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Subscriptions: Year 2023 (Volume 63): 450 €

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Previous volumes (2010-2021): 250 € / year (4 issues)

Acarologia, CBGP, CS 30016, 34988 MONTFERRIER-sur-LEZ Cedex, France

ISSN 0044-586X (print), ISSN 2107-7207 (electronic)

The digitalization of Acarologia papers prior to 2000 was supported by Agropolis Fondation under the reference ID 1500-024 through the « Investissements d'avenir » programme (Labex Agro: ANR-10-LABX-0001-01)

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New and interesting species of the genera *Galumna* and *Pergalumna* (Acari, Oribatida, Galumnidae) from the Montagne d'Ambre National Park, Madagascar

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Original research

ABSTRACT

This work includes taxonomic and faunistic data on galumnid mites (Oribatida, Galumnidae) belonging to the genera *Galumna* and *Pergalumna* collected from the Montagne d'Ambre National Park, North Madagascar. Two new species are described: *Galumna sandormahunkai* n. sp. differs from its closest species, *Galumna sphagni* by the larger body size, the presence of strongly protruding rostrum, lanceolate, pointed apically bothridial setae, the direction of lamellar lines, and the absence of median pore; *Pergalumna janosbaloghi* n. sp. differs from the most similar species, *Pergalumna aegra*, by the smaller body size and the presence of long lamellar setae and elongate, distinctly or slightly triangular porose areas Aa. *Galumna granalata* and *Pergalumna amamiensis* are recorded in the Ethiopian region for the first time; *Pergalumna conspicua* and *P. frater* are recorded in Madagascar for the first time.

Keywords galumnid mites; systematics; morphology; fauna; Ethiopian region

Zoobank <http://zoobank.org/8DDB4D28-C1E9-4A71-94D8-D0FDAD9C20AA>

Introduction

This work is based on oribatid mite (Acari, Oribatida) material, which was collected from the Montagne d'Ambre National Park (Madagascar), and includes data on the genera *Galumna* Heyden, 1826 and *Pergalumna* Grandjean, 1936 of the family Galumnidae.

During taxonomic identification, we found eight species; of these, two species are new to science. The primary goal of this paper is to describe these new species and to provide the list of identified species.

Galumna was proposed by Heyden (1826), with *Notaspis alatus* Hermann, 1804 as type species. The nominative subgenus comprises about 190 species having a cosmopolitan distribution collectively (Subías 2019). *Pergalumna* was proposed by Grandjean (1936), with *Oribata nervosa* Berlese, 1914 as type species. The nominative subgenus comprises about 160 species collectively having a cosmopolitan distribution except the Antarctic region (Subías 2019). The subgeneric diagnoses of *Galumna* (*Galumna*) and *Pergalumna* (*Pergalumna*) were presented by Ermilov & Klimov (2017). Identification keys to many species of *Galumna* and *Pergalumna* from different geographical regions are given by Ermilov *et al.* (2014, 2015a, b; 2018), Ermilov & Starý (2017, 2018), Ermilov & Friedrich (2019).

At present, representatives of *Galumna* and *Pergalumna* are poorly studied in Madagascar; only few species have been recorded (Mahunka 1996, 1997, 2009, 2011a, b).

Received 15 November 2019

Accepted 10 January 2020

Published 17 January 2020

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Academic editor

Baumann, Julia

DOI

10.24349/acarologia/20204357

ISSN 0044-586X (print)

ISSN 2107-7207 (electronic)

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OPEN ACCESS

How to cite this article Ermilov S. G. and Starý J. (2020), New and interesting species of the genera *Galumna* and *Pergalumna* (Acari, Oribatida, Galumnidae) from the Montagne d'Ambre National Park, Madagascar. *Acarologia* 60(1): 64-74; DOI 10.24349/acarologia/20204357

Material and methods

The studied galumnid mites were collected in the Montagne d'Ambre National Park, North Madagascar, during long-term official cooperation between the Moravian Museum in Brno (Czech Republic) and Université d'Antananarivo (Madagascar) in 2010–2014.

Specimens (all exemplars were studied and measured) were mounted in lactic acid on temporary cavity slides for measurement and illustration. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the notogaster. Notogastral width refers to the maximum width of the notogaster in dorsal view (behind pteromorphs). Lengths of body setae were measured in lateral aspect. All body measurements are presented in micrometers. Formulae for leg setation are given in parentheses according to the sequence trochanter-femur-genu-tibia-tarsus (famulus included). Formulae for leg solenidia are given in square brackets according to the sequence genu-tibia-tarsus.

Drawings were made with a camera lucida using a Leica transmission light microscope "Leica DM 2500".

Morphological terminology used in this paper follows that of F. Grandjean (see Ermilov & Klimov 2017 for review and application).

The following abbreviations are used: *L* = lamellar line; *S* = sublamellar line; *N* = prodorsal leg niche; *E*, *T* = lateral ridges of prodorsum; *ro*, *le*, *in*, *bs*, *ex* = rostral, lamellar, interlamellar, bothridial and exobothridial setae, respectively; *bo* = bothridium; *Ad* = dorsosejugal porose area; *D* = dorsophragma; *P* = pleurophragma; *c*, *la*, *lm*, *lp*, *h*, *p* = notogastral setal alveoli/microsetae; *Aa*, *A1*, *A2*, *A3* = notogastral porose areas; *ia*, *im*, *ip*, *ih*, *ips* = notogastral lyrifissures; *gla* = opisthonotal gland opening; *a*, *m*, *h* = subcapitular setae; *or* = adoral seta; *v*, *l*, *d*, *cm*, *acm*, *ul*, *sul*, *vt*, *lt* = palp setae; ω = palp and leg solenidion; *as* = axillary saccule; *cha*, *chb* = cheliceral setae; *Tg* = Trägårdh's organ; *I*, *II* = pedotecta I, II, respectively; *1b*, *3b*, *4a*, *4b*, *4c* = epimeral setae; *dis* = discidium; *cp* = circumpedal carina; *g*, *ag*, *an*, *ad* = genital, aggenital, anal and adanal setae, respectively; *iad* = adanal lyrifissure; *po* = preanal organ; *Ap* = postanal porose area; *Tr*, *Fe*, *Ge*, *Ti*, *Ta* = leg trochanter, femur, genu, tibia, tarsus, respectively; *pa* = leg porose area; σ , ϕ = leg solenidia; ε = leg famulus; *v*, *ev*, *bv*, *l*, *d*, *ft*, *tc*, *it*, *p*, *u*, *a*, *s*, *pv*, *pl* = leg setae.

Systematics

Superfamily Galumnoidea

Family Galumnidae

Genus *Galumna* Heyden, 1826

Type species *Notaspis alatus* Hermann, 1804

Galumna (Galumna) sandormahunkai n. sp.

Zoobank: 98E9F2F2-5384-4E4D-BADE-C6A461B64755

(Figures 1–3)

Diagnosis — Body size 780–996 × 564–780. Rostrum protruding, narrowly rounded. Lamellar and sublamellar lines divergent distally, *L* directed to lateral sides of prodorsum, *S* curving backwards. Rostral and lamellar setae of medium size, setiform, slightly barbed. Interlamellar setae minute. Bothridial setae long, narrowly lanceolate, barbed. Dorsosejugal porose areas present. Dorsosejugal suture complete. Four pairs of small porose areas, *Aa* oval, others rounded. Median pore absent. Epimeral setal formula 1-0-1-2. Epimeral and anogenital setae short, setiform, roughened. Circumpedal carinae short. Postanal porose area narrowly elongate oval. Solenidion on tibiae IV inserted in anterior part of the segment.

Description — Measurements – Large species. Body length 996 (holotype, female), 780–996 (13 paratypes, 10 females and three males); notogaster width 763 (holotype), 564–780 (13 paratypes). Females larger than males: 946–996 × 747–780 versus 780–846 × 564–614.

Integument – Body color light brown to brown. Body surface densely microgranulate, granules (less than 1) poorly developed (visible only at high magnification $\times 1000$). Antiaxial sides of all leg femora and trochanters III, IV with rounded and elongated tubercles.

Prodorsum (Figs 1a, 2a, 2c) – Rostrum strongly protruding (visible in frontal view), narrowly rounded. Lamellar and sublamellar lines slightly divergent distally, *L* thickened, directed to lateral sides of prodorsum, *S* thin, curving backwards. Lateral structures *N* and ridges *E* and *T* well developed. Rostral (49–53) and lamellar (49–53) setae setiform, slightly barbed. Interlamellar setae very short (4–6), setiform, thin, smooth. Bothridial setae (159–168) with long stalk and short, narrowly lanceolate, barbed head. Exobothridial setae represented by alveoli. Dorsosejugal porose areas (24–32 $\times$ 4–6) elongate oval, transversely oriented, located posterior or posterolateral to *in*. Dorsophragmata slightly elongated longitudinally.

Notogaster (Figs 1a, 2a, 2b) – Dorsosejugal suture complete. With 10 pairs of setal alveoli or vestigial setae (up to 1) and four pairs of small porose areas having distinct borders, *Aa* (22–26 $\times$ 10–12) oval, *A1*, *A2* and *A3* (10–20) rounded. Porose areas *Aa* located close to pteromorphal hinges, anteriorly to *la*. Median pore absent in females and males. Opisthonotal gland openings and all lyrifissures distinct, *gla* located anterolateral to *A1* and removed from them, *im* anterior to *A1* and slightly removed from them, *ip* lateral to *p*₁, *ih* anterior to *p*₃, *ips* lateral to *p*₃.

Gnathosoma (Figs 2d-f) – Subcapitulum size 196–205 $\times$ 180–192. Subcapitular setae (*a*, 32; *m*, 32; *h*, 24) setiform, slightly barbed; *a* thickest, *h* thinnest. Adoral setae (24) setiform,

Figure 1 *Galumna sandormahunkai* n. sp., adult: a – dorsal view; b – ventral view (gnathosoma and legs omitted). Scale bar 100 µm.

Figure 2 *Galumna sandormahunkai* n. sp., adult: a – anterior part of body, lateral view (gnathosoma and legs omitted); b – posterior part of body, lateral view; c – anterior part of prodorsum, frontal view; d – subcapitulum, ventral view; e – palp, right, antiaxial view; f – chelicera, left, paraxial view. Scale bar 100 µm (a, b), scale bar 50 µm (c, d, f), scale bar 20 µm (e).

barbed. Length of palps 139–143. Postpalpal setae (8) spiniform, smooth. Length of chelicerae 237–241. Cheliceral setae (*cha*, 82–86; *chb*, 45–49) setiform, barbed. Trägårdh's organ of chelicerae long, elongate triangular.

Epimeral and lateral podosomal regions (Figs 1b, 2a) – Anterior margin of epimere I smooth. Epimeral setal formula 1-0-1-2. Epimeral setae setiform, thin, roughened, *3b* (30–32) longer than *1b*, *4a* and *4b* (18–20). Pedotecta I broadly rounded, pedotecta II quadrangular in ventral view. Discidia triangular. Circumpedal carinae short, thin, directed to acetabula IV.

Anogenital region (Figs 1b, 2b) – Six pairs of genital setae (*g₁*, *g₂*, 26–28; *g₃*–*g₆*, 18–20), one pair of aggenital (18–20), two pairs of anal (18–20) and three pairs of adanal (18–20) setae setiform, thin, roughened. Anterior edge of genital plates with two setae. Aggenital setae located between genital and anal apertures, nearer to genital aperture. Adanal lyrifissures

located close and parallel to anal plates. Adanal setae ad_1 and ad_2 posterior, ad_3 lateral to anal aperture. Distance ad_1 – ad_2 slightly shorter than ad_2 – ad_3 . Unpaired postanal porose area narrowly elongate oval (41 – 49×4 – 6).

Legs (Figs 3a, 3b) – Median claw distinctly thicker than lateral claws, all slightly barbed on dorsal side. Porose area on all femora and on trochanters III, IV well visible. Formulae of leg setation and solenidia I (1 – 4 – 3 – 4 – 20) [1 – 2 – 2], II (1 – 4 – 3 – 4 – 15) [1 – 1 – 2], III (1 – 2 – 1 – 3 – 15) [1 – 1 – 0], IV (1 – 2 – 2 – 3 – 12) [0 – 1 – 0]; homology of setae and solenidia indicated in Table 1. Famulus on tarsi I inserted between solenidia ω_1 and ω_2 . Solenidion on tibiae IV inserted in anterior part of the segment.

Material examined — Holotype (female) and 13 paratypes (10 females and three males): North Madagascar, Montagne d’Ambre National Park, circuit Ampijoroana, evergreen rain forest, $12^{\circ}31'28''\text{S}$, $49^{\circ}09'52''\text{E}$, 950 m a.s.l., sifting of leaf litter sample under big unidentified tree, Winkler apparatus extraction, 13.I.2014 (R. Ravebolun and L. Rabotenson).

Type deposition — The holotype and two paratypes are deposited in the collection of the Senckenberg Institute, Görlitz, Germany. Eleven paratypes are deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia. All specimens are preserved in ethanol with drop of glycerol.

Etymology — The new species is named after late Prof. Dr. S. Mahunka, the Hungarian acarologist, for his extensive contributions to our knowledge of oribatid mites.

Remarks — In the presence of long rostral and lamellar setae, short interlamellar setae, long bothridial setae with developed head, complete dorsosejugal suture, and four pairs of rounded notogastral porose areas, *Galumna sandormahunkai* n. sp. is morphologically most similar to *Galumna sphagni* Ermilov, Hugo-Coetzee and Theron, 2018 from South Africa, but differs from the latter by the larger body size (780 – 996×564 – 780 versus 415 – 431×315 – 332), the presence of strongly protruding rostrum (versus not protruding), lanceolate, pointed apically bothridial setae (versus unilaterally dilated, rounded apically), the direction of lamellar lines to lateral sides of the prodorsum (versus anterior part of the ventral plate), and the absence of median pore (versus present).

Genus *Pergalumna* Grandjean, 1936

Type species *Oribata nervosa* Berlese, 1914

Pergalumna (*Pergalumna*) *janosbaloghi* n. sp.

Zoobank: 668307A5-D67E-4A81-A600-057C5ABE7542

(Figures 4–6)

Diagnosis — Body size 290 – 298×232 – 249 . Rostrum broadly rounded. Rostral and lamellar setae of medium size, setiform, slightly barbed. Interlamellar setae minute. Bothridial setae long, setiform, shortly ciliate. Dorsosejugal porose areas present. Dorsosejugal suture

Table 1 Leg setation and solenidia of adult *Galumna sandormahunkai* n. sp. and *Pergalumna janosbaloghi* n. sp.

Leg	Tr	Fe	Ge	Ti	Ta
I	v'	$d, (l), bv''$	$(l), v', \sigma$	$(l), (v), \phi_1, \phi_2$	$(ft), (tc), (it), (p), (u), (a), s, (pv), v', (pl), l'', \varepsilon, \omega_1, \omega_2$
II	v'	$d, (l), bv''$	$(l), v', \sigma$	$(l), (v), \phi$	$(ft), (tc), (it), (p), (u), (a), s, (pv), \omega_1, \omega_2$
III	v'	d, ev'	l', σ	$l', (v), \phi$	$(ft), (tc), (it), (p), (u), (a), s, (pv)$
IV	v'	d, ev'	d, l'	$l', (v), \phi$	$ft'', (tc), (p), (u), (a), s, (pv)$

Note: Roman letters refer to normal setae, Greek letters to solenidia (except ε = famulus). Single prime (') marks setae on anterior and double prime (") setae on posterior side of the given leg segment. Parentheses refer to a pair of setae.

Figure 3 *Galumna sandormahunkai* n. sp., adult: a – leg I, without trochanter, right, antiaxial view; b – leg IV, left, antiaxial view. Scale bar 50 μ m.

absent. Three pairs of porose areas, *Aa* elongate, distinctly or slightly triangular, transversely oriented, *A1* and *A3* rounded. Median pore absent. Epimeral setal formula 1-0-1-3. Epimeral and anogenital setae short, setiform, smooth. Circumpedial carinae long. Postanal porose area absent. Solenidion on tibiae IV inserted in anterior part of the segment.

Description — Measurements – Small species. Body length 298 (holotype, female), 290–298 (nine paratypes, all females); notogaster width 240 (holotype), 232–249 (nine paratypes).

Integument – Body color light brown to brown. Body surface densely microgranulate, granules (up to 1) well visible even at low magnification $\times 400$). Antiaxial sides of all leg femora and trochanters III, IV with rounded and elongated tubercles.

Prodorsum (Figs 4a, 5a) – Rostrum broadly rounded. Lamellar and sublamellar lines thin, parallel, curving backwards. Lateral structures *N* and ridges *E* and *T* slightly developed. Rostral (20–22) and lamellar (30–32) setae setiform, slightly barbed. Interlamellar setae very short (2–4), setiform, thin, smooth. Bothridial setae (73–86) setiform, shortly ciliate. Exobothridial setae represented by alveoli. Dorsosejugal porose areas (10–12 $\times$ 4) elongate oval, transversely oriented, located posterolateral to *in*. Dorsophragmata distinctly elongated longitudinally.

Notogaster (Figs 4a, 5a, 5b) – Dorsosejugal suture absent. With 10 pairs of setal alveoli three pairs of porose areas having indistinct borders, *Aa* (36–49 $\times$ 8–12) elongate, distinctly or slightly triangular, transversely oriented, *A1* (16–24) and *A3* (8–12) rounded. Porose areas *Aa* located close to pteromorphal hinges, anteriorly to *la*. Median pore absent in females (males not found). Opisthonotal gland openings and all lyrifissures distinct (except *ips* not observed), *gla* located lateral to *A1* and slightly removed from them, *im* anterolateral to *A1* and removed from them, *ip* lateral to *p*₁, *ih* anterior to *p*₃.

Gnathosoma (Fig. 5c) – Similar to *G. sandormahunkai* **n. sp.** Subcapitulum size 82–86 $\times$ 69–73. Subcapitular setae (*a*, 12; *m*, 12; *h*, 8) setiform, roughened; *a* thickest, *h* thinnest. Adoral setae (10) setiform, barbed. Length of palps 57–63. Postpalpal setae (2) spiniform,

Figure 4 *Pergalumna janosbaloghi* **n. sp.**, adult: a – dorsal view; b – ventral view (gnathosoma and legs omitted). Scale bar 50 μ m.

smooth. Length of chelicerae 94–98. Cheliceral setae (*cha*, 16; *chb*, 10) setiform, barbed. Trägårdh's organ of chelicerae long, elongate triangular.

Epimeral and lateral podosomal regions (Figs 4b, 5a) – Anterior margin of epimere I smooth. Epimeral setal formula 1-0-1-3. Epimeral setae setiform, thin, smooth, *1b*, *3b* and *4c* (6–8) longer than *4a* and *4b* (2–4). Pedotecta I broadly rounded, pedotecta II quadrangular in ventral view. Discidia triangular. Circumpedal carinae long, thin, directed to epimere I.

Anogenital region (Figs 4b, 5b) — Six pairs of genital setae (*g*₁, *g*₂, 6–8; *g*₃–*g*₆, 2–4), one pair of aggenital (2–4), two pairs of anal (2–4) and three pairs of adanal (2–4) setae setiform, thin, smooth. Anterior edge of genital plates with two setae. Aggenital setae located between genital and anal apertures, nearer to genital aperture. Adanal lyrifissures located close and parallel to anal plates. Adanal setae *ad*₁ and *ad*₂ posterior, *ad*₃ lateral to anal aperture. Distance *ad*₁–*ad*₂ slightly shorter than *ad*₂–*ad*₃. Postanal porose area absent.

Legs (Figs 6a, 6b) — Median claw distinctly thicker than lateral claws, all slightly barbed on dorsal side. Porose area on all femora and on trochanters III, IV well visible. Formulae of leg setation and solenidia I (1-4-3-4-20) [1-2-2], II (1-4-3-4-15) [1-1-2], III (1-2-1-3-15) [1-1-0], IV (1-2-2-3-12) [0-1-0]; homology of setae and solenidia indicated in Table 1. Famulus on tarsi I inserted between solenidia ω_1 and ω_2 . Solenidion on tibiae IV inserted in anterior part of the segment.

Figure 5 *Pergalumna janosbaloghi* n. sp., adult: a – anterior part of body, lateral view (gnathosoma and legs omitted); b – posterior part of body, lateral view; c – subcapitulum, ventral view. Scale bar 50 μ m (a, b), scale bar 20 μ m (c).

Material examined — Holotype (female) and nine paratypes (nine females): North Madagascar, Montagne d'Ambre National Park, circuit Ampijoroana, evergreen rain forest, 12°31'28"S, 49°09'52"E, 950 m a.s.l., sifting of leaf litter sample under big unidentified tree, Winkler apparatus extraction, 13.I.2014 (R. Ravebolun and L. Rabotensonon).

Type deposition — The holotype and two paratypes are deposited in the collection of the Senckenberg Institute, Görlitz, Germany. Seven paratypes are deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia. All specimens are preserved in ethanol with drop of glycerol.

Etymology — The new species is named after late Prof. Dr. J. Balogh, the Hungarian

Figure 6 *Pergalumna janosbaloghi* n. sp., adult: a – leg I, without trochanter, right, antiaxial view; b – leg IV, left, antiaxial view. Scale bar 20 μ m.

acarologist, for his extensive contributions to our knowledge of oribatid mites.

Remarks — In the presence of short interlamellar setae, setiform bothridial setae, interrupted medially dorsosejugal suture, and three pairs of notogastral porose areas with *Aa* elongated transversely oriented, *Pergalumna janosbaloghi* n. sp. is morphologically most similar to *Pergalumna aegra* Pérez-Iñigo and Baggio, 1986 from Brazil and India, but differs from the latter by the smaller body size (290–298 × 232–249 versus 468 × 408) and the presence of long lamellar setae (versus short) and triangular porose areas *Aa* (versus elongate oval).

Other identified species of *Galumna* and *Pergalumna*

(with same locality data as both new species)

Galumnidae

- *Galumna armatifera* Mahunka, 1996: 40 ex. Distribution: Madagascar.
- *Galumna granalata* Aoki, 1984: 4 ex. Distribution: Oriental region. New record in the Ethiopian region.
- *Pergalumna amamiensis* Aoki, 1984: 15 ex. Distribution: Japan. New record in the Ethiopian region.
- *Pergalumna conspicua* Balogh, 1962: 13 ex. Distribution: Ethiopian region. New record in Madagascar.
- *Pergalumna fastigata* Mahunka, 1996: 17 ex. Distribution: Madagascar.
- *Pergalumna frater* Balogh, 1960: 11 ex. Distribution: Ethiopian region, Japan. New record in Madagascar.

Acknowledgements

We thank to R. Ravebolun and L. Rabotenoson who collected soil and litter samples in Madagascar; and the Moravian Museum in Brno, Czech Republic, which kindly provided material for our study. Also, we would like to thank Dr. Lala Harivelo Ravaomanarivo Raveloson (University of Antananarivo, Faculty of Sciences, Department of Entomology), Dr. Mamy A. Rakotoarijaona (Directeur des Opérations, Madagascar National Parks, Antananarivo) and Dr. Dimby Raharinjanahary (Chargé des Bases de données de suivibiodiversité et recherche, Madagascar National Parks, Antananarivo) for supporting joint Czech-Madagascan research project (2009–2014 Samples collected in Madagascar were based on collection permit no. 314/13/MEF/SG/DGF/DCB.SAP/SCB by the Moravian Museum in Brno, Czech Republic; sample exportation to Czech Republic was based on permit no. 028N-EA02/MG14; and Dr. Julia Baumann (University of Graz, Graz, Austria) and two anonymous reviewers for valuable comments. The presented research was supported by Czech Academy of Sciences (Research Plan No. RVO: 60077344).

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