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Article

Taxonomic contribution to knowledge of the oribatid mite genus *Flagellozetes* (Acari, Oribatida, Galumnidae)

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ABSTRACT

A new species of the genus *Flagellozetes* (Oribatida, Galumnidae) – *F. (Cosmogalumna) daklakensis* sp. nov. – is described from dry litter in *Shorea* dipterocarp forest in Daklak Province, Central Vietnam. The species *F. (C.) maolanensis* is recorded for the first time in Vietnamese fauna. An identification key to the known species of *Flagellozetes* is presented.

KEYWORDS: Galumnid mites, morphology, new species, taxonomy, Vietnam.

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INTRODUCTION

Flagellozetes (Acari, Oribatida, Galumnidae) was proposed by Balogh (1970), with *Flagellozetes porosus* Balogh, 1970 as type species. The genus comprises three subgenera (Ermilov and Klimov 2017) with 24 species and one subspecies (*F. (Flagellozetes)* Balogh, 1970 – one species and one subspecies; *F. (Cosmogalumna)* Aoki, 1988 – 22 species; and *F. (Variogalumna)* Mahunka, 1995 – one species) which are distributed in the Oriental, Neotropical and southern Palearctic regions (Ermilov and Corpuz-Raros 2022; Subías 2022b, online version 2023; Hu *et al.* 2023). Subías (2022a) proposed the genus *Aliuscosmogalumna* Subías, 2022, with *Flagellozetes (Cosmogalumna) sacculus* Kolesnikov & Leonov, 2021 as type species, but I support the initial placement of the species in *Flagellozetes (Cosmogalumna)*. The generic and subgeneric diagnoses were presented by Ermilov and Klimov (2017). Data on distribution and habitats of many representatives of *Flagellozetes* were provided by Ermilov and Kalúz (2019). An identification key to species of *Flagellozetes* was presented by Ermilov and Kalúz (2019) and updated by Ermilov and Corpuz-Raros (2022).

Among the oribatid mite material (from one sample) collected from Daklak Province (Central Vietnam), I found two species belonging to *F. (Cosmogalumna)*, one species is new to science, the other is *F. (C.) maolanensis* Hu, Zheng & Yang, 2023 (it is first record for Vietnamese fauna) which was described from Southeast China. The main goals of the paper are: to describe a new species; and to update and correct an identification key to the known species of *Flagellozetes* adding data on five species.

Prior to this study, eight species of *Flagellozetes* were recorded in Vietnam (Corpuz-Raros and Ermilov 2020; Ermilov and Salavatulin 2022): *F. (C.) carinodentatus* Ermilov & Salavatulin, 2022;

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F. (C.) dongnaiensis (Ermilov & Anichkin, 2013); *F. (C.) imperfectus* (Aoki & Hu, 1993); *F. (C.) lineatus* Kolesnikov & Leonov, 2021; *F. (C.) ornatus* (Aoki, 1988); *F. (C.) pseudoareticulatus* Ermilov & Salavatulin, 2022; *F. (C.) sacculus* Kolesnikov & Leonov, 2021; and *F. (C.) tenensis* (Ermilov, Vu & Nguyen, 2011).

METHODS

Observation and documentation – For measurement and illustration, specimens were mounted in lactic acid on temporary cavity slides. All measurements are in micrometers; 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 in dorsal aspect (behind pteromorphs); setal lengths were measured perpendicular to their long axis, accounting for curvature. Formulas for leg setation are given in parentheses according to the sequence trochanter-femur-genu-tibia-tarsus (famulus included); formulas 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 DM 2500 light microscope.

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

Abbreviations – *Prodorsum*: *L* = lamellar line; *S* = sublamellar line; *N* = prodorsal leg niche; *E*, *T* = lateral ridges of prodorsum; *ro*, *le*, *in*, *bs* = rostral, lamellar, interlamellar, and bothridial setae, respectively; *Ad* = dorsosejugal porose area; *D* = dorsophragma; *P* = pleurophragma. *Notogaster*: *c*, *la*, *lm*, *lp*, *h*, *p* = setae; *Aa*, *A1*, *A2*, *A3* = porose areas; *mp* = median pore; *ia*, *im*, *ip*, *ih*, *ips* = lyrifissures; *gla* = opisthonotal gland opening. *Gnathosoma*: *a*, *m*, *h* = subcapitular setae; *or* = adoral seta; *sup*, *inf*, *d*, *l*, *cm*, *acm*, *ul*, *su*, *vt*, *lt* = palp setae; ω = palp solenidium; *as* = axillary sacculae; *cha*, *chb* = cheliceral setae; *Tg* = Trägårdh's organ. *Epimeral and lateral podosomal regions*: *1a*, *3b*, *4a* = epimeral setae; *PdI*, *PdII* = pedotecta I, II, respectively; *dis* = discidium; *cir* = circumpedal carina. *Anogenital region*: *g*, *ag*, *an*, *ad* = genital, aggenital, anal, and adanal setae, respectively; *iad* = adanal lyrifissure; *po* = preanal organ; *Ap* = postanal porose area. *Legs*: *Tr*, *Fe*, *Ge*, *Ti*, *Ta* = trochanter, femur, genu, tibia, and tarsus, respectively; ω , ϕ , σ = solenidia; ε = famulus; *d*, *l*, *v*, *bv*, *ev*, *ft*, *tc*, *it*, *p*, *u*, *a*, *s*, *pv*, *pl* = setae; *pa* = porose area.

TAXONOMY

Family Galumnidae

Genus *Flagellozetes* Balogh, 1970

Subgenus *Flagellozetes* (*Cosmogalumna*) Aoki, 1988

Type species: *Flagellozetes porosus* Balogh, 1970

Flagellozetes (*Cosmogalumna*) *daklakensis* sp. nov. (Figs. 1–2)

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Type material

Holotype (female) and four paratypes (two males and two females): Vietnam, Daklak Province, ca. 25 km SSW of Buon Ma Thuot, Dak Linh, 500 m a.s.l., dry litter in *Shorea* dipterocarp forest, 28–29.IV.1986 (L. Medvedev, S. Golovatch *et al.*).

The holotype is deposited in the collection of the Senckenberg Museum of Natural History, Görlitz, Germany; four paratypes are in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia. All specimens are preserved in 70% solution of ethanol with a drop of glycerol.

Diagnosis

Body length: 375–390. Prodorsum, lateral and medioposterior parts of notogaster, and subcapitular mentum heavily granulate/tuberculate; pteromorph with neural ridges forming regular reticulate pattern, and with some sparse grain-like cerotegumental structures; medioanterior part of notogaster (except smooth area nearly *lm*) with numerous neural ridges partially forming reticulate pattern with cells of different size; anogenital region with regular reticulate pattern; genital plate with some longitudinal stria in medial part and three grain-like cerotegumental structures; anal plate striate (medial part) and granulate/tuberculate (mediolateral part). Rostral seta long, lamellar seta medium-sized, both setiform, roughened; interlamellar seta short, needleform; bothridial seta long, clavate, slightly barbed. Dorsosejugal porose area present. All notogastral setae short, needleform. Four pairs of porose areas rounded (*Aa* largest; *A2* smallest). Median pore present. Lyrifissure *im* located between *lm* and *lp*. Three pairs of epimeral setae (*1a*, *3b*, *4a*). Circumpedal carina long. Postanal porose area oval. Leg famulus inserted anteriorly to solenidia ω_1 and ω_2 .

Description

Measurements – Small species. Body length: 390 (holotype, female), 375 (two male paratypes), 390 (two female paratypes); notogaster width: 300 (holotype), 285, 300 (two male paratypes), 300 (two female paratypes).

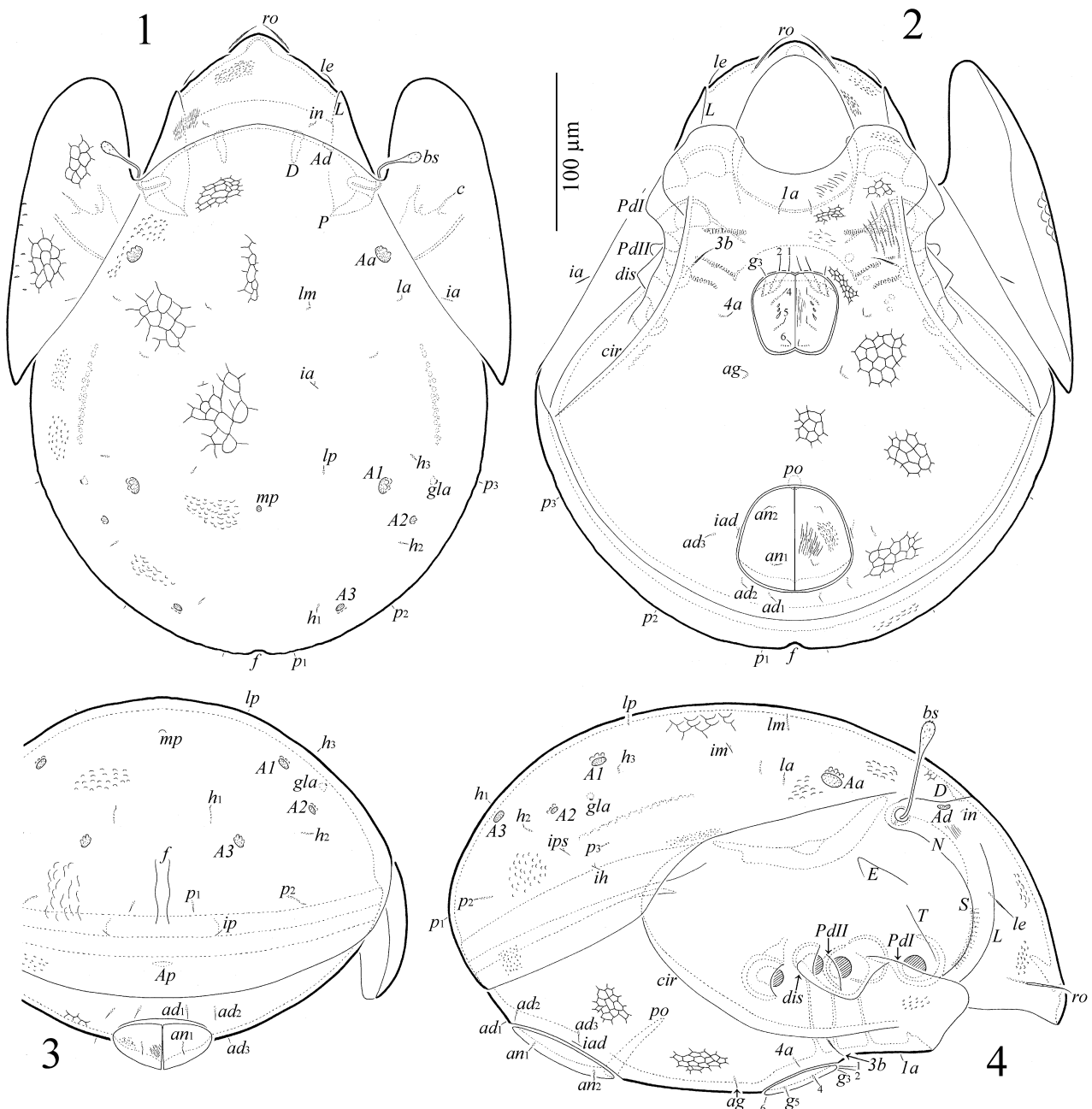
Integument – Body color brown. Body surface densely microfoveolate (visible under high magnification in dissected specimens); prodorsum (except slightly striate laterobasal part and smooth mediobasal part), lateral and medioposterior parts of notogaster, lateral part of epimere I, and subcapitular mentum heavily granulate/tuberculate; pteromorph with neural ridges forming regular reticulate pattern, and with some sparse grain-like cerotegumental structures; medioanterior part of notogaster (except smooth area nearly *lm*) and partially epimere I with numerous neural ridges partially forming reticulate pattern with cells of different size; lateral parts of epimeres I, II with longitudinal neural ridges forming lineate pattern; anogenital region (entirely; including area anterior to aperture) with regular reticulate pattern represented by dense small cells; genital plate with some slight longitudinal stria in medial part and three grain-like cerotegumental structures in central part; anal plate striate (medial part) and granulate/tuberculate (mediolateral part); sublamellar line mostly with short, narrow, transverse depression; antiaxial side of leg femora I–IV and trochanters III, IV partially with tubercles.

Prodorsum – Rostrum rounded. Lamellar and sublamellar lines simple, parallel, curving backwards. Rostral (30) and lamellar (15) setae setiform, roughened; *le* inserted medial to lamellar line; interlamellar seta (2) needleform; bothridial seta (64–67) clavate, with long stalk and short head slightly barbed; exobothridial seta absent. Dorsosejugal porose area (7–9 × 4) oval, transversely oriented, located posterolateral to interlamellar seta. Dorsophragma elongated longitudinally.

Notogaster – Dorsosejugal suture complete, simple, convex medially. Posterior part with longitudinal medial furrow. Ten pairs of setae (2) needleform. Four pairs of porose areas rounded (*Aa*: 13–19; *A1*: 9–13; *A2*: 5–7; *A3*: 7–11); *Aa* located close to pteromorph hinge, anterior to seta *la*; distance *A1*–*A2* shorter than *A2*–*A3*. Median pore present in males and females, located between *A2*. Opisthonotal gland openings and all lyrifissures distinct: *gla* located lateral to *A1*; *im* between *lm* and *lp*; *ip* posterolateral to *p1*; *ih* and *ips* between *p2* and *p3*, removed from each other.

Gnathosoma – Subcapitulum size: 90–94 × 75–79; subcapitular setae (*a*: 17–22; *m*: 9–11; *h*: 13–15) setiform, roughened; *a* thickest; *m* thinnest; adoral seta (9–11) setiform, barbed. Length of palp: 67–75; postpalpal seta (4) spiniform, smooth. Length of chelicera: 105–112; cheliceral setae (*cha*: 37; *chb*: 24) setiform, barbed.

Epimeral and lateral podosomal regions – Epimeral setal formula: 1–0–1–1; seta *3b* (11–13) setiform, roughened; *1a* and *4a* (4) needleform. Circumpedal carina long, reaching epimere I.



Figures 1–4. *Flagellozetes (Cosmogalumna) daklakensis* sp. nov. (adult) – 1. Dorsal view; 2. Ventral view (gnathosoma, legs and right pteromorph not shown); 3. Right lateral view (gnathosoma, legs and pteromorph not shown); 4. Posterior view (part of left half not shown).

Anogenital region – Anogenital setal formula: 6–1–2–3; genital setae g_1 , g_2 (both 9–11) setiform, roughened, others (g_3 : 6; g_4 – g_6 : 4) needleform; aggenital, anal and adanal setae (4) needleform. Anterior edge of genital plate with three setae. Aggenital seta located between genital and anal apertures, closer to genital aperture. Adanal lyrifissure located close and parallel to anal plate. Adanal setae ad_1 and ad_2 posterior, ad_3 lateral to anal plate; distance ad_1 – ad_2 shorter than ad_2 – ad_3 . Postanal porose area oval (15–19 × 5–7).

Legs – Median claw distinctly thicker than lateral claws, all slightly barbed on dorsal side. Porose area on femora I–IV and on trochanters III, IV present, but poorly visible. Formulas 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–

Table 1. Leg setation and solenidia of adult *Flagellozetes (Cosmogalumna) daklakensis* sp. nov.

Leg	Tr	Fe	Ge	Ti	Ta
I	v'	d, (l), bv''	(l), v', σ	(l), (v), φ ₁ , φ ₂	(ft), (tc), (it), (p), (u), (a), s, (pv), v', (pl), l'', ε, ω ₁ , ω ₂
II	v'	d, (l), bv''	(l), v', σ	(l), (v), φ	(ft), (tc), (it), (p), (u), (a), s, (pv), ω ₁ , ω ₂
III	v'	d, ev'	l', σ	l', (v), φ	(ft), (tc), (it), (p), (u), (a), s, (pv)
IV	v'	d, ev'	d, l'	l', (v), φ	ft'', (tc), (p), (u), (a), s, (pv)

Note: Roman letters refer to normal setae, Greek letters to solenidia (except ε = famulus); single quotation mark (') designates seta on the anterior and double quotation mark (') seta on the posterior side of a given leg segment; parentheses refer to a pair of setae.

Etymology

The species name *daklakensis* refers to the province of origin, Daklak.

Remarks

Flagellozetes (Cosmogalumna) daklakensis sp. nov. is morphologically similar to *F. (C.) maolanensis* Hu, Zheng & Yang, 2023 from Southeast China and Vietnam in having numerous neural ridges on the notogaster, reticulate pattern with dense small cells in anogenital region, granulate/tuberculate prodorsum, and several grain-like cerotegumental structures on the pteromorph and genital plate. However, the new species differs from the latter by the ornamentation of the pteromorph and anterior part of the notogaster (neural ridges forming reticulate pattern versus neural ridges and ornamentation absent), the ornamentation of epimere I and region anteriorly to genital plate (partially with reticulate pattern versus not reticulate), the sculpturing of posterior part of the notogaster (heavily granulate/tuberculate versus indistinctly granulate/tuberculate sculpturing), pteromorph hinge (smooth versus with numerous short transverse stria) and anal plate (striate in medial part and granulate/tuberculate in mediolateral part versus anal plate granulate/tuberculate entirely), and by the presence (versus absence) of longitudinal medial furrow in the posterior part of the notogaster.

Key to known species of *Flagellozetes*

(added and revised after Ermilov and Corpuz-Raros 2022)

1. All notogastral setae medium-sized or long, setiform 2
 - All notogastral setae absent or very short 3
2. Notogastral seta long (distinctly longer than length of notogastral porose area *Aa*), with flexible mediiodistal part; notogastral porose areas *A1* and *A2* removed from each other; body length: 529 *Flagellozetes (Flagellozetes) porosus porosus* Balogh, 1970. Distribution: Sri Lanka
 - Notogastral seta medium-sized (not longer than length of notogastral porose area *Aa*), not flexible; notogastral porose areas *A1* and *A2* located close to each other; body length: 485–536.... *Flagellozetes (Flagellozetes) porosus indicus* Balakrishnan & Haq, 1985. Distribution: India
3. Lamellar line costula-like; interlamellar seta medium-sized (distinctly longer than diameter of bothridium), thickened; body length: 470–497
 - *Flagellozetes (Variogalumna) singularis* (Mahunka, 1995). Distribution: Oriental region
 - Lamellar line thin; interlamellar seta short (shorter than diameter of bothridium), needleform, or represented by alveolus 4
4. Centrodorsal part of notogaster with neural ridges (sometimes partially forming reticulate cells of different size) 5
 - Centrodorsal part of notogaster with regular reticulate pattern represented by dense small cells 16
5. Anogenital region with regular reticulate pattern represented by dense small cells 6
 - Anogenital region with neural ridges (sometimes partially forming reticulate cells of different

- size) 8
6. Anogenital region with reticulate pattern only between genital and anal plates; prodorsum not heavily granulate/tuberculate; pteromorph without grain-like cerotegumental structures; body length: 282–298
Flagellozetes (Cosmogalumna) sumatrensis (Ermilov, Sandmann, Klarner, Widyastuti & Scheu, 2015). Distribution: Indonesia
- Anogenital region with reticulate pattern almost entirely; prodorsum heavily granulate/tuberculate; pteromorph with several grain-like cerotegumental structures 7
7. Pteromorph and anterior part of notogaster with neural ridges forming reticulate pattern; pteromorphal hinge not striate; anal plate striate (medial part) and granulate/tuberculate (mediolateral part); body length: 375–390
 *Flagellozetes (Cosmogalumna) daklakensis* **sp. nov.** Distribution: Vietnam
- Pteromorph and anterior part of notogaster without neural ridges forming reticulate pattern; pteromorphal hinge transversely striate; anal plate granulate/tuberculate entirely; body length: 360–397 *Flagellozetes (Cosmogalumna) maolanensis* Hu, Zheng & Yang, 2023. Distribution: Southeast China, Vietnam
8. Notogaster with three pairs of porose areas (A2 absent) 9
- Notogaster with four pairs of porose areas (A2 present) 10
9. Aggenital seta absent; bothridial seta fusiform, truncate distally; pteromorph with sparse stria; genital and anal plates not striate; body length: 266–315
 *Flagellozetes (Cosmogalumna) ekaterinae* (Ermilov & Friedrich, 2016). Distribution: Peru
- Aggenital seta present; bothridial seta clavate, rounded distally; pteromorph densely striate; genital and anal plates striate; body length: 324–330
 *Flagellozetes (Cosmogalumna) lineatus* Kolesnikov & Leonov, 2021. Distribution: Vietnam
10. Pteromorph with reticulate pattern; body length: 278–307
Flagellozetes (Cosmogalumna) vladopesici (Ermilov & Corpuz-Raros, 2015). Distribution: Philippines
- Pteromorph without reticulate pattern 11
11. Pteromorph striate 12
- Pteromorph not striate 14
12. Median pore present; circumpedal carina medium-sized, directed to epimeral seta *3b* and distinctly not reaching of epimere I; body length: 332–340
Flagellozetes (Cosmogalumna) naredoi Ermilov & Corpuz-Raros, 2022. Distribution: Philippines
- Median pore absent; circumpedal carina long, reaching of epimere I 13
13. Body minutely and sparsely foveolate; prodorsum without prodorsal furrows; sublamellar line without teeth; body length: 265–272
 *Flagellozetes (Cosmogalumna) sandori* Ermilov & Kalúz 2019. Distribution: Malaysia
- Body not foveolate; prodorsum with two prodorsal furrows; sublamellar line with row of teeth; body length: 270–300
Flagellozetes (Cosmogalumna) carinodentatus Ermilov & Salavatulin, 2022. Distribution: Vietnam
14. Pteromorph heavily granulate/tuberculate; adanal lyrifissure located anterolateral to anal plate and removed from it; body length: 333–368
Flagellozetes (Cosmogalumna) kirishimaensis (Hagino & Shimano, 2017) (see Hagino *et al.* 2017). Distribution: Japan
- Pteromorph not granulate/tuberculate; adanal lyrifissure located close and lateral to anal plate ...
 15
15. Neural ridges occupy the narrow transverse area between and slightly anterior to porose areas *A1–A1* on notogaster and between aggenital setae in anogenital region; lamellar and rostral

- setae similar in length; notogastral lyrifissure *im* located close and anterior to porose area *A1*; aggenital seta equally distanced from genital and anal apertures; body length: 330–352
Flagellozetes (Cosmogalumna) pseudoareticulatus Ermilov & Salavatulin, 2022. Distribution: Vietnam
- Neural ridges occupy centrodorsal part of notogaster and region between genital and anal plates; lamellar seta distinctly shorter than rostral seta; notogastral lyrifissure *im* located between setal alveoli *lm* and *lp*, equally removed from them; aggenital seta located closer to genital aperture than to anal aperture; body length: 298–315
Flagellozetes (Cosmogalumna) areticulatus (Ermilov, Sandmann, Klarner, Widyastuti & Scheu, 2015). Distribution: Oriental region
16. Notogaster with centrodorsal reticulation forming transverse band 17
- Notogaster with broad area of reticulate pattern, not forming transverse band 20
17. Anogenital region with neural ridges; body length: 315–332
Flagellozetes (Cosmogalumna) sibuyanensis Ermilov & Corpuz-Raros, 2022. Distribution: Philippines
- Anogenital region with regular reticulate pattern represented by dense small cells 18
18. Octotaxic system of notogaster represented by sacculi (porose areas absent); body length: 316–320
Flagellozetes (Cosmogalumna) sacculus Kolesnikov & Leonov, 2021. Distribution: Vietnam
- Octotaxic system of notogaster represented by porose areas (sacculi absent) 19
19. Transverse reticulate band of notogaster undulate (with two acrhes); pteromorph heavily granulate/tuberculate; genital plate striate; body length: 339–356
Flagellozetes (Cosmogalumna) centroclathratus (Hagino & Shimano, 2017). Distribution: Japan
- Transverse reticulate band of notogaster not undulate (without acrhes); pteromorph not granulate/tuberculate; genital plate not striate; body length: 326–365
Flagellozetes (Cosmogalumna) imperfectus (Aoki & Hu, 1993) (Syns.: *Galumna (Cosmogalumna) praeoccupata* Subías, 2004; *Flagellozetes (Cosmogalumna) macroporosus* Liang, Yang & Ren, 2018). Distribution: China
20. Prodorsum with reticulate pattern 21
- Prodorsum without reticulate pattern 22
21. Median pore absent; genital and anal plates granulate/tuberculate; body length: 336
 ...*Flagellozetes (Cosmogalumna) hiroyoshii* (Nakamura & Fujikawa, 2004). Distribution: Japan
- Median pore present; genital plate striate, and anal plate with reticulate pattern; body length: 282–298
Flagellozetes (Cosmogalumna) tenensis (Ermilov, Vu & Nguyen, 2011). Distribution: Vietnam
22. Prodorsum striate; notogaster with three pairs of porose areas (*A2* absent); body length: 298–315
Flagellozetes (Cosmogalumna) dongnaiensis (Ermilov & Anichkin, 2013). Distribution: Vietnam
- Prodorsum not striate or only basally with stria; notogaster with four pairs of porose areas (*A2* present) 23
23. Pteromorph with reticulate pattern; median pore absent; body length: 310–325
*Flagellozetes (Cosmogalumna) yonaguniensis* (Aoki, 2009). Distribution: Japan
- Pteromorph without reticulate pattern; median pore present 24
24. Notogaster with reticulate pattern only in centrodorsal region; anterior part of notogaster heavily granulate/tuberculate; prodorsum not granulate/tuberculate; body length: 326–362
Flagellozetes (Cosmogalumna) longtanensis Hu, Zheng & Yang, 2023. Distribution: Southern China
- Notogaster with reticulate pattern almost entirely; anterior part of notogaster not

- granulate/tuberculate; prodorsum heavily granulate/tuberculate 25
25. Pteromorph with stria and ridges; genital plate with longitudinal ridges; anal plate with reticulate pattern; body length: 315–332
Flagellozetes (Cosmogalumna) sanqingi Ermilov, 2020 (see Ermilov and Liao 2020).
 Distribution: Taiwan
- Pteromorph heavily granulate/tuberculate; genital plate mostly granulate/tuberculate and partially striate; anal plate granulate/tuberculate; body length: 317–348
Flagellozetes (Cosmogalumna) ornatus (Aoki, 1988) (see also Hagino and Shimano 2017).
 Distribution: Japan, Oriental region

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اطلاعات آرایه‌شناختی کنه اورibatید جنس *Flagellozetes* (Acari, Oribatida, Galumnidae)

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چکیده

گونه جدیدی از جنس *Flagellozetes* (Oribatida, Galumnidae) – *F. (Cosmogalumna) daklakensis* sp. nov. – از بستر خشک در جنگل شورآ دپتروکارپ در استان داکلاک، ویتنام مرکزی توصیف شده است. گونه *F. (C.) maolanensis* برای نخستین بار در فون ویتنام ثبت می‌شود. کلید شناسایی برای گونه‌های شناخته شده *Flagellozetes* آرایه شده است.

واژگان کلیدی: هرناهای گالومنید، ریخت‌شناسی، گونه جدید، آرایه‌شناسی، ویتنام.

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