimens taken in Morocco and Burkina Faso from the hosts *Genetta thierrii* Matschie, *Gerbillus* sp., *M. libycus* and *Elephantulus rozeti* (Duvernoy). A list of species, hosts and localities and a key to the species of the Apoloniinae of the world are presented.

The subfamily Apoloniinae Wharton, 1947 was created to accommodate two monotypic genera containing the species *Apolonia tigipioensis* Torres et Braga, 1938 and *Womersia strandtmanni* Wharton, 1947 from South and North America. Since that time, 17 additional species from Africa, Central America, China, Europe, Russia and Pacific Islands have been added. Vercammen-Grandjean and Kolebinova (1968) revised the Apoloniinae and divided the subfamily into two tribes, the Sauracarellini and the Apoloniini. The species here described fit morphologically into the Apoloniini and bring the totals for that tribe to 14 species in 5 genera and for the Apoloniinae to 19 species in 8 genera. A list of the species, hosts, and localities is provided and the key of Goff (1983) to then known apoloniine taxa, is revised and expanded.

MATERIALS AND METHODS

Chiggers from small mammal hosts taken from Morocco and Burkina Faso were collected in conjunction with the African Mammal Project (AMP) of the U.S. National Museum / Smithsonian Institution (USNM) in 1968, 1969 and 1970. The program spanned the period of 1961 to 1972 resulting in a massive ectoparasite collection only a small portion of which is reported on here. Captured mammals were killed, identified to genus and when possible to species by mammalogists and support members of the USNM. Pelts were deposited in the USNM and are recorded by accession number. Pelts were examined for ectoparasites and when found were removed and preserved in 70% ethanol. Slide mounts were later prepared for microscopy using a clearing agent and polyvinyl alcohol mounting media. Examination of chigger specimens collected in those three years of the project has revealed the presence of the three families Trombiculidae, Leeuwenhoekiidae and Walchiidae. This portion of the study is concentrated on the subfamily Apoloniinae of the Leeuwenhoekiidae. The microscopy for this material utilized both phase contrast (Wild Heerbrugg microscope with bright field, dark field and phase contrast

lenses, and micrometer and camera attachments) and differential interference microscopy (Olympus BX-51 with Aptronic Macrofield digital camera and Picture Frame software for computer enhancement). Illustrations were made utilizing micrometer measurements and computerized photomicrographs. Accession numbers are not assigned to the chiggers, which are catalogued alphabetically by species, followed by genus, date and collector. The holotypes of the described species have been deposited in the collection of the U.S. National Museum of Natural History / Smithsonian Institution, Washington, D.C., USA. Paratypes are there, as well as in the collection of the Institute of Parasitology, Academy of Sciences of the Czech Republic, České Budějovice (PaÚ) and collection of the author. Terminology and abbreviations follow Goff et al. (1982). All measurements are given in micrometres (µm).

RESULTS

Liuela Wang et Bai, 1992

Type species: *Liuela virtus* Wang et Bai, 1992

In 1992 Wang and Bai assigned *Liuela virtus* to Trombiculini of the Trombiculidae comparing it to *Miyatrombicula* (*Miyatrombicula*) *kochiensis* Sasa, Kawashima et Egashira, 1952 and *Miyatrombicula* (*Miyacarus*) *tokioensis* Kumada, 1954 from Japan. Comparison of Ip, scutal and eye placement measurements and morphology and sternal and coxal setation of *Liuela virtus* with the *Miyatrombicula* taxa and with members of the Apoloniinae, tribe Apoloniini, indicate that this species more appropriately belongs in the latter grouping and it is here reassigned. The original diagnosis is repeated with emendation to reflect its transfer from Trombiculidae (Trombiculini) to Apoloniinae (Apoloniini) and to encompass measurement differentials required by addition of a new species.

Emended diagnosis. Larvae of Apoloniinae (Apoloniini) B/B/BB-NB/4BS. Galeala nude. Scutum round shield without anterolateral shoulders, with obvious

papilla-shaped centro-projection on the posterior margin (cordiform scutum). PL far off the scutum (peniscutum). Sensillae filiform, with setules near base and thick branches closely following the setules. Palpal claw 3-pronged. Parasubterminala I absent. Mastifemorala, mastitibiala and mastitarsala all absent but with a rather long nude seta on the middle part of basifemur of leg III. Genuala II and III, tibiala III all absent. fCx = 1/2/1. fSt = 2/2/9–13. Chelicerae broad at base, strongly recurved, lacking denticles. SIF 4BS-N-3-1000.0000. Ip 414–648.

Liuela monosetosa sp. n.

Fig. 1

Description. Larvae 4BS-3-N-1000-0000. Idiosoma measuring 150 × 110 in unengorged specimen, 310 × 160 in partially engorged holotype. Eyes 2 pairs, on idiosoma, surrounded by epiotracheal pleats, anterior 10 in diameter, posterior weak or unapparent. One pair of humeral setae 24–26 long; 96–104 dorsal idiosomal setae 16–23 long, arranged in irregular rows beginning 12–12; 9–13 sternal setae irregularly placed, 10–15 long; 4–8 bilateral intercoxal setae, between coxa II and III, usually 7, arranged 3–4, 10–15 long; 18–20 preanal setae 10–15 long; 30–34 postanal setae 15–17 long. Total idiosomal setae 159–173 in number. Gnathosoma. Palpal setal formula B/B/BBB/4BS; palpal claw 3-pronged, 11–12 long; galeala N; cheliceral blade 14–15 long, broad at base, strongly recurved, lacking denticles; gnathobase lightly punctate to squamous at edges, bearing a pair of branched setae. Scutum. Cordiform, smooth or with few puncta, arched crescents above sensillar bases, biconcave anterior margin lacking nasus; posterior margin rounded with acute pointed apex; convex lateral margins; AM base slightly posterior to AL bases; PL setae extrascutal (peniscutum); SB anterior to level of PL bases; PL > AL > AM; sensillae flagelliform with basal barbs and branches along entire structure. Scutal standard measurements are tabulated below. Legs. All 7-segmented, terminating in 2 claws with claw-like empodium. Onychotriches absent. Leg measurements are tabulated below. Leg I: coxa with 1 branched seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, genuala; tibia 8B, 2 tibialae, microtibiala; tarsus 20B, tarsala, microtarsala, subterminala, pretarsala. Leg II: coxa 2B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B; tibia 6B, 2 tibialae; tarsus 16B, tarsala. Leg III: coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B; tibia 6B; tarsus 13B.

Standard measurements of type series (n = 9):

	AW	SB	ASB	PSB	SD	AM	AL	PL
holotype	36	10	12	12	24	7	22	24
minimum	31	10	12	12	24	6	15	18
maximum	36	13	13	17	30	10	22	25
mean	34	12	12	14	26	7	19	22

S	H	D	V	pa	pm	pp	Ip
18	26	18	11	149	124	144	412
13	24	16	10	147	122	136	405
18	26	23	15	157	126	150	423
15	20	20	12	154	124	143	414

Hosts: *Gerbillus* sp., *Meriones libycus* Lichtenstein.

Type data: Type series from Morocco. Holotype from *Gerbillus* sp., USNM 473444, Tarfaya, Tuisgui Remz, 28°28'N, 09°12'W, 15 XII 1969, Col. L. W. Robbins. Site habitat was a small valley wash with gravel, soil and some vegetation, surrounded by small rocky hills. Eight paratypes, number from each host in parentheses. *Gerbillus* sp., USNM 472247 (1), Agadir, Aouinet Torkoz, 28°42'N, 09°52'W, 07 XI 1969, Col. H. W. Setzer. Site habitat was a small palm grove near rocky hillside. USNM 471732 (2), Ouarzazate, Fom Zguid, 30°04'N, 06°53'W, 07 III 1970, Col. M. G. Hearst. Site habitat was at oasis palm grove edge with acacias and pebble desert. USNM 471736 (1), Ouarzazate, Fom Zguid, 30°04'N, 06°53'W, 07 III 1970, Col. M. G. Hearst. Site habitat as above. USNM 471780 (1), Ouarzazate, Fom Zguid, 30°04'N, 06°53'W, 07 III 1970, Col. M. G. Hearst. Site habitat as above. *Meriones libycus*, USNM 473913 (3), Ouarzazate, Tazenakht 30°04'N, 07°17'W. Site habitat consisted of fairly thick vegetation of thorn bushes and small woody shrubs in hills above a riverbed. The holotype and six paratypes (M-1 to M-7) are deposited in USNM, one paratype (M-8) is in the collection of the author and one paratype (M-9) is in PaÚ (coll. no.: PaÚ 2005).

Etymology: The new species name “*monosetosa*” reflects the presence of a single anterior medial seta characteristic of this genus.

Differential diagnosis. *Liuela monosetosa* can be separated from the type species *L. virtus* by the smaller size and standard data measurements Ip = 648, AW = 45, SD = 51 in that species as opposed to Ip = 414, AW = 34, SD = 26 in *L. monosetosa*. It further differs from *L. virtus* by the less pilose total idiosomal setae, circa 253 in that species while *L. monosetosa* displays circa 170.

Straelensia Vercammen-Grandjean et Kolebinova, 1968

Type species: *Straelensia europaea* Vercammen-Grandjean et Kolebinova, 1968

The original diagnosis, based on one specimen, was emended by Wen et al. (1996) in their paper which encompassed properties of new members assigned to *Straelensia*. This new species fits within the parameters of that re-diagnosis.

Straelensia variocula sp. n.

Fig. 2

Description. Larvae 4BS-3-N-1000-0000. Idiosoma measuring 500 × 270 in partially engorged specimen. Eyes 2 pairs, on idiosoma surrounded by epiotracheal pleats, anterior 10 in diameter, posterior weak, often absent or unapparent. One pair of humeral setae 34–38

Fig. 1. *Liuella monosetosa* sp. n. **A** – Scutal area of unengorged specimen with placement of eyes, extrascutal PLs and 2 dorsal setae. **B** – Scutal area of partially engorged specimen, as above. **C** – Ventral aspect of palpal tarsus. **D** – Sternal area with placement of coxal setae, and sternal and intercoxal setae, both of which are variable in placement and number. **E** – Dorsal aspect of gnathosoma. **F** – Leg I distal three segments showing specialised setae and bases of branched setae. **G** – Leg II, as above. **H** – Leg III, as above.

long; 96–110 dorsal idiosomal setae 20–28 long, arranged in irregular rows beginning 12–12; 7–13 sternal setae irregularly placed, 16–20 long; 5–9 bilateral intercoxal setae between coxa II and III, usually placed 4–3, 16–20 long; 46–50 preanal setae 16–20 long; 46–50

postanal setae 16–20 long; total idiosomal setae 202–234 in number. Gnathosoma. Palpal setal formula B/B/BBB/4BS; palpal claw 3-pronged, 16–20 long; galeala N; cheliceral blade 15–16 long, broad at base, strongly recurved without denticles; gnathobase lightly

punctate to squamous at edges, bearing a pair of branched setae. Scutum. Cordiform, smooth or with few puncta, arched crescents above sensillar bases, with biconcave anterior margin and anteriomedial nasus 3×10 long; posterior margin rounded with acute pointed apex; convex lateral margins; AM base slightly posterior to AL bases; PL setae extrascutal; SB anterior to level of PL bases; $PL > AL > AM$; sensillae flagelliform with basal barbs and branches throughout structure. Scutal measurements are tabulated below. Legs. All 7-segmented, terminating in 2 claws with claw-like empodium. Onychotriches absent. Leg measurements are tabulated below. Leg I: coxa with 1 branched seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, genuala; tibia 8B, 2 tibialae, microtibiala; tarsus 20B, tarsala, microtarsala, pretarsala. Leg II: coxa 2B; trochanter 1B; basifemur 1B; telofemur 5B; genu 3B; tibia 5B, 2 tibialae; tarsus 16B, tarsala. Leg III: coxa 1B; trochanter 1B; basifemur 1B; telofemur 4B; genu 3B; tibia 6B; tarsus 13B.

Standard measurements of type series (n = 15):

	AW	SB	ASB	PSB	SD	AM	AL	PL
holotype	32	15	18	19	37	9	24	29
minimum	32	12	15	15	30	6	18	27
maximum	44	17	20	22	42	10	24	36
mean	36	15	17	19	36	7	21	30

S	H	D	V	pa	pm	pp	Ip
20	36	22	18	168	150	162	492
18	34	20	16	165	146	152	480
27	38	28	20	186	165	184	530
22	36	24	18	174	174	168	505

H o s t s : *Elephantulus rozeti* (Duvernoy), *Genetta thierryi* Matschie, *Gerbillus* sp., *Meriones libycus* Lichtenstein.

T y p e d a t a : Type series from Morocco and Burkina Faso. Morocco: Holotype from *Elephantulus rozeti*, USNM 476133, Fes Missouri, $33^{\circ}08'N$, $04^{\circ}05'W$, 28 VI 1970, Col. L. W. Robbins. Site habitat was a bushy wash area. Fourteen paratypes, number from each host in parentheses. *Elephantulus rozeti*, USNM 476133 (2), Fes Missouri, $33^{\circ}08'N$, $04^{\circ}05'W$, 28 VI 1970, Col. L. W. Robbins. Site as above. *Gerbillus* sp., USNM 472768 (2), Ouarzazate, Ouarzazate, $30^{\circ}52'N$, $06^{\circ}52'W$, 23 II 1970, Col. L. W. Robbins. Site habitat was sandy wash with rocky hillsides with little vegetation. USNM 472769 (1), Ouarzazate, Ouarzazate, $30^{\circ}52'N$, $06^{\circ}52'W$, 23 II 1970, Col. L. W. Robbins. Site as above. USNM 472774 (1), Ouarzazate, Ouarzazate, $30^{\circ}52'N$, $06^{\circ}52'W$, 24 II 1970, Col. L. W. Robbins. Site as above. USNM 472772-3 (1), Ouarzazate, Ouarzazate, $30^{\circ}52'N$, $06^{\circ}52'W$, 23 II 1970, Col. L. W. Robbins. Site as above. USNM 472778 (1), Ouarzazate, Ouarzazate, $30^{\circ}52'N$, $06^{\circ}52'W$, 23 II 1970, Col. L. W. Robbins. Site as above. USNM 471968 (1) Oujda, Figuig, $32^{\circ}09'N$, $01^{\circ}15'W$, 09 II 1970, Col. M. G. Hearst. Site habitat was rocky, sand dunes with vegetation tufts. USNM 476133 (2), Fes Missouri, $33^{\circ}08'N$, $003^{\circ}59'W$ 26 VI 1970, Col. L. W. Robbins. Site habitat rocky plain. *Meriones libycus*, USNM 473982 (1), Fes Missouri, $33^{\circ}08'N$, $003^{\circ}59'W$, 26 VI 1970, Col. L. W. Robbins. Site as above.

Burkina Faso: *Genetta thierryi*, USNM 450962 (2). Natiaboni, $11^{\circ}42'N$, $00^{\circ}30'E$, 11 XII 1968, Col. R. E. Vaden. Site habitat riverbed, no running water but with some pools and areas of high grass. The holotype and twelve paratypes (M-1 to M-11 and B-1 to B-2) are deposited in USNM, one paratype (M-12) is in the collection of the author and one paratype (M-13) is in PaÚ (coll. no.: PaÚ 2006).

E t y m o l o g y : The species name reflects the variability of observing the posterior eyes of this taxon.

Differential diagnosis. *Straelensia variocula* can be separated from *S. europaea*, by the smaller size and standard data measurements $Ip = 676$, $SD = 48$ in that species as opposed to $Ip = 505$, $SD = 36$ in *S. variocula* and the differing galeala seta, branched in *S. europaea* but nude in *S. variocula*. It differs from *S. africana* by the more pilose total idiosomal setae, circa 130 in that species while *S. variocula* displays circa 218 and in the differing alignment of coxalae II, parallel in *S. africana* and perpendicular in the new species.

Key to the species of the Apoloniinae of the world

- 1 Sensillae expanded 2
 - Sensillae slender 4
- 2 Coxa II bisetose; palpal tarsus 6BS; 3 galealae I ...
 - *Afracarella africana*
 - Coxa II unisetose; palpal tarsus 7BS; 2 galealae I 3
- 3 Tarsala I < Tarsala II; $AM < PL$
 - *Sauracarella whartoni*
 - Tarsala I > Tarsala II; $AM > PL$
 - *Sauracarella montana*
- 4 Nasus present 5
 - Nasus absent 16
- 5 Single AM seta 6
 - Paired AM setae 11
- 6 Palpal tarsus formula 5B or greater 7
 - Palpal tarsus formula 4BS or less 10
- 7 Palpal tarsus formula 5B; large nasus with AM seta on nasus 8
 - Palpal tarsus formula 5BS or greater; thin nasus with AM seta on scutum 15
- 8 Tarsala II bluntly tapering
 - *Womersia strandtmanni*
 - Tarsala II with bulbapex. 9
- 9 Mastitarsala III absent; eyes on ocular plate.....
 - *Womersia irani*
 - Mastitarsala III present; eyes on idiosoma
 - *Womersia midwayensis*
- 10 Palpal tarsus 3BNS; palpal tibia 2B and with a subterminal 3-pronged dorsal curved spine.....
 - *Straelensia cynotis*
 - Palpal tarsus 4BS; palpal tibia 3B 11
- 11 Galeala B 12
 - Galeala N 14

Fig. 2. *Straelensia variocula* sp. n. **A** – Scutal area with placement of eyes and extrascutal PLs. **B** – Dorsal aspect of gnathosoma. **C** – Ventral aspect of palpal tarsus. **D** – Sternal area with placement of coxal setae, and sternal and intercoxal setae, both of which are variable in placement and number. **E** – Leg I distal three segments showing specialised setae and bases of branched setae. **F** – Leg II, as above. **G** – Leg III, as above.

12 Index pedibus greater than 600	13	14 Coxalaea II parallel to edge of segment; NDV $\approx$ 130	<i>Straelensia africana</i>
– Index pedibus less than 580		– Coxalaea II perpendicular to edge of segment; NDV $\approx$ 218	<i>Straelensia variocula</i> sp. n.
<i>Straelensia taurica</i>		15 Palpal tarsus formula 5BS; subterminala absent ...	
13 Coxalaea III centrally located; NDV $\approx$ 208		<i>Afropolonia tgifi</i>	
<i>Straelensia europaea</i>		– Palpal tarsus formula 7BS; subterminala present ...	
– Coxalaea III excentrally located, anteriorly; NDV $\approx$ 239		<i>Apolonia tigipioensis</i>	
<i>Straelensia tiani</i>			

- 16 Single AM seta; coxal setae II bisetose 17
 – Paired AM setae; coxal setae II unisetose or bisetose 18
 17 Index pedibus $\approx$ 648; NDV $\approx$ 253
 Liella virtus
 – Index pedibus $\approx$ 414; NDV $\approx$ 170
 Liella monosetosa sp.n.
 18 Coxa II bisetose; tibiala III absent; eyes absent
 Vargatula hispida
 – Coxa II unisetose; tibiala III present; eyes present 19
- 19 Pretarsala II present; palpal claw 4-pronged
 Vargatula somaliensis
 – Pretarsala II absent; palpal claw 3-pronged
 Vargatula pacifica

Acknowledgements. Thanks are extended to two anonymous reviewers for critically reading and providing useful comments on the manuscript. Studies were conducted at the College of Tropical Agriculture and Human Resources, University of Hawaii, Honolulu, Hawaii.

Table 1. Species of the Apoloniinae of the world.

Chigger species	Host species	Localities
<i>Afracarella africana</i> (Lawrence, 1949)	<i>Tetradactylus seps seps</i>	South Africa
<i>Sauracarella whartoni</i> Lawrence, 1949	<i>Pseudocordylus subviridis</i>	South Africa
<i>Sauracarella montana</i> Lawrence, 1949	<i>Tropidodroma cottrelli</i>	South Africa
<i>Womersia strandtmanni</i> Wharton, 1947	<i>Pelecanus occidentalis</i>	North America
<i>Womersia irani</i> Vercammen-Grandjean, Rhode et Mesgali, 1970	<i>Neophron percnopterus</i>	Iran
<i>Womersia midwayensis</i> Goff, Sivert et Sileo, 1989	<i>Diomedea immutabilis</i>	Midway Island
<i>Sraelensia europaea</i> Vercammen-Grandjean et Kolebinova, 1968	<i>Canis lupus</i>	Bulgaria
<i>Sraelensia africana</i> Vercammen-Grandjean, 1971	<i>Herpestes sanguineus</i>	South Africa
<i>Sraelensia taurica</i> Hushcha, 1975	<i>Lepus europaeus</i>	Crimea, Ukraine
<i>Sraelensia tiani</i> Wen, Tian, Guan et Wang, 1996	<i>Lepus capensis</i>	Shanxi, China
<i>Sraelensia cynotis</i> Fain et Le Net, 2000	<i>Canis</i> sp., dogs	France
<i>Sraelensia variocula</i> sp.n.	<i>Elephantulus rozeti</i> , <i>Genetta thierryi</i> , <i>Gerbillus</i> sp., <i>Meriones libycus</i>	Morocco and Burkina Faso, Africa
<i>Afropolonia tgif</i> Goff, 1983	<i>Aethomys namaquensis</i>	South Africa
<i>Apolonia tigipioensis</i> Torres et Braga, 1938	<i>Gallus gallus domesticus</i> , man	South America
<i>Vargatula hispida</i> Brennan et Yunker, 1966	<i>Dasyus novemcinctus</i>	Panama, C. America
<i>Vargatula pacifica</i> Goff et Loomis, 1982	<i>Sus scrofa</i>	N. Solomon Islands
<i>Vargatula somaliensis</i> Goff, 1983	<i>Heterocephalus glaber</i>	Somalia, Africa
<i>Liella virtus</i> Wang et Bai, 1992	<i>Citellus dauricus alashanicus</i>	Ningxia, China
<i>Liella monosetosa</i> sp.n.	<i>Gerbillus</i> sp., <i>Meriones libycus</i>	Morocco, Africa

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Received 27 June 2005

Accepted 13 March 2006