

One new species of the subgenus *Cosmogalumna* (Acari: Oribatida: Galumnidae: *Galumna*) from Japan with supplementary description of *Galumna* (*Cosmogalumna*) *ornata* Aoki, 1988

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ABSTRACT — The present work deals with two members of the oribatid mite subgenus *Galumna* (*Cosmogalumna*) Aoki, 1988 from Japan. A new species, *G. (C.) centroclathrata* n. sp. is morphologically most similar to *G. (C.) praeoccupata* Subías, 2004 from China; however it differs from it by conspicuous granular ornamentation on the surface of the pteromorph, the shape of the polygonal sculpture on the notogaster, and a conspicuous linear sculpture on the middle part of the genital plates.

Galumna (*Cosmogalumna*) *ornata* Aoki, 1988, the type species of the subgenus, is additionally described based on the specimens from the type locality. The position of lamellar setae slightly anterior to L lines and the presence of 10 pairs of minute notogastral setae should be considered in any future identification of *G. (C.) ornata*.

KEYWORDS — Acari; Oribatida; *Galumna* (*Cosmogalumna*); new species; Japan; SEM; supplementary description

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INTRODUCTION

The family Galumnidae Jacot, 1925 includes 33 genera, 11 subgenera, 522 species and 33 subspecies (Subías 2004 updated in 2016). Among the genera, *Galumna* Heyden, 1826 is the largest: it includes seven subgenera and 192 species (including nine subspecies). Of these, the nominotypical subgenus *Galumna* contains the majority (172 species and nine subspecies). Aoki (1988) proposed *Cosmogalumna* as a new genus based on the presence of notogastral polygonal sculpture. Currently, *Galumna* (*Cosmogalumna*) contains 11 species, which are distributed in Oriental, Neotropic and Palearctic Regions (Sub-

ías 2004 updated in 2016, Ermilov and Friedrich 2016). Modified subgeneric diagnosis and an identification key to known species were proposed by Ermilov and Corpuz-Raros (2015). However, based on our observation on notogastral microsetae by SEM and modified subgeneric diagnosis provided by Ermilov and Corpuz-Raros (2015), the subgeneric diagnosis of *Galumna* (*Cosmogalumna*) can be further modified as follows: with characters of the genus *Galumna* (Ermilov *et al.* 2013); lamellar setae inserted usually between lamellar and sublamellar lines, rarely between lamellar lines; notogaster with 10 pairs of microsetae or setal alveoli; surface of notogaster covered by reticulate pattern.

During taxonomic survey of oribatid mites from Japan, we found two *Cosmogalumna* species; first one is the type species of the subgenus, *Cosmogalumna ornata* Aoki, 1988, and the other species is new. The main goal of this paper is to describe the new species and provide an additional description of *Cosmogalumna ornata*.

MATERIALS AND METHODS

12 specimens (two males, six females and four unknown specimens) collected from flourishing mosses growth on rocks near by the stream in *Cryptomeria* forest, Misatocho, Tsu city, Mie Prefecture, 34°45'49.8"N, 136°21'11.1"E, 419.4 m a.s.l., 20 November 2014, by W. Hagino. More than thirty specimens collected from soil and litter of evergreen forest, Nakanoshima Island, Toshima Village, Kagoshima Prefecture, 29°50'03.5"N, 129°54'01.6"E, 67 m a.s.l., 30 September 2015, by S. Shimano. More than 50 specimens collected from soil and litter of evergreen forest, Takarajima Island, Toshima Village, Kagoshima Prefecture, 29°9'13.5"N, 129°11'53.7"E, 25 m a.s.l., 28 September 2015, by W. Hagino. Two specimens collected from soil and litter of evergreen forest, Mt. Nishime, Okinawajima Island, Okinawa prefecture, 26°48'14.1"N, 128°15'37.5"E, 302 m a.s.l. 19 April 2006, by S. Shimano.

Oribatid mites were mounted in lactic acid on temporary cavity slides for measurement and illustration, with gam chloral liquied for permanent slides. For scanning electron microscopy (SEM), mites were fixed in 99.5% ethanol. Dehydration was conducted with graded ethanol series acetone and pentane. The specimens were placed on aluminum stubs with a double-stick carbon tape and coated with palladium-gold, then studied using Hitachi S3400-N scanning electron microscope. The morphological terminology used below is mostly that developed over many years by Grandjean (see Travé and Vachon, 1975 for references). All measurements are given as a range, with the mean in parentheses. Body length was measured in dorsal or ventral view, from the tip of the rostrum to the posterior edge of the ventral plate. Setal formulas

are given as numbers per segment for appendages (from trochanter to tarsus, famuli included) as number per podosomal segment (I–IV).

DESCRIPTIONS

Genus *Galumna* Heyden, 1826

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

Type species: *Galumna* (*Cosmogalumna*) *ornata* Aoki, 1988

Galumna (*Cosmogalumna*) *centroclathrata* n. sp.

[Japanese name: Harakazari-furisodedani]

(Figures 1-5, Table 1)

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Diagnosis — Body length and width: 339 – 356 × 252 – 299 µm. Sexual dimorphism not observed. Sensillus with long stalk and short, rounded distally head with minute spicules. Lamellar setae inserted slightly anteriorly from line L. Dorsosejugal suture well developed. Middle part of notogaster and ventral plate ornamented with polygonal sculpture, remaining part minutely foveolated throughout. Notogastral porose areas with densely spotted surface. Medial pore (*mp*) on notogaster present. Surface of pteromorph ornamented with conspicuous granules centrally. Genital plates with conspicuous linear sculpture centrally.

Description — Measurements – Body length and width: 339 (344) 356 × 252 (272) 299 µm (n = 9).

Integument (Figs. 1, 2A-B, D, F, 3A-C, E, 4) — Body color brown to dark brown. Body surface minutely punctate. Prodorsum with faint longitudinal striations along its lateral margins. Surface of pteromorph ornamented with conspicuous granules centrally. Middle parts of notogaster and ventral plate ornamented with polygonal network (Figs. 1A-B, 4C-D). All porose areas surface densely spotted. Surface of mentum plate smooth. Genital plate centrally ornamented with conspicuous linear structure as in Figs. 2F and 3E.

Prodorsum (Figs. 1A, 2A, C, 3A, D, 4A) — Rostrum broadly rounded. Lamellar (*L*) and sublamellar (*S*) lines distinct, parallel, curving backwards. Rostral setae (*ro*) (approx. 29 µm) thin,

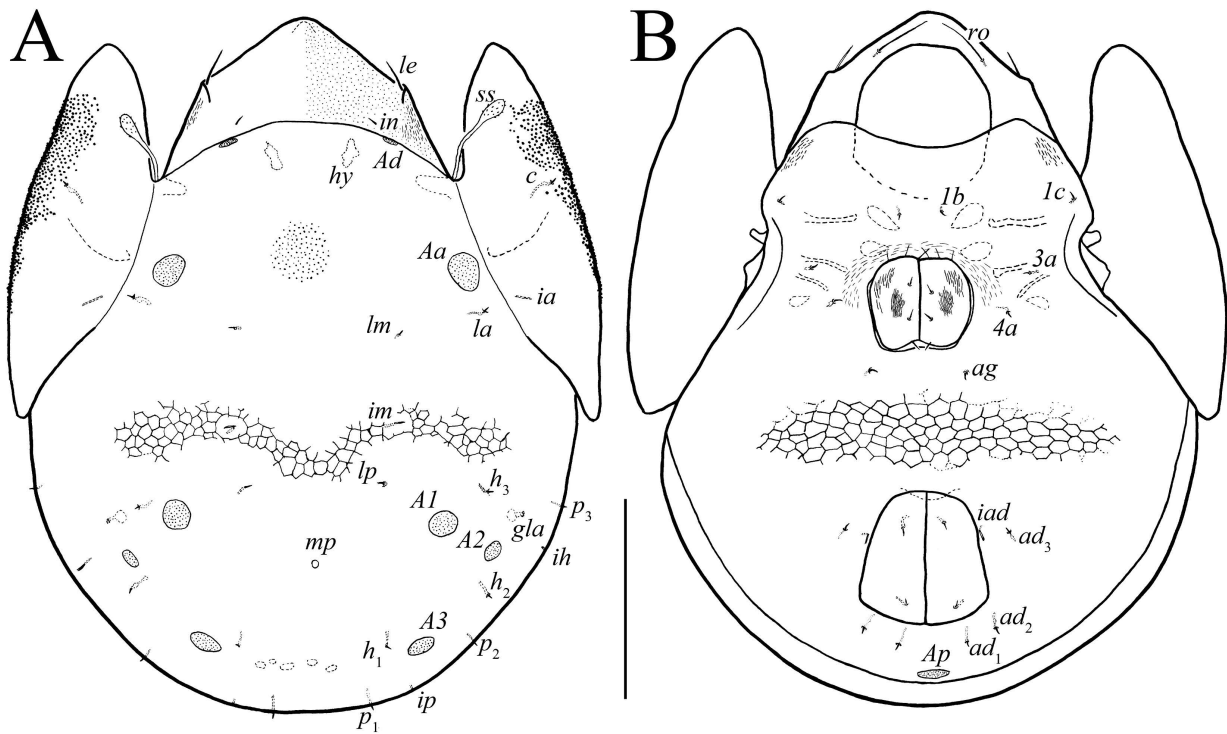


FIGURE 1: Adult *Galumna* (*Cosmogalumna*) *centroclathrata* n. sp., holotype: A – dorsal view; B – ventral view. Scale bar 100 µm.

slightly barbed. Lamellar setae (*le*) (approx. 18 µm) thin, slightly barbed, inserted just anterior to line L. Interlamellar setae (*in*) minute (approx. 3 µm), thin, smooth, hard to see. Sensillus (*ss*) with long stalk and short, rounded distally head, covered by minute spicules. Exobothridial setae not observed. Dorsosejugal porose areas (*Ad*) oval; posterior to seta *in*. Dorsophragmata (*hy*) near anterior notogastral margin.

Notogaster (Figs. 1A, 2B, D, 3A, C, 4B-C) — Dorsosejugal suture well developed. Ten pairs of minute (approx. 3 µm) notogastral setae present as Fig. 4B, hard to observe under the optical microscopy. Four pairs of circular porose areas present: *Aa* (diameter 14–16 µm) larger than others, *A2* (diameter 8 – 10 µm) smaller than others, *A1* and *A3* (diameter 11–12 µm) almost same in size. Four pairs of lyrifissures (*ia*, *im*, *ih*, and *ip*) present; *im* anterior to setae *lp*, surrounded by polygonal network structure. A pair of opisthonotal gland openings (*gla*) anterior to *A2*.

Gnathosoma (Fig. 2E) — Morphology of subcapitulum, palp and chelicera typical for subgenus (see Ermilov and Corpuz-Raros 2015). Setation of palp and chelicera typical for subgenus.

Ventral side (Figs. 1B, 2F-G, 3B, E-F, 4D) — Six pairs of thin, short, smooth genital setae (approx. 5 µm); *g₁*, *g₂*, and *g₃* inserted on anterior margin of genital plate; *g₄*, *g₅*, and *g₆* arranged longitudinally. One pair of minute aggenital setae (approx. 3 µm) posterior of genital plates. Two pairs of thin, smooth anal setae (approx. 5 µm) arranged longitudinally. Three pairs of minute adanal setae (approx. 3 µm); *ad₁* and *ad₂* posterior to anal plates, *ad₃* situated on lateral side of anal aperture. Adanal lyrifissures *iad* along edge of anal plate, lateral to *ad₃*. Setal formula of epimera 2–0–1–1. Posterior porose area (*Ap*) large (8 µm wide), oval, posterior to anal plate.

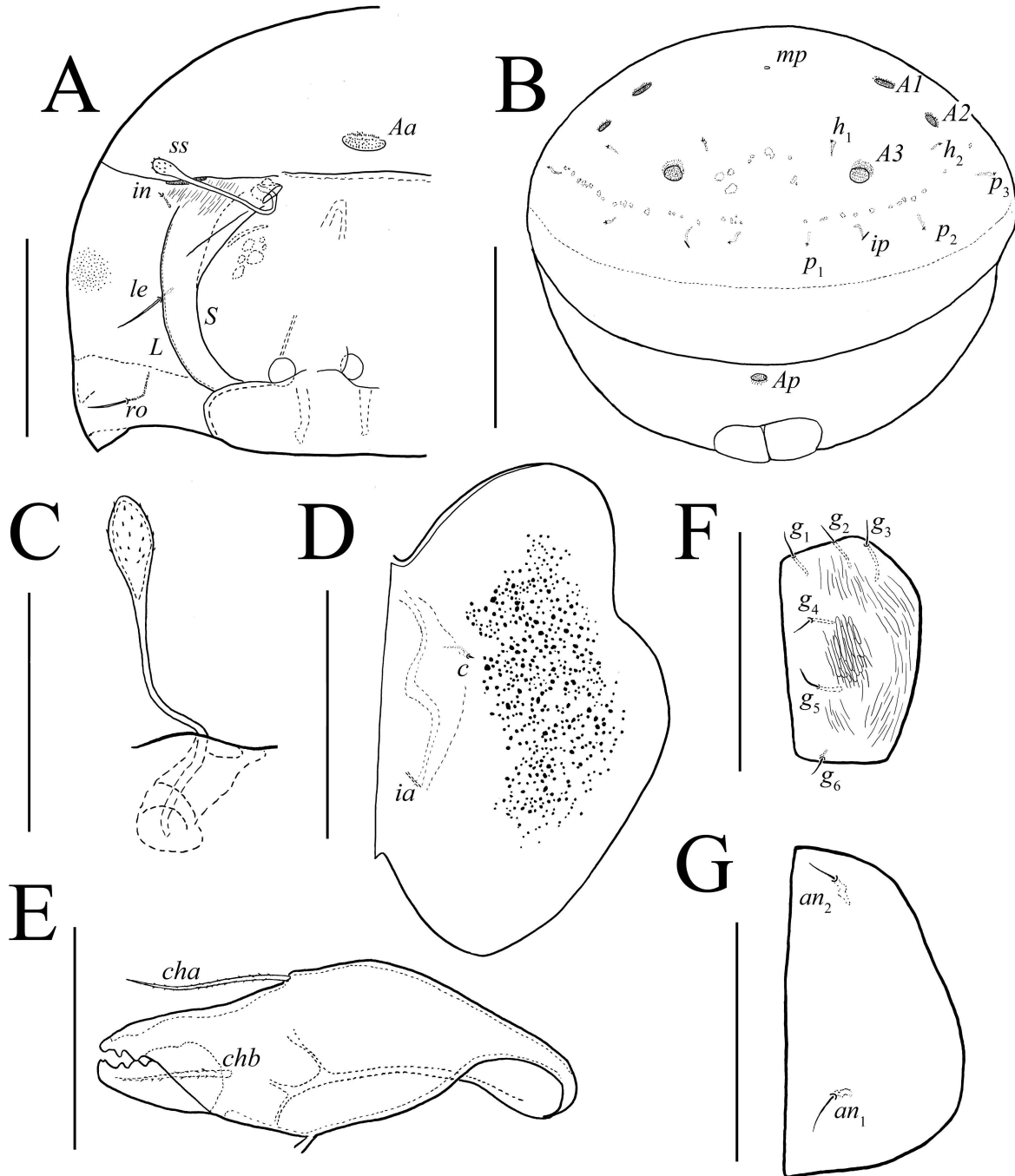


FIGURE 2: Adult *Galumna* (*Cosmogalumna*) *centroclathrata* n. sp., holotype for A, B, C, and D, paratype (NSMT-Ac 13969) for E, F, and G: A – aspidosoma, lateral view; B – opisthosoma, posterior view; C – sensillus; D – pteromorph; E – chelicera; F – genital plate; G – anal plate. Scale bar (A, B, D) 100 μ m, (C, E, F, G) 50 μ m.

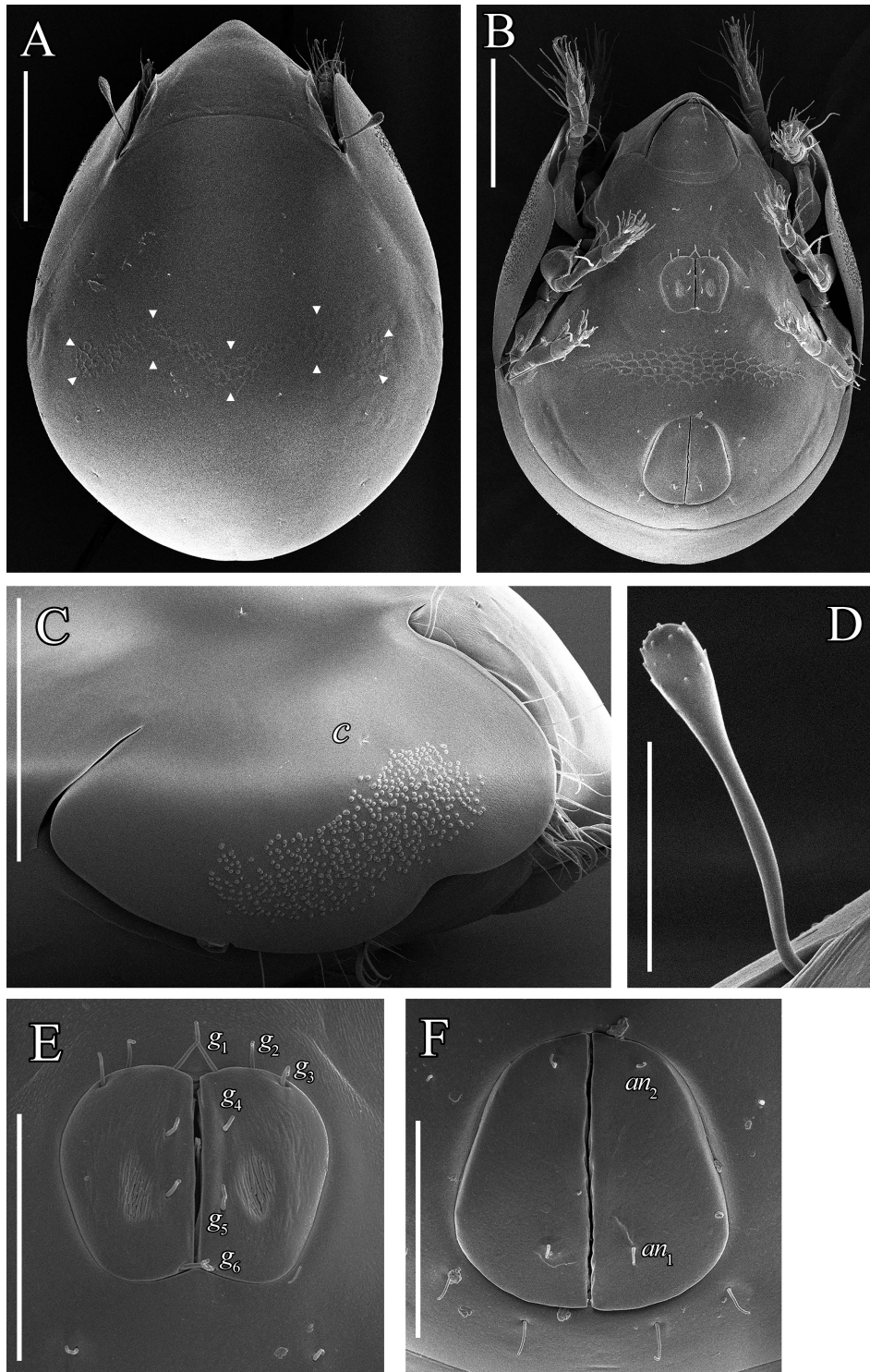


FIGURE 3: Scanning electron micrographs of adult *Galumna* (*Cosmogalumna*) *centroclathrata* n. sp., non-type specimens: A – dorsal view, arrow heads indicate polygonal sculpture on notogaster; B – ventral view; C – lateral view of pteromorph; D – sensillus; E – genital plates; F – Anal plates Scale bar (A, B, C) 100 μ m, (D) 30 μ m, (E, F) 50 μ m.

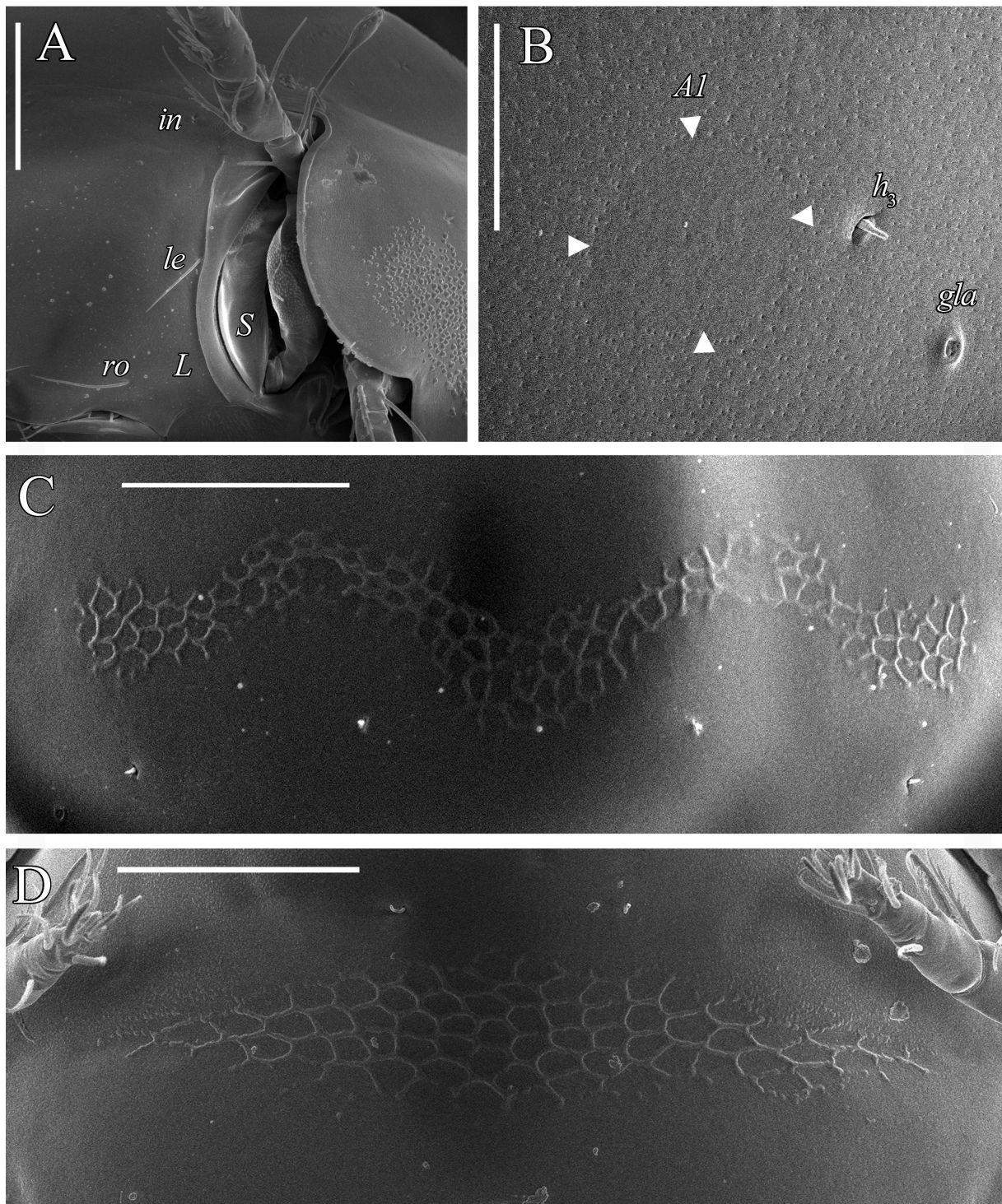


FIGURE 4: Scanning electron micrographs of adult *Galumna* (*Cosmogalumna*) *centroclathrata* n. sp., non-type specimens: A – partial anterior view; B – porose area A1 and setae *h*₃ (arrow heads indicate porose area A1); C – area of notogaster showing polygonal sculpture; D – area of ventral plate showing polygonal sculpture. Scale bar (A) 50 μm, (B) 20 μm, (C, D) 50 μm.

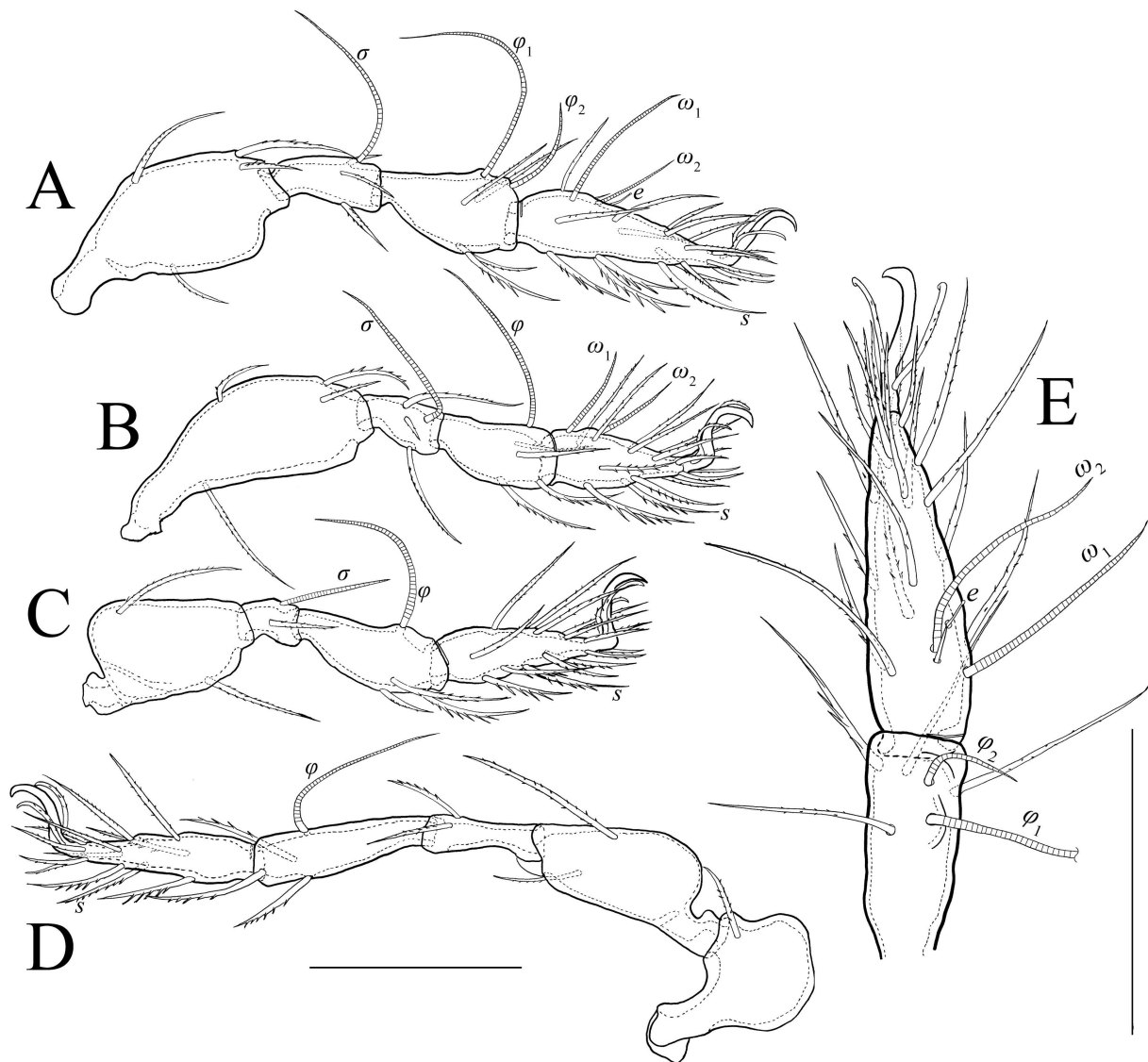


FIGURE 5: Legs of adult *Galumna* (*Cosmogalumna*) *centroclathrata* n. sp., holotype for A, and E, paratype (NSMT-Ac 14210) for B, C, and D: A – leg I, without trochanter, right, paraxial view; B – leg II, without trochanter, left, paraxial view; C – leg III, left, antiaxial view; D – leg IV, left, antiaxial view; E – leg I, right tarsus and tibia, dorsal view. Scale bar 50 μ m.

Legs (Fig. 5, Table. 1) — All legs tridactylous. Morphology of leg segments, setae and solenidia generally typical for species of the subgenus *Galumna* (*Cosmogalumna*) and other Galumnidae (Engelbrecht 1972; Ermilov and Anichkin 2013). Leg setation (Tr–Fe–Ge–Ti–Ta) including famulus: leg I, (1–4–3–4–20); II, (1–4–3–4–15); III, (1–2–1–3–15); IV, (1–2–2–3–12). Solenidiotaxy (Ge–Ti–Ta): I, (1–2–2); II, (1–1–2); III, (1–1–0); IV, (0–1–0).

Material examined — 12 specimens (two males, six females and four unknown specimens) collected from flourished mosses growing rocks near by the stream in a cryptomeria forest, Misatocho, Tsu city, Mie Prefecture, 34°45′49.8″N, 136°21′11.1″E, 420 m a.s.l., 20 November 2014, by W. Hagino.

Type deposition — Holotype (NSMT-Ac 14208, female) on slide: mosses growth on the rocks by the stream in a *Cryptomeria* forest, Misatocho, Tsu city, Mie Prefecture, 34°45′49.8″N, 136°21′11.1″E,

TABLE 1: Leg setation of adult *Galumna* (*Cosmogalumna*) *centroclathrata* n. sp. (same data for *Galumna* (*Cosmogalumna*) *ornata* Aoki, 1988), Roman letters refer to normal setae (*e* to famulus), Greek letters to solenidia. 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.

Leg	Trochanter	Femur	Genu	Tibia	Tarsus
I	<i>v'</i>	<i>d</i> , (<i>l</i>), <i>bv''</i>	(<i>l</i>), <i>v'</i> , σ	(<i>l</i>), (<i>v</i>), φ_1 , φ_2	(<i>ft</i>), (<i>tc</i>), (<i>it</i>), (<i>p</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , (<i>p</i> <i>v</i>), <i>v'</i> , (<i>pl</i>), <i>l''</i> , <i>e</i> , ω_1 , ω_2
II	<i>v'</i>	<i>d</i> , (<i>l</i>), <i>bv''</i>	(<i>l</i>), <i>v'</i> , σ	(<i>l</i>), (<i>v</i>), φ	(<i>ft</i>), (<i>tc</i>), (<i>it</i>), (<i>p</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , (<i>p</i> <i>v</i>), ω_1 , ω_2
III	<i>v'</i>	<i>d</i> , <i>ev'</i>	<i>l'</i> , σ	<i>l'</i> , (<i>v</i>), φ	(<i>ft</i>), (<i>tc</i>), (<i>it</i>), (<i>p</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , (<i>p</i> <i>v</i>)
IV	<i>v'</i>	<i>d</i> , <i>ev'</i>	<i>d</i> , <i>l'</i>	<i>l'</i> , (<i>v</i>), φ	<i>ft''</i> , (<i>tc</i>), (<i>p</i>), (<i>u</i>), (<i>a</i>), <i>s</i> , (<i>p</i> <i>v</i>)

a.s.l., 419.4 m, 20 November 2014, by W. Hagino. Two paratypes (NSMT–Ac 14209, and 14210, one male and one female) on slide: same data as holotype. The holotype and paratypes are to be deposited in the National Museum of Nature and Science, Tsukuba, Japan. Additional non-type specimens from the same locality as holotype, are preserved in the collections of W. Hagino.

Distribution — At present, this species only known from Mie Prefecture, Japan.

Etymology — The species epithet refers to the polygonal sculpturing of the middle part of notogaster and ventral plate.

Remarks — Among the 11 species of *Galumna* (*Cosmogalumna*), *Galumna* (*Cosmogalumna*) *centroclathrata* n. sp. most closely resembles *G. (C.) praeoccupata* Subías, 2004 (= *Cosmogalumna imperfecta* Aoki and Hu, 1993) from Yunnan Province, China in 1) long sensillus having rounded distally head with minute spicules, 2) polygonal sculpture on the middle part of notogaster and middle part of ventral plate, and 3) presence of medial pore on the notogaster. However, *Galumna* (*Cosmogalumna*) *centroclathrata* n. sp. differs from *G. (C.) praeoccupata* in having 1) conspicuous granular ornamentation on the whole surface of pteromorph, 2) polygonal sculpture on the dorsal side of notogaster has a form of a pair of weak arches connected in the middle part of notogaster (bended at both lyrifissure *im* and at the middle point of setae *lp*) spreaded transversely up to the mid-distance between notogastral setae *la* and *gla* at both side of notogaster, while in *G. (C.) praeoccupata* Subías, 2004, it has a form of straight band terminating on each side with a large cloud-like expansion, spreaded longitudinally between notogastral setae *lm* and nearby *gla*,

spreaded transversely beyond the mid-distance between notogastral setae *la* and *gla*. 3) conspicuous linear sculpture on the genital plates.

***Galumna* (*Cosmogalumna*) *ornata* Aoki, 1988**

pp. 31–32, Figures 1–3.

**[Japanese name: Kazari-furisededani]
(Figures 6–8)**

Supplementary description — Measurements – Body length and width: 320 (336) 348 × 259 (266) 285 μ m (n = 10).

Integument (Figs. 6, 7A–C, E–H, 8A–F) — Body color brown to dark brown. Body surface fully foveolated minutely. Prodorsum with dense granules and striations; especially central part with larger granules, faint longitudinal striations along its lateral margins. Surface of pteromorph fully ornamented with conspicuous granules, with fine granules in anterior part. Notogaster fully ornamented with polygonal network. Surface of all porose areas ornamented with multiple conspicuous granules (approx. 3 μ m) (see Aoki (1988), fig. 3). Anterior margin of ventral plate granulated, posterior to genital aperture ornamented with polygonal network except smooth posterior edge. Mentum plate with irregular granules. Each genital plate ornamented with granules, fine wrinkles in its distal edge, and longitudinal striation running nearly parallel with the median border. Surface of anal plate ornamented with irregularly shaped granules.

Prodorsum (Figs. 6A, 7A, D, 8A) — Rostrum broadly rounded. Lamellar and sublamellar lines distinct, parallel, curving backwards. Rostral setae (approx. 26 μ m) thin, slightly barbed, hard to observe from dorsal side. Lamellar setae (approx. 15 μ m) thin, slightly barbed, inserted just anterior to

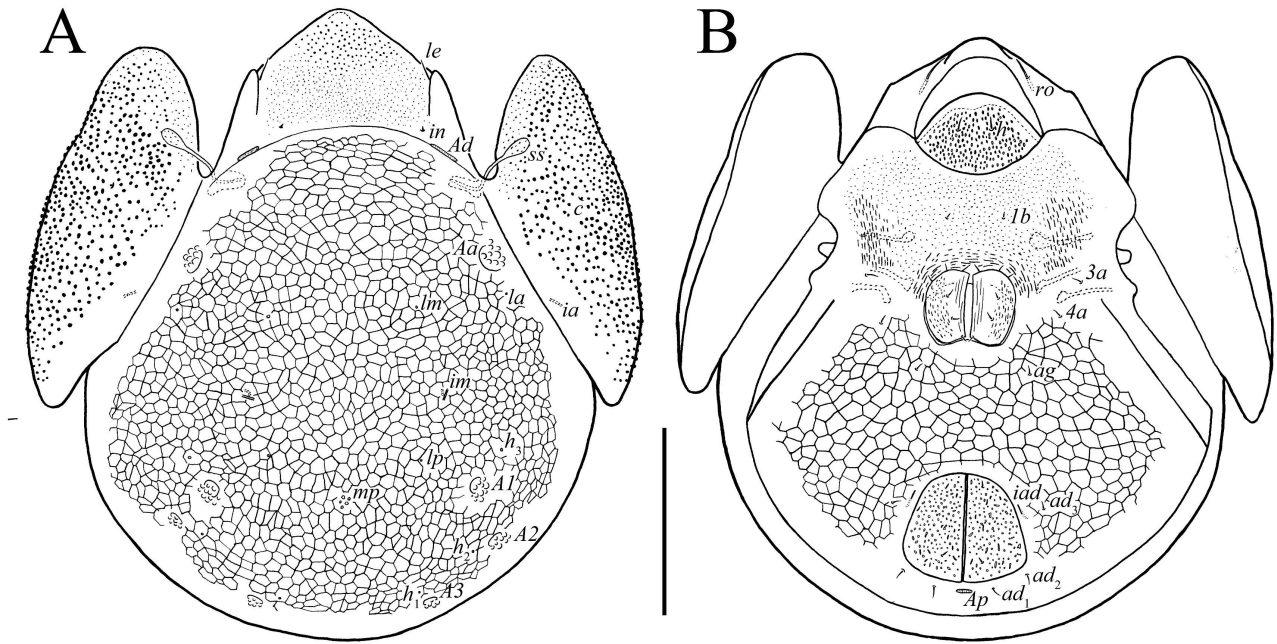


FIGURE 6: Adult *Galumna (Cosmogalumna) ornata* Aoki, 1988: A – dorsal view; B – ventral view. Scale bar 100 µm.

line L. Interlamellar setae minute (approx. 2 µm) thin, smooth, hard to discern. Sensillus with long stalk and short, rounded distally head, covered by minute spicules. Exobothridial setae not observed. Dorsosejugal porose areas oval; posterior to seta *in*. Dorsophragmata near anterior notogastral margin.

Notogaster (Figs. 6A, 7B-C, 8A, C-D) — Dorsosejugal suture well developed. Ten pairs of minute (approx. 3 µm) notogastral setae present as Fig. 8D, hard to observe under optical microscope. Four pairs of circular porose areas present: *Aa* (diameter 12 – 13 µm) larger than others, *A2* (diameter 5 – 6 µm) smaller than others, *A1* and *A3* (diameter 10 – 11 µm) almost same in size. Four pairs of lyrifissures (*ia*, *im*, *ih*, and *ip*) present. Opisthonotal gland openings anterior to *A2*.

Gnathosoma (Figs. 7E-F) — Morphology of subcapitulum, palp and chelicera typical for genus (see Ermilov and Corpuz-Raros 2015). Setation of palp and chelicera typical for subgenus (see Ermilov et al. 2011).

Ventral side (Fig. 6B, 7G-H, 8B, E-8F) — Six pairs of thin, short, smooth genital setae (approx. 5 µm); *g*₁, *g*₂, and *g*₃ inserted on anterior margin of genital

plate; *g*₄, *g*₅, and *g*₆ arranged longitudinally. Pair of minute aggenital setae (approx. 3 µm) in posterior region of genital plates. Two pairs of thin, smooth anal setae (approx. 4 µm) arranged longitudinally on anal plates. Three pairs of minute adanal setae (approx. 3 µm); *ad*₁ and *ad*₂ posterior to anal plates, *ad*₃ situated on lateral side of anal aperture. Adanal lyrifissures *iad* along edge of anal plate, lateral to *ad*₃. Setal formula of epimera 2-0-1-1. Posterior porose area oval (5 µm wide), posterior to anal plate.

Legs (Table 1) — All legs tridactylous. Morphology of leg segments, setae and solenidia generally typical for species of the subgenus *Galumna (Cosmogalumna)* and other Galumnidae (e.g. Engelbrecht 1972; Ermilov and Anichkin 2013). Leg setation (Tr-Fe-Ge-Ti-Ta) including famulus: leg I, (1-4-3-4-20); II, (1-4-3-4-15); III, (1-2-1-3-15); IV, (1-2-2-3-12). Solenidiotaxy (Ge-Ti-Ta): I, (1-2-2); II, (1-1-2); III, (1-1-0); IV, (0-1-0).

Material examined — Five males and five females collected from soil and litter of evergreen forest, Nakanoshima Island, Toshima Village, Kagoshima Prefecture, 29°50'03.5"N, 129°54'01.6"E, 67 m a.s.l., 30 September 2015, by S. Shi-

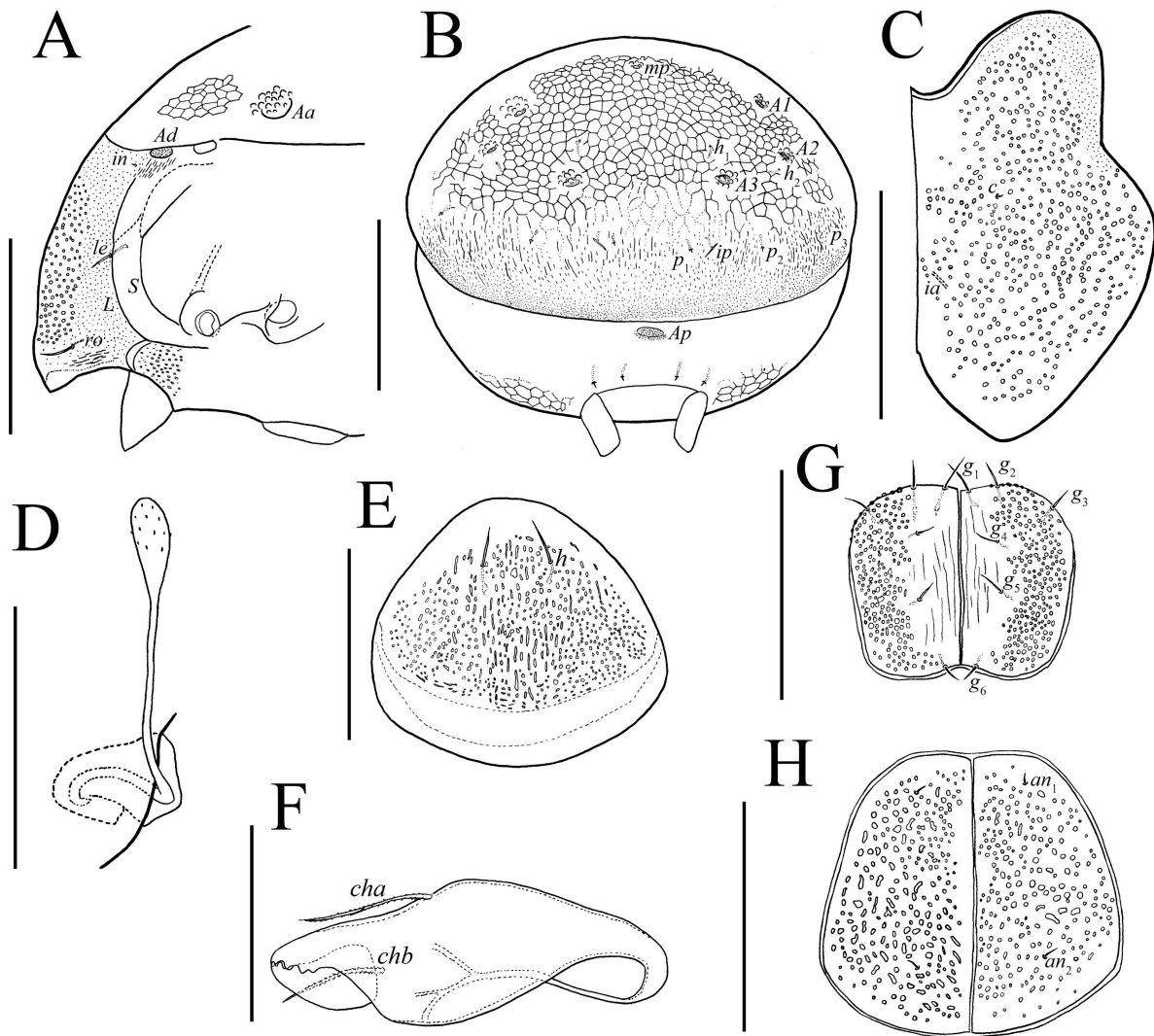


FIGURE 7: Adult *Galumna (Cosmogalumna) ornata* Aoki, 1988: A – aspidosoma; B – opisthosoma, posterior view; C – pteromorph; D – sensillus; E – mentum plate; F – chelicera; G – genital plates; H – anal plates. Scale bar (A, B, C) 100 μ m, (D, E, F, G, H) 50 μ m.

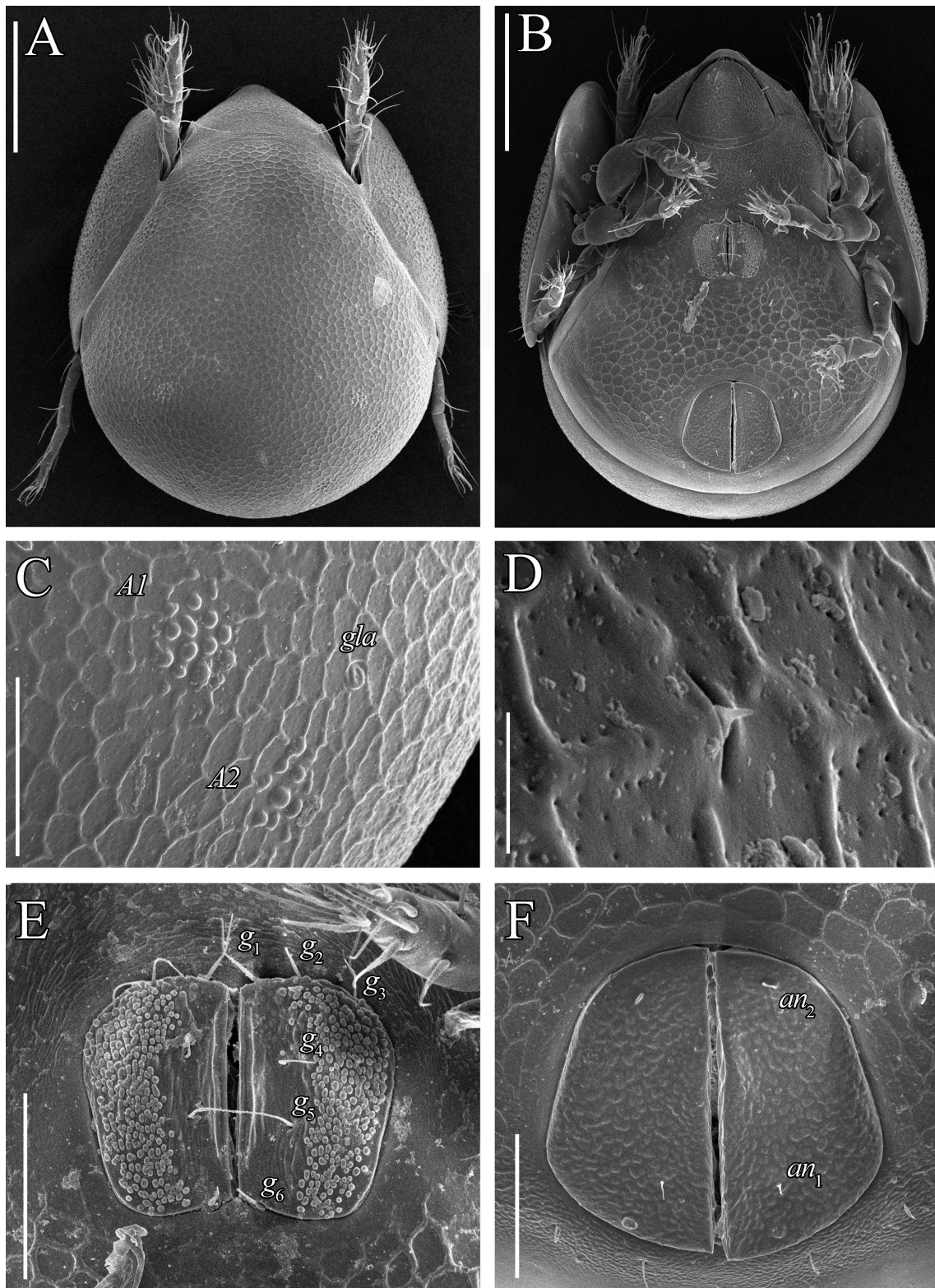


FIGURE 8: Scanning electron micrographs of adult *Galumna* (*Cosmogalumna*) *ornata* Aoki, 1988: A – dorsal view; B – ventral view; C – porose area A1 and A2; D – notogastral seta *lp*; E – genital plates; F – anal plates. Scale bar (A, B) 100 μ m, (C, E, F) 30 μ m, (D) 5 μ m.

mano. More than 50 specimens collected from soil and litter of evergreen forest, Takarajima Island, Toshima Village, Kagoshima Prefecture, 29°9'13.5"N, 129°11'53.7"E, 25 m a.s.l., 28 September 2015, by W. Hagino. Two specimens collected from soil and litter of evergreen forest, Mt. Nishime, Okinawajima Island, Okinawa Prefecture, 26°48'14.1"N, 128°15'37.5"E, 302 m a.s.l., 19 April 2006, by S. Shimano.

Distribution — At present, this species is known from Nakanoshima Island, Takarajima Island, Tokashiki Island, Miyako Island, Ishigaki Island, Yonaguni Island, and Okinawa Island in Southwestern Japan (Aoki, 2009).

DISCUSSION

Two of *Cosmogalumna* species seem to be endemic to one of the southwestern islands of Japan: *G. (C.) hiroyoshii* from Ishigakijima Island and *G. (C.) yonaguniensis* from Yonagunijima Island. In contrast, *G. (C.) ornata* is recorded commonly, from various localities in southwestern archipelago in Japan, e.g. Nakanoshima Island as type locality, Takarajima Island, Tokashikijima Island, Miyakojima Island, Ishigakijima Island, Yonagunijima Island, and Okinawajima Island (Aoki, 2009). Therefore, this new species of *Galumna* (*Cosmogalumna*) found in Mie prefecture is the first record of the subgenus from Honshu Island in Japan, and the northernmost record of this subgenus in the world.

Ermilov and Corpuz-Raros (2015) mentioned “notogaster with 10 pairs of setal alveoli” in their modified subgeneric diagnosis based on Aoki (1988). However, our SEM observation on the specimens of *G. (C.) ornata* Aoki, 1988 from its type locality showed the presence of ten pairs of very short (approx. 3 µm) notogastral setae (Fig. 8D).

Aoki (1988) described lamellar setae as inserted between carinae L and S, however, our observation exhibits that the lamellar setae were inserted slightly anterior to the L lines. Aoki (1988) overlooked the location of setae. Ermilov and Corpuz-Raros (2015) mentioned “lamellar setae inserted usually between lamellar and sublamellar lines,

rarely between lamellar lines” and our observation supports their modified subgeneric diagnosis. These corrections should be considered in any future identification of the species.

ACKNOWLEDGEMENTS

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