Two new oribatid mites from the Republic of Rwanda. *Plasmobates zarae* sp. n. (Acari, Plasmobatidae) and *Basilobelba spasmenosi* sp. n. (Acari, Basilobelbidae)

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Abstract

Two new species of oribatid mites, *Plasmobates zarae* sp. n. and *Basilobelba spasmenosi* sp. n. are described from the Republic of Rwanda. They can easily be differentiated from other species by a number of characters. *Plasmobates zarae* sp. n. is differentiated the following characters: four types of particular cerotegumental layers. Integument slightly foveate to smooth on prodorsum; foveate on notogaster; ventral region rugose to smooth. Large rostral setae inserted on protuberance, whip-shaped, with longitudinal pucker; interlamellar setae rod-shaped with triangular scales; interlamellar setae small. Medial band on prodorsum extending to anterior of central part, but not reaching rostrum. Bothridium horn-shaped; opening basally incised with rectilinear wall, internal bothridial rings dentate. Sensillus whip-like, with minute triangular scales. Variably distributed circumgastric macro pores. Opisthosomal gland apophysis flat, triangular in lateral view and cylindrical in posterolateral view. Six pairs of notogastral setae, all situated posterior to opisthosomal gland level. Aggenital setae not detected; three pairs of anal setae; two pairs of anal setae present. Nymphal scalps simple without anterior tuft or filaments, with dentate peripheral ridge. Larval scalp shaped like Chinese hat.

*Basilobelba spasmenosi* sp. n. is characterized by the combination of the following characters: Cerotegument: thick basal layer with amorphous coat and cavities of different sizes, as well as structures resembling small cauliflowers. Setation: *simple*: notogastral, epimeral, genital, anal; *simple long, basally barbate*: le,
ro setae; simple, whip-shaped; ex setae; medium length, sharpened tip with thorns on surface. in setae, leg setae; Flabellate: setae situated in ventral neotrichous zone. Thorn-like barbs and more or less parallel longitudinal grooves present on body surface of le, ro, in and leg setae. Prodorsum: rostrum finger-shaped, relative sizes of setae: le > ro > in > ex. Prodorsal cuticular surface smooth with shallow transversal furrow and two oblique furrows determining two triangular structures. Large humpbacked CSO situated anterior to and in medial line with in setal insertion, dorsal bothridial opening. Notogaster swollen, hemispheric; nine pairs of minute setae, only $h_1$, $h_2$, $h_3$ easily identifiable, cuticular wart and dimple clearly visible. Humeral apophysis with longitudinal furrow dorsally. Elongate chelicera with cha, chb setae, behind them a series of scales directed dorsoventrally. Epimeral setation 3-1-3-3, adanal-aggenital neotrichy with between 8-10 setae. Nymphal scalps with very particular bean-shaped structure on either side of the decoupage zone, surrounding horn-like structure. Scalps with cuticular polyhedral reticulate to ovoid structure, often forming a cavity, either completely perforated or with a thin cuticular layer resembling an interior membrane.

**Keywords**
Republic of Rwanda, *Plasmobates zarae* sp. n., *Basilobelba spasmenosi* sp. n., Afrotropic Ecozone

**Introduction**

This paper is the second on material collected in Rwanda, housed at the Natural History Museum in Geneva, Switzerland. Two new species, *Plasmobates zarae* sp. n. and *Basilobelba spasmenosi* sp. n. are described. At present the family Plasmobatidae consists of four genera: *Orbiculobates* Grandjean, 1961; *Malgachebates* Fernández, Cleva, Theron, 2011; *Plasmobates* Grandjean, 1929 and *Solenozetes* Grandjean, 1931. Over the course of many years the authors have studied members of the family Plasmobatidae, principally those collected from the Afrotropic ecozone (formerly known as Ethiopian zone). This resulted in the description of the genus *Malgachebates* and included a summary of the principal characteristics of each genus of the family (Fernandez et al. 2011). Fernandez et al. (2013) analyzed some problematic aspects of the genus *Solenozetes* and presented a redefinition of the genus, as well as the description of *S. makokouensis* Fernandez et al., 2013.

The taxonomy of the family Plasmobatidae is problematic due to succinct original descriptions lacking in detail, or in which important characteristics were neglected.

*Plasmobates* (sensu Subías 2015) consists of the following species: *P. pagoda* Grandjean, 1929, *P. carboneli* Pérez-Ínigo & Sarasola, 1998, *P. hyalinus* Hammer, 1971, *P. asiaticus* Aoki, 1973, *P. africanus* Balogh, 1958 “sp. inq.”, *P. foveolatus* Ermilov, Sidorchuk & Rybalov, 2010, *P. machadoi* Balogh, 1958 “sp. inq.”, *P. minor* Balogh, 1958 “sp. inq.”. The last four species are from the Afrotropic ecozone, and three of the four species are “species inquerendae” (sensu Subías 2015) (see Discussion). We continue the study of this group by providing a description of *Plasmobates zarae* sp. n. Despite more than forty years in alcohol, material was in an excellent state of preservation, conserved to the point that adequate SEM studies could be conducted.

The family Basilibelbidae contains two genera: *Basilobelba* Balogh, 1958 and *Xiphobelba* Csíszár, 1961. The taxonomy of Basilibelbidae is not clear, principally relat-
ing to the problematic original description of *Xiphobelba* (Csiszar 1961 page: 353) which indicates: “Rostrum pointed, chelicerae attenuated to a point, chela very small reduced” and “The new genus is an ally of *Basilobelba* Bal.1958, differing from it by the peculiar oral organs, resembling those of *Eupelops*”. The oral organs were not illustrated, and other characteristics, such as the cerotegumental layer were neither described nor figured. Only two figures were given, one dorsal with scalps and the other dorsal without scalps. In the description of a second species of the genus, *X. setosa* Aoki, 1968, the chelicera are partly illustrated with the rest of the infracapitulum (Aoki 1968 p: 271, figure 14). Due to several subsequent papers, the taxonomy of *Basilobelba* is becoming clearer, permitting understanding of several aspects of this group.

More recently Fernandez et al. (2015) described a new species of *Basilobelba* (*B. maidililae*) from Vietnam, analysed problematic aspects of the group, and provided a comparison of species of both genera of the family.

**Materials and methods**

Specimens studied by means of light microscopy were macerated in lactic acid, and observed in the same medium using the open-mount technique (cavity slide and cover slip) as described by Grandjean (1949) and Krantz and Walter (2009). Drawings were made using a Zeiss GFL (Germany) compound microscope equipped with a drawing tube.

Specimens were also studied under a Scanning Electron Microscope (SEM). Specimens preserved in ethanol were carefully rinsed by sucking them several times into a Pasteur pipette, after which they were transferred to buffered glutaraldehyde (2.5%) in Sörensen phosphate buffer: pH 7.4; 0.1 m for two hours. After postfixation for 2hr. in buffered 2% OsO₄ solution and being rinsed in buffer solution; all specimens were dehydrated in a series of graded ethanol and dried in a critical point apparatus. After mounting on Al-stubs with double sided sticky tape, specimens were gold coated in a sputter apparatus (Alberti and Fernandez 1988, 1990a, 1990b; Alberti et al. 1991, 1997, 2007; Fernandez et al. 1991). SEM micrographs were taken using a SEM FEI-Quanta Feg 250; with 10 Kv and working distance (WD) variable.

Measurements: total length (tip of rostrum to posterior edge of notogaster); width (widest part of notogaster) in micrometers (μm). Leg setation was studied using standard, polarized and phase contrast microscopes are provisional, due to the fact that only adult specimens were available for study. Setal formulae of the legs include the number of solenidia (in parentheses); tarsal setal formulae include the famulus (ε). For *Plasmobates zarae* we added SEM images of leg setae as detail in order to clarify a number of particularities.

**Morphological terminology**

Morphological terms and abbreviations used herein are those developed by F. Grandjean (1928–1974) (cf. Travé and Vachon 1975). For the setae types Evans (1992);
ornamentation of cuticular surfaces Murley (1951, *ex*: Evans *op.cit*) were used. Some specific morphological characters have never been described before in detail, and hence no terminology or abbreviations exist. For the sake of clarity we include the following in the text and on the figures: bean-shaped structure (b.sc); macropores (mp); medial band extension (m.b); polyhedral reticulate to ovoid structure (s.r.s); promontories of podocephalic canal (a.o.g); thin cuticular layer (t.c.l).

**New taxa description**

*Plasmobates zarae* sp. n.

http://zoobank.org/4D90B90C-D50E-4465-B125-128295332B6F

Figures 1–42, Table 1

**Etymology.** The specific epithet “zarae” is derived from (ζάρα, Grec=pucker, English) due to longitudinal pucker present on ro setae.

**Material examined.** Holotype: Female and two paratypes (adult females): “73/2. Kayove-Rwanda; 2100 mts. 15/V/1973” Leg. P.Werner; deposited in the Collection of the Natural History Museum of Geneva (M.H.N.G), Switzerland; preserved in 70% ethanol. Material studied for SEM: three specimens, not deposited.

**Diagnosis (adult female).** Cerotegumental layer. *Amorphous*: bothridial zone, tubercle of seta in, ro setae insertion, lateral gland, epimeral zone, genital plate and surrounding zone, anal plate and surrounding zone. *Layer with small tubercles*: internal bothridial zone. *Mixed-layer* (mushroom-like microtubercles associated with irregular cauliflower-like microtubercles): infracapitulum, epimeral zone, lateral body zone, basal zone lateral gland. Integument: prodorsum, small foveate to smooth; notogaster, foveate; ventral region rugose to smooth.

Setation: *simple*: lamellar, notogastral, exostigmatal, epimeral, genital, aggenital anal; *whip-shaped, with longitudinal pucker*: rostral setae; *rod-shaped with triangular scales*: interlamellar setae; *simple, basally inflated*: subcapitular a; *simple spur*: m.

Prodorsum: medial band extension on central part towards anterior, not extending to rostrum. Interlamellar setae inserted on large protuberances, lamellar setae small, rostral setae large, with longitudinal cuticular puckers, inserted on protuberances. Large horn-shaped bothridium, directing laterally, rectilinear wall with basally incised opening. Internal bothridial rings dentate. Whip-shaped sensillus with minute, triangular scales; exostigmatal seta small. Rostrum medially incised, posterior of incision rounded. Notogaster: fovea situated in smooth zone with circumgastrically distributed macropores on fovea margins or inside fovea. Opisthosomal gland apophysis flat, triangular in lateral view, cylindrical in posterolateral view. Six pairs of notogastral setae, all situated posterior to level of opistosomal gland. Lateral region: opening of podocephalic canal on large promontories.

Ventral region: epimeral setal formula (3-1-2-2). Seven pairs of genital setae; aggenital setae not detected. Three pairs of adanal setae, two pairs of anal setae. Scalps
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Figures 1–8. Plasmobates zarae sp. n. Adult; 1–5 optical microscopy image 6–8 SEM 1 dorsal view 2 lateral view 3 frontal view 4 lamellar setae 5 promontories podocephalic canal 6 dentate peripheral ridge (p.d.r), lateral inclined view 7 cerotegumental layer and cuticular microsculpture 8 dentate peripheral ridge (p.d.r), frontal view. Abbreviations: see Materials and methods. Scale: 1 = 100 μm; 2 = 200 μm; 3 = 70 μm; 8 = 50 μm; 6 = 30 μm; 7 = 10 μm; 4, 5 = 5 μm.
Figures 9–13. Plasmobates zarae sp. n. Adult; SEM micrographs. 9 dorsal view with scalp and cerotegument layer 10 rostral setae, detail 11 rostral setae, general view 12 interlamellar seta 13 medial band detail, dorsal view. Abbreviations: see Materials and methods. Scale: 9 = 100 μm; 11, 13 = 20 μm; 12 = 5 μm; 10 = 2 μm.

multilayered, medial band extending anteriorly from each scalp. Medial band covers central zone, firmly adhered to prodorsal surface. Nymphal scalps with dentate peripheral ridge. Setae hardly discernible, scalps simple without anterior tuft of filaments. Chinese hat-shaped larval scalp differing greatly from nymphal scalps.

**Description.** **Measurements.** SEM: total length with scalps 580–615 μm × 600 μm (measurements on three specimens). Total length without scalps 433–438 μm × 435μm (measurements on three specimens). Notogastral width without scalps 248–
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Figures 14–19. *Plasmobates zarae* sp. n. Adult; SEM. 14 lateral view with scalp and cerotegumental layer 15 bothridium and interlamellar seta, lateral view 16 bothridium, internal structures 17 sensillus, superficial scales (high magnification) 18 lateral gland 19 sensillus detail. Abbreviations: See Materials and methods. Scale: 14 = 100 μm; 15 = 20 μm; 18 = 10 μm; 16, 19 = 5 μm; 17 = 1 μm.
Figures 20–24. Plasmobates zarae sp. n. Adult; SEM. 20 frontal view 21 ro seta 22 tritonymphal scalp with medial bands, lateral view 23 larval scalp detail 24 ag seta detail. Abbreviations: see Materials and methods. Scale: 20 = 200 μm; 22 = 20 μm; 23 = 50 μm; 21 = 10 μm; 24 = 5 μm.

253 μm x 250 μm. Light microscopy: 612–656 μm x 639 μm (measurements on three specimens). Specimens with scalps ovoid, elongate in dorsal view. (Figures 1, 9, 22). In lateral view specimens with scalps appear pyramidal (Figure 14); without scalps anterior triangular and posterior rounded (Figure 2).

Colour. Specimens without cerotegument and scalps dark yellowish to medium brown.

Cerotegument (scalps not considered). Thick complex layer with elaborate pattern, composed of wax layer and amorphous cement layer covering entire body and legs. Amorphous layer (Figure 33, indicated in all Figures with *): external bothridial zone of prodorsum (Figures 14, 15), tubercles of in setae (Figure 12), ro setae insertion zone
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(Figure 21), gla (Figure 18), epimeral zone (Figure 25) subcapitular setae h (Figure 26), genital plate and surrounding zone, anal plate and surrounding zone (Figure 32). **Small tubercules**: internal bothridial zone (Figure 16 indicated by $\text{h}$). **Mixed-layer** (Figures 28, 29, 30): mushroom-like microtubercles ($\text{mus}$) diameter 0.02–0.6 μm, height 0.2–1.9 μm associated with irregular cauliflower-like microtubercles ($\text{cau}$) diameter 1.2–1.9 μm, height 1.4–3.1 μm. Distribution: infracapitulum, epimeral zone, lateral body zone, basal zone of gla (Figures 18, 19, 25, 31). Legs: Trochanters covered by mixed-layer, femur, genu, tibia, covered by amorphous layer with prominent folds. Tarsus: amorphous layer with subtle folding and several smooth areas (Figures 14, 20, 35, 36, 38, 39, 42).

**Integument.** Lateral microsculpture of prodorsum faintly foveate to smooth (Figures 1, 2, 3), dorsal microsculpture of prodorsum flat, foveate (Figure 7 indicated by $\text{h}$). Notogaster: foveate in vicinity of notogastral border (Figures 1, 2, 3), posterior notogastral zone smooth, posterolateral notogastral zone presenting ridges anterior to macropore zone (Figures 1, 2, 3). Distribution of macropores circumgastric (Figures 1, 2). Ventral region rugose to smooth on subcapitulum (Figure 25), epimeral zone, surrounding genital and anal openings and genital and anal plates.

**Setation.** Lamellar (Figure 4), notogastral, exostigmatal, epimeric, genital, aggenital (Figure 24) and anal setae simple; ro setae whip-shaped, with longitudinal pucker (Figures 9, 10, 11); in setae (10–13 μm) rod-shaped with triangular scales (Figure 12); subcapitular setae simple, slightly basally inflated (Figure 27) 30–36 μm $\text{a}$; $\text{h}$ simple, spur-shaped (Figure 26) 16–21 μm.

**Prodorsum.** Medial band extension ($\text{m.b}$) observed on central part towards anterior, not extending to rostrum, terminating anterior to le setal insertion level on specimens with scalps (Figures 9, 13, 14, 20, 31). Elevated zone surrounding medial band extension (Figure 14). Interlamellar setae ($\text{in}$) inserted near bothridial base on large protuberances, extending upward and inclined backward (Figures 9, 12, 14, 15). Lamellar setae ($\text{le}$) small, inserted on small protuberances (Figure 4), rostral setae ($\text{ro}$) (58-61 μm) inserted on protuberances, cuticular folds at base of setae (Figures 10, 11, 14, 20, 21). Large laterally directing horn-shaped bothridium (Figures 14, 20). Semicircular lateral bothridial opening, basally incised with thin rectilinear wall ($\text{r.w}$) (Figures 14, 15). Internal bothridial rings dentate with triangular teeth (Figure 16).

Whip-shaped filiform sensillus ($\text{si}$) (80-106 μm) with minute triangular scales, height 196 nm, length 603-987 nm (Figure 17), exostigmatal setae ($\text{ex}$) small. Narrow medial incision on rostrum, in dorsal view posterior end of incision rounded (Figure 1).

**Notogaster.** Circumgastrically distributed macropores ($\text{mp}$) of varying diameter (0.3–1 μm) situated in small foveae on smooth zone, either on periphery or internally to foveated notogastral pattern (Figures 1, 2). In dorsal view anterior zone $\text{mp}$ clearly visible (Figure 1), but those located near gla need to be observed in lateral or posterior views (Figure 2) due to notogastral shape, in order to obtain the best impression of their distribution.

Distribution of $\text{mp}$: a) single line in anterior notogastral zone; b) linear in anterior lateral zone near gla; c) irregularly distributed on posterior notogastral zone (setal zone) (Figure 1).
Figures 25–33. *Plasmobates zarae* sp. n. Adult; SEM. 25 epimeral zone 26 subcapitular setae b 27 subcapitular seta a 28 cerotegumental layer 29 detail cerotegumental “cauliflower” (cau) 30 detail cerotegumental “mushroom” (mus) 31 prodorsum with m.b. 32 anogenital region 33 detail cerotegumental layer. Abbreviations: see Materials and methods. Scale: 25 = 50 μm; 26 = 5 μm; 27 = 5 μm; 28 = 1 μm; 29 = 0.5 μm; 30 = 0.5 μm; 31 = 20 μm; 32 = 50 μm; 33 = 5 μm.
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Figures 34–42. Plasmobates zarae sp. n. Adult; Optical and SEM observations. 34 leg I, antiaxial 35 detail with SEM; solenidium s genu I 36 detail with SEM, solenidia j₁, j₂ and setae d, femur I 37 leg II, antiaxial 38 apical zone, tarsus II (detail with SEM) 39 solenidium j₁, dorsal setae d and complementary seta indicated byl, tibia I (detail SEM observation) 40 leg III, antiaxial 41 leg IV, antiaxial 42 tibia I, solenidium j and setae d (detail SEM observation). Abbreviations: see Materials and methods. Scale: 34–42 = 70 μm.
In dorsal view opisthosomal gland (gla) apophysis observed as flat triangle, but appears cylindrical in lateral and lateroposterior views, directing slightly obliquely forward (Figures 1, 9, 14, 18); opening with protuberances (Figure 18). Six notogastral setae on small protuberances (Figure 1), all setae situated behind level of apo.gla.

**Lateral region.** Exobothridial seta (ex) small but clearly discernible (Figure 3); two macropores situated one above and one below promontories of podocephalic canal (Figure 2 surrounding a.o.g). Opening of podocephalic canal on large promontories (Figures 2, 3, 5). Tubercles of interlamellar setae more or less cylindrical (Figures 12, 15); setae ro inserted on tubercles (Figures 12, 14); notogastral border clearly discernible even after long preservation in lactic acid; sejugal depression deep, easily discernible.

**Ventral region.** Specimens with cerotegument: plate-like cerotegumental structures on epimeres resulting in irregular levels on upper surface, epimeral furrows easily discernible with mus, cau and amorphous cerotegumental layer (Figure 25). Flat lateral cerotegumental zones, deep epimeral furrows 1 and 2. Epimeres III, IV small, epimeral setal formula (3-1-2-2). Seven pairs of genital setae in a single longitudinal line; aggenital setae not detected; three pairs of adanal setae; two pairs of anal setae.

**Gnathosoma.** Subcapitulum suctorial with short tube. Subcapitular setae large, especially a, m (Figure 25).

**Legs (Table 1).** Legs differ from those of congeners studied by the authors (See Table 1), particularities illustrated on SEM micrographs (Figures 34–42). Setal and solenidial formulae (trochanter to tarsus): I(1-6-4-5-19-1) (1-2-2); II(1-4-5-6-12-1) (1-1-2); III(2-3-3-4-11-1) (1-1-0); IV(1-3-4-5-10-1) (0-1-0).

**Scalps.** Exuviae of immature stases adhering one on top of the other, creating a multilayered structure. Each scalp extending anteriorly into a medial band (m.b) (Figures 14, 20, 23, 31) covering central zone, adhering to prodorsal surface (Figure 20) and extending backward towards ro setal insertion (Figure 20). Sometimes m.b is slightly detached (Figure 14).

Cerotegumental layer: medial band covered by thick amorphous layer with a network of round to polygonal depressions (Figure 13). Nymphal scalps with dentate peripheral ridge (p.d.r) (Figures 6, 8, 14, 20, 22, 23). Setae hardly discernible, scalps simple without anterior tuft of filaments. Larval scalp unlike the others, broad and elevated, Chinese hat-shaped, with three gibbose areas (gi) separated by transverse furrows (t.f) (Figure 22). In lateral view insertion of dp setae clearly visible (Indicated by Figure 22).

**Remarks.** SEM is vital in order to observe aspects such as: 1) dorsal seta d associated with solenidium hardly discernible (detailed drawings are included to facilitate understanding) 2) clavate shape of small solenidia is problematic, as doubt regarding the exact shape remains if using only optical microscopy 3) the position of dorsal seta d relative to j1 and j2 on tibia II differs from Solenozetes makokouensis and Malgachebates peyrierasi. Changed angles of observation and rotation of specimens in SEM clarified the situation. 4) accessories available in SEM facilitated measurements of minute triangular scales of the sensillus with great precision 5) protuberances situated around the opening of the lateral gland also had to be observed from different angles. See Discussion for comparison with congeners.
Table 1. *Plasmobates zarae* sp. n. adult, legs.

| Leg  | Femur | Genu  | Tibia | Tarsus | Observations |
|------|-------|-------|-------|--------|--------------|
| Leg I |       |       |       |        | Crispinate (socket-like) dorsal femur, solenidium s clavate, d seta positioned near j, usually near j_1 |
| Setae | da(l,v,va,sp, (l,v,d) | d(l,v) | p'L(l,v),(v),(x)(p),(a)(a),S(v),e | | |
| Solenidium | | | | | |
| Leg II |       |       |       |        | Crispinate (socket-like) dorsal femur, solenidium s clavate, genu with one d seta near j, also another associated minute seta indicated by l |
| Setae | l",d,sa,sp | d(l,v) | d,l,v,,(v) | (f),(l,l),(p)(a),S(a),p'v | |
| Solenidium | | | | | |
| Leg III |       |       |       |        | |
| Setae | d"l,v | d,l",v | d,l",(v) | (f),(p),(a),S(a),l | |
| Solenidium | | | | | |
| Leg IV |       |       |       |        | |
| Setae | l,v | d,l",v | d,l,l | (f),p'v:(a),S(a),p | |
| Solenidium | | | | | |

*Basilobelba spasmenosi* sp. n.

http://zoobank.org/F4ABFDAF-99F0-45DB-876C-DD914C7852A7

Figures 43–74; Table 2

**Etymology.** The specific epithet “*spasmenosi*” is derived from (Σπασμένος, Grec = broken, English), due to characteristics of scalps with cavities or perforations.

**Material examined.** Holotype: Female and two paratypes (adult females): “73/2. Kayove-Rwanda; 2100 mts.15/V/1973” Leg. P. Werner; material deposited in the Collection of the Natural History Museum of Geneva (M.H.N.G), Switzerland; preserved in 70% ethanol. Material studied for SEM: three specimens, not deposited.

**Diagnosis (adult female).** Cerotegument. Thick basal layer with amorphous coat, perforations of various sizes, and structures resembling small cauliflowers. Setation. *Simple*: notogastral, epimeral, genital, anal; *simple, long, basal barbs*: le, ro setae; *simple, whip-shaped*: ex setae; *medium length, sharpened tip with thorn-like barbs on surface*: in setae, leg setae; *flabellate*: setae situated in ventral neotrichy zone. Thorn-like barbs and more or less parallel longitudinal grooves on body of le, ro, in and leg setae. Prodorsum. Rostrum finger-shaped, relative sizes of setae: *le > ro > in > ex*. Prodorsal cuticular surface smooth, with shallow transversal furrow and two oblique furrows delineating two triangular structures. Large humpbacked CSO situated anterior to and in medial line with in setal insertion, dorsal bothridial opening. Notogaster. Swollen, hemispheric, with nine pairs of minute setae. Only h_1, h_2, h_3 easily identifiable. Cuticular wart and dimple clearly visible. Humeral apophysis with longitudinal furrow dorsally. Chelicera elongate, series of dorsoventrally directing scales behind setae *cha, chb*. Epimeral setation 3-1-3-3, anal-agenital neotrichy with 8-10 setae. Nymphal Scalps. Particular
Bean-shaped structure on either side of the decoupage zone around horn-like structure. Scalps with polyhedral reticulate to ovoid cuticular structure. Polyhedral reticulate cuticular structure often appears either completely perforated or with a thin cuticular layer resembling an interior membrane.

**Description.** Measurements. SEM: total length without scalps 618–598 × 605 μm; width without scalps 310–290 × 303 μm (measurements on three specimens). Light microscopy: 660–632 μm × 643 μm; width 325–315 × 320 μm (measurements on three specimens).

**Shape.** Elongated oval (Figures 43, 49, 53).

**Colour.** Specimens without cerotegument brown, slightly shiny when observed in reflected light.

**Cerotegument.** Present only on prodorsum, notogastral anterior zone, ventral region and legs. Thick basal layer with amorphous coat and perforations of various sizes (indicated by ¿ Figure 47). Small structures on surface resembling cauliflowers (cau) of different sizes (Figures 47, 56, 59, 60).

**Setation. Simple:** notogastral, epimeral, genital, anal (Figures 50, 52, 54); simple, long, basal barbs: le, ro setae (Figures 48, 55); simple, whip-shaped: ex setae (Figures 43, 46); medium length, sharpened tip with thorns on surface: in setae (Figures 43, 44, 46, 58, 59, 61), leg setae. These setae are very particular, with large thorn-like barbs basally and small thorn-like barbs distally. Flabellate (Figure 56): setae situated in ventral neotrichous zone. Particular to le, ro, in and leg setae (Figure 60) is the presence of thorn-like barbs and more or less parallel longitudinal grooves on setal body (Figures 58, 59, 60).

**Integument.** Smooth

**Prodorsum.** Rostrum finger-shaped (Figures 43, 46). Rostral setae ro laterally inserted on large promontories 107 μm (96–109 μm); le setae 155 μm (151–159 μm); in setae on small promontories 46 μm (48–50 μm); ex 40 μm (38–42 μm). Relative sizes of setae: le > ro > in > ex.

Prodorsal cuticular surface smooth with a shallow transversal furrow situated anterior to in setal insertion (Figure 46 indicated by 5). Two oblique furrows (Figure 46 indicated by a) delimiting two triangular structures (Figure 46 indicated by *). Large humpbacked CSO situated in front of and in medial line with in setal insertion (Figures 43, 46, 53). More or less parallel le setae with criss-crossing tips (Figure 46). Two oblique furrows and two triangular structures conspicuous in dorsal view of prodorsum.

Ovoid bothridial opening dorsally (Figures 43, 48, 53); in medial zone ovoid loop directing anteriorly and slightly obliquely (Figure 61 indicated by ¿). Sensillus long, setiform, generally directing backward, both sides barbate (Figure 61).

**Frontal view.** Beak-shaped rostral margin (Figure 57). Large humpbacked CSO clearly visible, slightly anterior to interlamellar setal insertion.

**Notogaster.** Swollen, hemispheric (Figure 53), bearing four-layered exuviae (larval, protonymphal, deutonymphal and tritonymphal) stacked to resemble a low tower (Figure 43), fixed anteriorly and posteriorly by particular structures (See Scalps). Dorso-jugal furrow large, rectilinear, well delimited (Figure 44). After removal of exuviae, glabrous notogastral surface becomes visible (Figure 53), bearing nine pairs of minute setae
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(Figure 52). Only $h_1$, $h_2$, $h_3$ setae easily identifiable ($h_2$ and $h_3$ always in very close proximity to each other), $h_1$ setae identified by relative position to lyrifissures (See Discussion). Unidentified setae indicated by * (Figure 52). Lyrifissures $ih$ and $ips$ identified as pores, other lyrifissures probably present but difficult to identify due to ornamentation. Anterior notogastral zone (Figures 43, 44) bearing cuticular wart ($ve$) hooking arched tritonymphal buckle ($co.bu$) by coaptation. Depression in posterior zone (Figure 53, simple ($f$) indicated by rounded dotted zone) housing the $us$ zone of tritonymphal horn by coaptation. (Figure 69 indicated by $us$ and $i$). SEM observations of this small depression is necessary from different angles, hence it is indicated by a rounded zone (See Scalps). Humeral apophysis easily discernible, with dorsal longitudinal furrow (Figure 43).

**Lateral region.** Only pedotectum I present (Figure 49); $Pd I$ large lamina; the border can be followed a short distance to ex setae; $h.ap$ clearly discernible as a structure with longitudinal furrow (Figure 43).

**Ventral region.** Subcapitulum diarthric, cerotegumental layer observed only behind $b$ setal insertions (Figure 55). Subcapitular setae faintly barbate on either side, sharply tipped. Setae differing greatly in shape (see Figure 55): $a$ (42 $\mu m \pm 3 \mu m$) simple, sharply tipped; $m$ (55 $\mu m \pm 3 \mu m$); $h$ (48 $\mu m \pm 3 \mu m$). Chelicera (Figure 51) elongate, with $cha$, $chb$ setae. Series of dorsoventrally directing scales posterior to $cha$, $chb$ setae; the largest is found dorsally, appears darker, followed by small transparent scales. Small movable digit (Figure 51) (see Discussion).

Epimeres I, II typical morphology, ventrosejugal furrow easily discernible, other epimeres not visible. Epimeral setation 3-1-3-3 (Figures 49, 54). Aggenital and adanal setae difficult to identify due to adanal-agenital neotrichy. Neotrichy originates laterally to anal opening, is very prominent on posterior zone, number of setae varies between 8-10 (See Discussion).

**Legs** (Figures 70–74, Table 2). Leg shape similar to *Basilobelba retiarius* (Grandjean, 1959), moniliform with bulbous segments and large peduncles (Figures 70–74), femoral peduncles being largest. Tarsi particularly shaped, narrower between bulb and claw on legs I-IV. Cerotegumental layer covering segments but only basal zone of setae (Figure 60).

Setal formulae: I(1-6-4-5-20-1) (1-2-2); II(1-2-4-4-14-1) (1-1-2); III(2-3-3-4-12-1) (1-1-0); IV(1-3-2-4-10-1) (0-1-0). Setae $d$ present on all femurs, genua and tibiae. On tibia I (Figure 70) seta $d$ is small and hardly discernible (Figure 73), situated on the same promontory as solenidion $\varphi_2$. On all other tibiae (II, III, IV) (Figures 71, 72, 74), genua and femurs setae $d$ large and barbate (Figures 70, 71, 72, 74).

**Nymphal Scalps.** Limited number of specimens and the necessity of dissection impeded comprehensive study of scalps, for this reason our study was limited to deuto- and tritonymphal scalps. Observed particularities: Very particular bean-shaped structures are found on either side of the decoupage zone around the horn-like structure (Figures 63, 64, 65, 66).

Scalps present polyhedral reticulate to ovoid cuticular structure ($s.r.s$), most visible on internal side (Figure 69) but also on entire scalp (Figures 63–69). Internally scalps present a very thin cuticular layer ($t.c.l$) (Figure 69) covering polygonal-ovoid structures. The $s.r.s$ often appearing either completely perforated or with a thin cuticular
Figures 43–47. Basilobela spasmenosi sp. n. Adult; SEM. 43 dorsal view with scalps 44 dorsal view with scalp 45 posterior zone of scalps 46 prodorsum anterior zone 47 arched tritonymphal buckle. Abbreviations: see Materials and Methods. Scale bars: 43 = 200 μm; 44 = 50 μm; 45 = 20 μm; 46 = 50 μm; 47 = 2 μm.
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Figures 48–52. Basilobelba spasmenosi sp. n. Adult; Optical microscopy. 48 anterior zone prodorsum 49 ventral zone without subcapitulum 50 ventral setae 51 Chelicera, lateral view 52 notogaster posterior view. Abbreviations: see Materials and methods. Scale bars: 52 = 100 μm; 49 = 70 μm; 50 = 25 μm; 48, 51 = 20 μm.
Figures 53–57. Basilobelba spasmenosi sp. n. Adult; SEM. 53 general view without scalps 54 genito-anal zone 55 scapitulum, ventral view 56 ventral setae 57 frontal view. Abbreviations: see Materials and methods. Scale bars: 53 = 200 μm; 54 = 100 μm; 55 = 20 μm; 56 = 20 μm; 57 = 100 μm.
Figures 58–62. *Basilobelba spasmenosi* sp. n. Adult; SEM. 58 in seta 59 detail in seta 60 legs, dorsal setae 61 bothridium 62 wart, with part of tritonymphal buckle. Abbreviations: see Materials and methods. Scale bars: 58 = 10 μm; 59 = 2 μm; 60 = 10 μm; 61 = 20 μm; 62 = 10 μm.
Figures 63–69. *Basilobelba spasmenosi* sp. n. Adult; SEM. 63 posterior view deutonymphal and tritonymphal scalps 64 posterior zone deutonymphal scalps, detail 65 dorso-posterior view deuto and tritonymphal scalps 66 tritonymphal scalps, posterior view 67 deutonymphal scalp, detail, anterior zone 68 detail s.r.s and c1 seta, deutonymphal scalp 69 interior view, tritonymphal scalp. Abbreviations: see Materials and methods. Scale bars: 63 = 100 μm; 64 = 20 μm; 65 = 50 μm; 66 = 100 μm; 67 = 20 μm; 68 = 5 μm; 69 = 20 μm.
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Figures 70–74. *Basilobelba spasmenosi* sp. n. Adult; Optical observations. 70 leg I antiaxial 71 leg II antiaxial 72 leg III antiaxial 73 details tibia I solenidium j1, j2 and dorsal seta 74 leg IV, antiaxial. Abbreviations: See Materials and methods. Scale bars: 70, 71, 72, 74 = 100 μm; 73 = 25 μm.
layer (t.c.l) resembling an interior membrane (Figures 63, 65, 66, 67). In Figure 64 the s.r.s is clearly visible due to transparency, also internally, on both sides of the decoupage zone around the horn. The complexity of these perforated areas is yet more interesting as the polyhedral reticular structure, when not perforated, is more or less rounded, surrounded by a polyhedral structure (Figure 67, 68).

**Tritonymphal scalps** (Figures 43, 45, 66, 69). Basque beret-shaped (Figure 66) tritonymphal scalp fixed to the adult by two structures, one situated anteriorly and the other posteriorly. Heart-shaped structure (tritonymphal buckle) in anterior part affixing scalp to adult notogaster. Tritonymphal buckle consisting of two loops (a) (Figures 43, 44), curving outwards then inwards forming a heart-shaped structure, continuing to meet in the plane of symmetry forming a thong-like structure (n) (Figure 44) in order to receive the wart (ve) (Figures 53). The ve is a round-ovoid structure (Figure 62) situated on the adult cuticular surface, functioning like a snap button, fixing the anterior part of the scalp to the adult cuticle. Depression (f) on the posterior adult cuticular surface (Figure 53) is indicated by a dotted round zone with f in centre. Observing f is difficult, necessitating changes in angle of observation. Zone f functions by coaptation with the interior part (su) (Figure 69 indicated by z) (i.e. the inner curving part of the horn-like structure). Small polyhedral structures (poly) are present (Figure 69 indicated by poly and j) with similar characteristics to *Basilobelba maidililae* Fernandez et al., 2015 but obtaining high resolution SEM images was impossible due to a technical problem. Setae h, h, h, p, clearly visible; setae l, lm only visible in some instances, due to the cerotegumental layer impeding observation (Figure 65). Horn-like structure on posterior scalp border (Figure 64, 65) aiding in hooking the deutonymphal scalp.

**Deutonymphal scalps** (Figures 43, 63, 64, 65). Tritonymphal and deutonymphal scalps differ greatly (Figures 66 and 63). No buckles for adherence observed in anterior zone of deutonymphal scalps, and posterior zone (Figures 63, 64) with horn-like structure fixing the protonymphal scalp found on a mobile strip (le) consisting of a section of deutonymphal scalp (See Grandjean 1959). Horn-like structure composed of a style

### Table 2. *Basilobelba spasmenosi* sp. n. adult, legs.

|        | Femur | Genu | Tibia | Tarsus |
|--------|-------|------|-------|--------|
| **Leg I** |       |      |       |        |
| Setae  | d,l,v | l,d,v| d,l,v | (ft),l''(pl),v,(pv),(tc),(it),(i),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i'),(i')...
(s) and a stylet (st) (Figure 64). In common with the tritonymphal scalp, a bean-shaped structure (h.sc) is observed. Only posterior setae h₁, h₂, h₃, p₁ are visible.

Remarks. The remarkable perforated structures are not observed in other congeners. At present we are studying another species from Rwanda with bean-shaped structures on scalps, similar to those in Basilobelba spasmenosi sp. n.

Discussion

The taxonomy of the genus Plasmobates in the Afrotropic ecozone is very complex. Species of the genus Plasmobates Grandjean, 1929 recorded in this region are: P. africanus Balogh, 1958; P. foveolatus Ermilov et al., 2010; P. machadoi Balogh, 1958; P. minor Balogh, 1958; and P. zarae sp. n. Subías (2015) considers P. africanus Balogh, 1958; P. machadoi Balogh, 1958 and P. minor Balogh, 1958 as “sp. inq.”, without providing reasons. We analyzed the work of Balogh (1958), but found it impossible to identify the cited species. A comprehensive search in the available collection from this ecozone failed to provide specimens with the characters in the provided text. One comparable species from the region is P. foveolatus Ermilov et al., 2010, but the study lacks SEM micrographs, and is not detailed enough to provide a conclusive comparison.

In our opinion the following characteristics permit easy differentiation of species of Plasmobates from other congeners, not only those from the Afrotropic ecozone: the cerotegumental layer, shape and insertion type of ro and in setae, sensillus with scales, promontories of podocephalic canal, distribution of macropores, type of lateral gland, number and distribution of notogastral setae, positions of setae d of tibia I and particular setae found on tibia II.

The taxonomy of Basilobelba Balogh, 1958 and Xiphobelba Csiszár, 1961 were discussed in preceding work (Fernandez et al. 2015). B. spasmenosi sp. n. presents all characteristics of the genus and also displays very interesting particularities, permitting easy differentiation from other congeners, such as: shape and characteristics of cerotegumental layer, lamellar and rostral setae, prodorsum, rostrum and CSO, infracapitulum, notogastral setae, nymphal scalps with perforated areas and particular distribution of leg setae. The distribution of notogastral setae is especially particular as all nine setae are situated on the posterior notogastral zone.

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References

Alberti G, Fernandez NA (1988) Fine structure of a secondarily developed eye in the fresh water moss mite, *Hydrozetes lemnae* (Coggi 1899) (Acari: Oribatida). Protoplasma 146: 106–117. doi: 10.1007/BF01405919

Alberti G, Fernandez NA (1990a) Aspects concerning the structure and function of the lenticulus and clear spot of certain oribatids (Acari: Oribatida). Acarologia 31: 65–72.

Alberti G, Fernandez NA (1990b) Fine structure and function of the lenticulus and clear spot of Oribatids (Acari: Oribatida). In: Andre HM, Lions J-Cl (Eds) L’ontogène et le concept de stase chez les Arthropodes. Agar Publishers, Wavre, 343–354.

Alberti G, Fernandez NA, Coineau Y (2007) Fine structure of spermiogenesis, spermatozoa and spermatophore of *Saxidromus delamarei*, Coineau 1974 (Saxidromidae, Actinotrichida, Acari). Arthropod Structure & Development 36(2): 221–231. doi: 10.1016/j.asd.2006.11.002

Alberti G, Fernandez NA, Kümmel G (1991) Spermatophores and spermatozoa of oribatid mites (Acari: Oribatida). Part II. Functional and systematical considerations. Acarologia 32(4): 435–449.

Alberti G, Norton R, Adis J, Fernandez N, Franklin E, Kratzmann M, Moreno AI, Ribeiro E, Weigmann G, Woas S (1997) Porose integumental organs of oribatid mites (Acari: Oribatida). Zoologica 48(146): 33–114.

Aoki JI (1968) A new species of the genus *Xiphobelba* from New Britain Island (Acari, Cryptostigmata). Bulletin Natural Science Museum (Tokyo) 11(3): 269–274.

Balogh J (1958) Oribatides nouvelles de l’Afrique tropicale. Revue Zoologie Botanique Africaine 58(1-2): 1–34.

Csiszár J (1961) New oribatids from Indonesian soils (Acari). Acta Zoologica Academiae Scientiarum Hungaricae 7(3-4): 345–367.

Evans GO (1992) Principles of acarology. CAB International Cambridge, Wallingford, 563 pp.

Fernandez NA, Alberti G, Kümmel G (1991) Ultrastructure of the spermatophores and spermatozoa of some Oribatid mites (Acari: Oribatida) Part I. Fine structure and histochemistry. Acarologia 32(3): 261–286.

Fernandez N, Cleva R, Theron P (2011) *Malgachebates peyrierasi* n. gen., n. sp. (Acari: Oribatida: Plasmobatidae) from Madagascar. International Journal of Acarology 37(1): 61–74. doi: 10.1080/01647954.2010.495082

Fernandez N, Theron P, Rollard C (2013) First discovery of Plasmobatidae (Acari, Oribatida) in Gabon, redefinition and new species of the genus *Solenozetes* Grandjean, 1932. Zoosystema 35(2): 137–150. doi: 10.5252/z.2013n2a1

Fernandez N, Theron P, Rollard C, Leiva S (2015) Oribatid mites (Acari: Oribatida) from deep soils of Hòn Chông limestone hills, Kien Giang Province, Vietnam. II. Descriptions of two new species, Lohmanniidae (Acari: Oribatida), second part. *Papillacarus whitteni* sp. n. (family Lohmanniidae) and *Basilobelba maidililae*, sp. n. (family Basilobelbidae). International Journal of Acarology 41(2): 132–146. doi: 10.1080/01647954.2015.1014414

Grandjean F (1949) Observation et conservation des très petits arthropodes. Bulletin Museum National d’Histoire Naturelles (Paris) 21: 363–370.
Grandjean F (1959) *Hammation sollertius* n.g., sp. n. (Acarien, Oribate). Mémoires Muséum National d’Histoire Naturelle nouvelle série a, zoologie tome 16(6): 173–198.

Norton R, Alberti G, Weigmann G, Woas ST (1997) Porose integumental organs of oribatid mites (Acari, Oribatida) 1. Overview of types and distributions. In: Alberti G, Norton R (Eds) Porose Integumental Organs of Oribatid Mites (Acari, Oribatida). Zoologica 146: 1–31.

Subias L (2012) Listado de los ácaros oribátidos (acariformes, oribatida) de las diferentes regiones biogeográficas del mundo. Publicado originalmente en Monografías electrónicas SEA, 4, 805 pp. [Updated March 2015: 1–883]

Travé J, Vachon M (1975) François Grandjean 1882–1975 (Notice biographique et bibliographique). Acarologia 17(1): 1–19.