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Doctoral Dissertation

Taxonomic studies on oribatid mites of the genera *Neoribates*, *Trichogalumna* and *Cosmogalumna* (Acari: Oribatida: Galumnoidea) in Japan

(日本産フクロフリソデダニ属, チビゲフリソデダニ属, カザリフリソデダニ属(ダニ目：ササラダニ亜目：フリソデダニ上科)の分類学的研究)

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General Introduction

Suborder Oribatida

Oribatid mites are small arthropods that are also called beetle mites, armored mites, or moss mites. They comprise more than 10,000 species, classified into 1269 genera and 163 families within the suborder Oribatida (Subías, 2004 updated 2017). Most oribatid mites inhabit the soil–litter system; often, they are the dominant arthropods in temperate-forest soil (Schatz, 2005; Schatz *et al.*, 2011). In most modern taxonomic treatments, oribatid mites are classified in the order Sarcoptiformes, together with the suborder Endeostigmata and the cohort Astigmata (Krantz, 2009, Schatz *et al*., 2011). Krantz's (2009) classification, which is widely accepted today, is as follows:

Order Sarcoptiformes

Suborder Endeostigmata

Cohort Alycina

Superfamily Alycoidea

Cohort Nematalycina

Superfamily Nematalycoidea

Cohort Terpnacarina

Superfamily Oehserchestoidea

Superfamily Terpnacaroidea

Cohort Alicorhagiina

Superfamily Alicorhagioidea

Suborder Oribatida

Supercohort Palaeosomatides (Palaeosomata)

Superfamily Acaronychoidea

Superfamily Palaeacaroidea

Superfamily Ctenacaroidea

Supercohort Enarthronotides (Enarthronota)

Superfamily Brachychthonioidea

Superfamily Atopochthonioidea

Superfamily Hypochthonioidea

Superfamily Protoplophoroidea

Superfamily Heterochthonioidea

Supercohort Parhyposomatides (Parhyposomata)

Superfamily Parhypochthonioidea

Supercohort Mixonomatides (Mixonomata)

Superfamily Nehypochthonioidea

Superfamily Eulohmannioidea

Superfamily Perlohmannioidea

Superfamily Epilohmannioidea

Superfamily Collohmannioidea

Superfamily Euphthiracaroidea

Superfamily Phthiracaroidea

Supercohort Desmonomatides (Desmonomata)

Cohort Nothrina

Superfamily Crotonioidea

Cohort Brachypylina

Superfamily Hermannielloidea

Superfamily Neoliodoidea

Superfamily Plateremaeoidea

Superfamily Damaeoidea

Superfamily Cepheoidea

Superfamily Polypterozetoidea

Superfamily Microzetoidea

Superfamily Ameroidea

Superfamily Eremaeoidea

Superfamily Gustavioidea

Superfamily Carabodoidea

Superfamily Oppioidea

Superfamily Tectocepheoidea

Superfamily Hydrozetoidea

Superfamily Ameronothroidea

Superfamily Cymbaeremaeoidea

Superfamily Eremaeozetoidea

Superfamily Licneremaeoidea

Superfamily Phenopelopoidea

Superfamily Achipterioidea

Superfamily Oribatelloidea

Superfamily Oripodoidea

Superfamily Ceratozetoidea

Superfamily Galumnoidea

Cohort Astigmatina (Astigmata)

Superfamily Schizoglyphoidea

Superfamily Histiostomatoidea

Superfamily Canestrinioidea

Superfamily Hemisarcoptoidea

Superfamily Glycyphagoidea

Superfamily Acaroidea

Superfamily Hypoderatoidea

Superfamily Pterolichoidea

Superfamily Analgoidea

Superfamily Sarcoptoidea

Adult oribatid mites usually have a strong exoskeleton, hardened by sclerotization and mineralization. These slow-moving mites are 0.2–1.5 mm in length and occur in the top layer of soil. Most of them are not only particle-feeding saprophages and mycophages (Norton and Behan-Pelletier, 2009; Wehner *et al.*, 2016), but also opportunistic predators on nematodes and other microfauna and scavengers on small, dead arthropods (Schneider *et al.*, 2004). Oribatids have five stages in their life cycle, larva, protonymph, deutonymph, tritonymph and adult, therefore they shed four times before sexual maturity. In most groups, adults differ from immatures mostly in the degree of sclerotization and the addition of genitalia (Norton and Behan-Pelletier, 2009). Oribatid mites generally have low metabolic rates, slow development and low fecundity. In contrast to many other microarthropods, they reproduce slowly, usually lasting one to two years (Schatz, 1985); in cold climates, their life cycle can stretch up to seven years (Block, 1980). Although oribatid mites can be consumed by numerous predators such as newts, salamanders, caecilians, poison frogs, ants, true bugs and

beetles (Brockner *et al.*, 2016), the most important predators are most likely outer predatory mites, viz. gamasids (Hunt and Wall, 2002; Schneider and Maraun, 2009). Although there are a number of serious mite and tick pests, oribatid mites are not harmful and may play an important role in the breakdown of organic matter (Norton and Behan-Pelletier, 2009). A few species are known as transmitters of tapeworms to cattle or other ruminants (Denegri, 1993, Shimano 2004).

Superfamily Galumnoidea

In this study, I deal with the superfamily Galumnoidea, which is comprised of three families: 1) Galumnidae, a large assemblage of 536 species in 33 genera; 2) Parakalummidae, with 60 species in two genera: and 3) Galumnellidae, with 43 species in five genera. These species occur from polar regions to the tropics and are particularly diverse in the neotropics, especially in soil and arboreal habitats in rain forests. They are also recorded from many other habitats, including moss, pasture sod, forest litter and rotting wood (Norton and Behan-Pelletier, 2009). Since the first description of four new species by Aoki (1961), 48 species of Galumnoidea representing 10 genera have been

reported from Japan (Ohkubo *et al.*, 2015; Hagino *et al.*, 2016, 2017a, b; Hagino and Shimano, 2017).

Genus *Neoribates*

The genus *Neoribates* is the largest (56 species) in the family Parakalummidae. The genus *Neoribates* was proposed with *Oribata roubali* Berlese, 1915 as the type species (Berlese, 1915). Currently, this genus comprises four subgenera and 58 species, which have been reported from various parts of the world (Subías, 2004, 2017; Hagino *et al.*, 2016; Ermilov, 2017). The main characters of *Neoribates* were summarized by Balogh and Balogh (1990, 1992), and Ermilov and Kalúz (2013). Identification keys to some species of *Neoribates* were provided earlier (Balogh and Balogh, 2002), and modified by Grishina and Vladimirova (2009), and Ermilov and Kalúz (2013). Since the first description of a new species by Aoki (1965), eight species of *Neoribates* have been reported from Japan (Ohkubo *et al.*, 2015; Hagino *et al.*, 2016). Of these eight, *Neoribates roubali* (Berlese, 1915) and *Neoribates parvisetigerum* (Aoki, 1965) are widely distributed in the Palaearctic and Oriental

realms (Subías, 2004, 2017); they have also been reported from all over Japan (Fujikawa *et al.*, 1993). In contrast, some species seem to be endemic to restricted areas in Japan: *Neoribates rimosus* Suzuki, 1978 from Tochigi Prefecture, *Neoribates similis* Fujikawa, 2007 from Tokushima Prefecture, and *Neoribates elongatus* Aoki, 2009 from Yonagunijima Island. In the course of these investigations, I found a species of *Neoribates*, which turned out to be new to science.

Genus *Trichogalumna*

Among Galumnidae, *Trichogalumna* is one of the smallest genera (29 species), which was proposed by Balogh (1960a) with *Pilogalumna lunai* Balogh, 1958 as the type species. Currently, this genus comprises 29 named species, distributed in the Palaearctic, Ethiopean, Oriental, Neotropical and Australian regions (Subías, 2004, 2017; Hagino *et al.*, 2017; Subías *et al.*, 2017). Due to the extensive studies of Engelbrecht (1972) and Ohkubo (1984), and recent contributions by other authors (e.g. Mahunka, 1987; Nakamura *et al.*, 2013), *Trichogalumna* became one of the most well-known genera in Asia (10 spp.). The main morphological characters of this genus

were summarized by Balogh (1960a), Engelbrecht (1972) and Ohkubo (1984). Identification keys to species of *Trichogalumna* have been presented by Ohkubo (1984) and Villagomez and Palacios-Vargas (2013). Nine species of *Trichogalumna* have been recorded from Japan (Aoki, 1966; Ohkubo, 1984; Nakamura *et al.*, 2013). In the course of my investigations, I found four species of *Trichogalumna*, two of which were new to science.

Genus *Cosmogalumna*

The genus *Cosmogalumna* Aoki, 1988 comprises 12 species distributed in the Oriental, Neotropical and Palearctic regions (Subías, 2004, 2017; Hagino and Shimano, 2017). The main generic traits were listed by Aoki (1988); modified generic diagnoses were provided by Ermilov and Copuz-Raros (2015), and Hagino and Shimano (2017). The identification key to species of the genus *Cosmogalumna* was presented by Ermilov and Corpuz-Raros (2015). Two *Cosmogalumna* species seem to be endemic to one of the Nansei Islands of Japan: *C. hiroyoshii* Nakamura and Fujikawa, 2004 from Ishigakijima Island and *C. yonaguniensis* Aoki, 2009 from Yonagunijima Island. In

contrast, *C. ornata* Aoki, 1988 is recorded commonly from various localities in the Japanese southwestern archipelago, e.g. Nakanoshima Island (type locality), Takarajima Island, Tokashikijima Island, Miyakojima Island, Ishigakijima Island, Yonagunijima Island and Okinawajima Island (Aoki, 2009). During the course of the taxonomic identification of oribatid mites collected in Kagoshima and Mie Prefectures, I found three species of *Cosmogalumna*, two of which were new to science. The one from Mie Prefecture represents the first record of the genus from Honshu Island, Japan, and is also the northernmost record of this genus in the world.

The ultimate goal of my research is to clarify the entire Japanese oribatid fauna. Toward this goal, I performed a series of taxonomic studies targeting the three genera outlined above. Species of the first two genera, *Neoribates* and *Trichogalumna*, are widely distributed around the world (Subías, 2004, 2017), and thus are found in many places all across Japan (Fujikawa *et al.*, 1993; Ohkubo *et al.*, 2015); these genera can thus be referred to as ‘cosmopolitan’. Due to this wide-spread distribution, members of these two genera have been reported in ecological papers, in which, however, they

tend to be left unidentified to species (Kubota, 1987; Aoki, 2009). Therefore, sound taxonomic studies are essential for non-experts to identify these oribatids to the species level. On the other hand, Japanese oribatid mites in the other genus, *Cosmogalumna*, have so far been reported only from the southwestern islands of the country. The genus can thus be considered 'endemic' in terms of its geographic distribution in Japan, although other members of the genus are distributed in the Oriental, Neotripical and Palearctic regions (Subías, 2004, 2017; Hagino and Shimano, 2017). One of the questions that arise from this difference in the genus-level geographic distribution pattern is to what extent *Cosmogalumna* oribatids are really 'endemic' in Japan. One of the possibilities is that Japanese *Cosmogalumna* species are actually not confined to the Nansei Islands and may be found in Kyushu and Honshu, or even Hokkaido, if a better investigation is carried out. Another possibility would be that Japanese *Cosmogalumna* species are actually 'endemic' to the southwestern islands.

Materials and Methods

Oribatid mites were collected at 14 localities. Soil and litter including humus, fallen leaves and branches, mosses and mushrooms were collected by hand. In the laboratory, the soil arthropods were extracted with modified Tullgren's funnels using a settling time of approximately 72 hours. Extracted soil arthropods were stored in 99.5% ethanol.

For the optical observation, oribatid mites mounted on slides were observed under a compound microscope. Line drawings were prepared with a camera lucida attached to a compound microscope. For scanning electron microscopy (SEM), oribatids 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, and observed through a Hitachi S3400-N scanning electron microscope.

All morphological terminology and abbreviations used in this thesis follow those developed by François Grandjean for many years, the references of which were compiled and summarized by Travé and Vachon (1975). A recent overview of

Grandjean's morphological terminology and abbreviations as given in Norton and Behan-Pelletier (2009) as follows: *prodorsum*, the anterior dorsal region from the anterior body end to the anterior notogastral margin; *rostrum*, the anteriormost dorsal portion; *lamellae* (lamellar line = L line), the longitudinal projection on the prodorsum; *tutorium* (sublamellar line = S line), the ridge on the lateral prodorsum; *rostral setae* (*ro*), the most anterior setae on the prodorsum; lamellar setae (*le*), setae on near terminate lamrllae; *interlamellar setae* (*in*), setae on posteriorly from lamellar lines; *dorsosejugal suture*, the suture marking the fusion of the prodorsum and notogaster; *notogaster*, the posterior dorsal region from the anterior notogastral margin to the posterior body end; *notogastral seta*, seta on notogaster; *pteromorph*, wing-like to shelf-like lateral extensions of the body; *medial pore* (*mp*), one pore or several pores in the central part of the notogaster; *notogastral porose area* (*Aa*, *A1*, *A2*, *A3*), the respiratory organ represented as dermal glands on the notogaster; *notogastral lyrifissure* (*ia*, *im*, *ip*, *ips*), a cuticular proprioreceptor structure represented by slits or a round pit; *opisthonotal gland opening* (*gla*), a secretory gland, usually referring to the lateral opisthonotal glands; *capitulum*, the anteriormost part of a mite, composed of the

cheliceral and pedipalpal segments; *palp*, the second pair of limbs used for feeding and originating on either side of the chelicera, the primary mouthparts in mites; *genital plate*, the genital opening on the ventral region; *genital seta* (g_1–g_6), seta on the genital plate; *aggenital region*, areas on either side of the genital plate; *aggenital setae* (*ag*), setae on the aggenital region; *epimeral region*, the coxal area on the ventral region; *epimeral setae* (*1a*, *2a*, *3a*, *3b*, *4a*, *4b*, *4c*), setae on the epimeral region; *pedotectum*, the scale-like tectum arising around the insertion of legs I and II that covers the insertion of the legs; *discidium*, the spine- or ridge-like structure on the lateroventral side of the notogaster; *anal plate*, the anal opening in the ventral plate; *anal seta* (an_1 and an_2), seta on the anal plate; *adanal region*, areas on either side of the anal plate; *adanal setae* (ad_1–ad_3), setae on adanal region; *posterior porose area* (*Ap*), single respiratory organ located posteriorly to the anal plate. For leg setal nomenclature, I followed that by Norton (1977).

When there is more than one measurement, it is given as a range with the mean in parentheses. The body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate, to avoid discrepancies caused by

different levels of notogastral distension. The notogastral width refers to the maximum width in dorsal position. Setal formulae of legs are given as numbers per segment for appendages (from trochanter to tarsus).

Taxonomy

In total, I obtained more than 1,200 individuals of oribatids from 14 sampling sites round Japan. I describe and illustrate in detail eight species (five new and three previously known), for which mature individuals were collected.

Order Oribatida Dugès, 1834

Superfamily Galumnoidea Jacot, 1925

Family Parakalummidae Grandjean, 1936

Neoribates incisus Hagino, Shimano and Aoki, 2016

[Japanese name: Okinawa-fukuro-furisodedani]

(Figs. 1–5. Table. 1)

Diagnosis. Body length and width: 910–1045 × 642–765 μm. Sensillus slender rod-like, weakly barbed, with pointed tip. Tip of rostrum sharply pointed. Posterior end of notogaster with long shallow ditch. Four pairs of genital setae present. Adanal setae Ad1 and Ad2 long (61–63 μm).

Etymology. The specific name is Latin adjective which comes from morphology of notogaster incised posteriorly.

Material examined. Holotype (NSMT–Ac 13970, male) on slide: collected from soil and litter samples of bamboo glass bush (*Pleioblastus linearis*), nearby Fungawa-dam, Kunigami Village, Okinawa-jima Island, southwestern Japan, 26º44'34"N, 128º17'2" E, 178 m a.s.l., 28th June 1982, by J. Aoki. Eight paratypes (NSMT–Ac 13971–13973, three males and five females) on three slides: 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 the holotype, are kept in the collections of S. Shimano.

Measurements. Body length and width (min (mean) max): 910 (972) 1045 × 658 (778) 840 μm (n = 9).

Integument. Body color brown to dark brown. Body surface smooth except on ventral plate with a pattern of dense dots.

Prodorsum. (Figs. 1 and 3) Rostrum sharply pointed. Lamellar (*L*) ridges slender, but distinct. Rostral setae (*ro*) (97 μm) setiform, thin, barbed only lateral side.

Lamellar setae (*le*) (140 μm) setiform, thin, slightly barbed, inserted at the tip of lamellar ridges. Interlamellar setae (*in*) (237 μm) setiform, slightly barbed. Sensillus (*ss*) (152 μm) slender rod-like, only slightly thickened in distal half, with pointed tip; surface weakly barbed.

Notogaster. (Figs. 1 and 3) Anterior notogastral margin convex. Dorsosejugal suture complete. Posterior end of notogaster with long shallow ditch. Notogastral setae represented by 10 pairs of microsetae (approx. 3 μm). Four pairs of notogastral sacculi (*Sa*, *S1*–*S3*) developed, *Sa* the largest, situated along the near hinge of the pteromorph, *S1*, *S2*, and *S3* almost of the same in size. Three pairs of lyrifissures (*ia, im,* and *ip*) present; lyrifissure *im* situated between setae *lm* and sacculus *S1*, lyrifissure *ip* located posterior to sacculus *S3*.

Gnathosoma. Subcapitulum longer than wide (178 × 157 μm). Subcapitular seta *h* (55 μm) setiform, barbed; seta *a* (39 μm) setiform, slightly barbed; setae *m* and adoral seta not observed.

Epimeral region. (Fig. 2) Epimeral setal formula 3–1–3–3. All setae setiform, slightly barbed. Setae *1c*, *3c*, *4a*, *4b* (28–35 μm) shorter than *1a*, *1b*, *2a*, *3a*, *3b* (40–46

μm). Pairs of setae *1a*, *2a* and *3a* located close to each other. Pedotecta I, II, discidia and circumpedal carina normally developed.

Anogenital region. (Figs. 2 and 3) Four pairs of genital (g_1–g_4, 21–24 μm), one pair of aggenital (*ag*, 32 μm), three pairs of adanal (ad_1–ad_3, 50–63 μm) and two pairs of anal (an_1, an_2, 30–40 μm) setae setiform, slightly barbed. Lyrifissure *iad* located in the para-anal position. Adanal seta ad_1 (61 μm) and ad_2 (63 μm) longer than ad_3 (50 μm): ad_3 inserted at preanal position.

Legs. (Figs. 4 and 5, Table 1) All legs tridactylous with large, thick medial claw and thin lateral claws: lateral claws have a small tubercle near the tip. Leg setation (Tr–Fe–Ge–Ti–Ta) including famulus, excluding solenidia: leg I, (1–5–3–4–20); II, (1–5– 3–4–15); III, (2–3–1–3–15); IV, (1–2–2–4–12). Solenidiotaxy (Ge–Ti–Ta): I, (1–2–2); II, (1–1–2); III, (1–1–0); IV, (0–0–0).

Remarks. *Neoribates incisus* most closely resembles *N. parabulanovae* Ermilov and Martens, 2014 in 1) body size, 2) pointed rostrum tip. However, *Neoribates incisus* differs from *N. parabulanovae* Ermilov and Martens in having 1)

sensilli nearly rod-like, only slightly thickened and barbed in distal half, with pointed tip, 2) incision on posterior end of notogaster, 3) remarkably long adanal setae ad_1 and ad_2.

Distribution. At present, *Neoribates incisus* is only known from Okinawa-jima Island, the Ryukyus, southwestern Japan.

Family Galumnidae Jacot, 1925

Genus *Trichogalumna* Balogh, 1960

***Trichogalumna boninensis* Hagino, Bayartogtokh & Shimano, 2017**

(Figs. 6–8, Table. 2)

Diagnosis. Body length 285–302 μm, width of notogaster 208–232 μm; rostrum protruding; rostral and lamellar setae fairly long, barbed; interlamellar setae short, thin; sensillus with thin, smooth stalk and lanceolate head with dense spicules; anterior margin of notogaster not developed; pteromorph with granules and larger granular ornamentation along hinge of pteromorph; notogaster and ventral plate with

granular bands; mentum with fine wrinkles and microgranules.

Etymology. The species is named after the Bonin Islands, where the new species was found.

Material examined. Holotype: (female, NSMT-Ac-13965) and two paratypes (females, NSMT- Ac 13966 and 13967) from soil and litter, collected at the end of Tatsumi road in Chichi-jima Island of the Bonin Islands group, southern Japan, 27°03"N, 142°13'E, 258 m a.s.l., 1st March 2015, by S. Shimano and S. F. Hiruta. All type specimens are deposited in the National Museum of Nature and Science, Tsukuba, Japan.

Description.

Measurements. Body length and width (min (mean) max): 285 (295) 302 × 208 (217) 232 μm.

Integument. (Figs. 6 and 8) Body color brown to light brown. Body surface covered with microgranules; prodorsum with faint longitudinal striations along its lateral margins; pteromorph covered with large and dense granules, with larger ornamentation along its hinge; surface of mentum with fine wrinkles and

microgranules; anterior tectum of epimere I granulated; notogaster and ventral plate with granular bands; anal and genital plates nearly smooth.

Prodorsum. (Fig. 6) Rostrum protruding, slightly nasiform, rounded. Tutorial and lamellar ridges (lines *S* and *L*) distinct, nearly parallel, curving backwards. Rostral (*ro*, approx. 28 μm) and lamellar setae (*le*, approx. 30 μm) setiform, barbed. Interlamellar setae short (*in*, 10 μm), thin, smooth. Sensillus (*ss*, approx. 55 μm) having thin stalk and lanceolate head with dense spicules. Dorsosejugal porose area (*Ad*) oval, located posterolaterad to seta *in*.

Notogaster. (Figs. 6 and 8) Anterior margin of notogaster not developed. Dorsophragmatic apophysis (*D*) medium in size, elongated longitudinally. Notogastral setae short (approx. 7 m), thin, smooth. Four pairs of notogastral porose areas, *Aa*, *A1*, *A2* and *A3* almost circular in shape; *A1* and *A2* located close to each other; *A3* situated laterally to seta *h*1. Four pairs of notogastral lyrifissures (*ia*, *im*, *ih*, and *ip*) and opisthonotal gland opening (*gla*) well developed.

Gnathosoma. (Figs. 6 and 8) Morphology of subcapitulum, palp and chelicera typical for the genus (see Ermilov *et al*. 2011). Subcapitular setae short,

setiform, smooth. Structure and setation of palp and chelicera similar to those of *T. africana* Ermilov, Sidorchuk & Rybalov, 2011.

Epimeral region. (Fig. 6) Six pairs of short, but distinct epimeral setae (*1a, 1c, 3b, 3c, 4b, 4c*) thin, smooth. Setal formula of epimera 2-0-2-2. Discidium broadly triangular; pedotectum II scalelike, subtriangular in ventral view. Circumpedal carinae well developed.

Ano-genital region. (Figs. 6 and 8) All ano-genital setae short, thin, smooth; g_1, g_2, and g_3 inserted on the anterior margin of genital plate, g_4, g_5 arranged longitudinally, g_6 inserted on the posterior margin of genital plate; adanal setae ad_1 and ad_2 inserted posterior to anal plates; ad_3 inserted in paraanal position; lyrifissure *iad* situated anterolateral to the anal plate. Postanal porose area (*Ap*) elongate oval, transversely oriented.

Legs. (Fig. 7, Table. 2) Morphology of leg segments, setae and solenidia typical for *Trichogalumna* (e.g. Ermilov *et al*. 2011). Claws smooth dorsally. Famulus short, with a slight distal expansion. Formulas of leg setation and solenidia: I

(1-4-3-4-20) [1-2-2]; II, (1-4-3-4-15) [1-2-2]; III, (1-2-1-3- 15) [0-1-1]; IV, (1-2-2-3-12) [0-1-0]; homology of setae and solenidia indicated in Table 1.

Remarks. This species is similar to *T. granuliala* Ohkubo, 1984 in having a small body size, lanceolate sensillus, and granular structure of the integument. However, *T. boninensis*. differs from *T. granuliala* in the surface of notogastral porose areas which is ornamented by fine dots (whereas several protuberances on the surface of notogastral porose areas are present in *T. granuliala*), the large granular ornamentation situated along the hinge of the pteromorphs, the shorter interlamellar setae, larger notogastral porose areas, and six pairs of epimeral setae (five pairs in *T. granuliala*).

Habitat ecology. This species inhabits the soil and litter areas in the southern island of Japan, which is located in the Pacific Ocean. The climate of Chichijima Island is on the boundary of the tropical savanna climate zone with warm to hot and humid temperatures all year round. The sampling site is located in a well-preserved natural forest in the southeastern area of Chichijima Island.

***Trichogalumna ohkuboi* Hagino, Bayartogtokh & Shimano, 2017**

(Figs. 9, 10, Table. 2)

Diagnosis. Body length 316 μm, width of notogaster 234 μm; rostrum slightly protruding; rostral and lamellar setae fairly long, smooth; interlamellar setae short, thin; sensillus with smooth, thin stalk and lanceolate head with dense spicules; pteromorph with dense linear ornamentation in its distal half, and a smooth proximal part; anterior margin of notogaster not developed; notogaster and ventral plate with transverse granular bands; genital plate with longitudinal striations on its central part.

Etymology. I dedicate this species to acarologist Dr. Norihide Ohkubo (Mie Prefecture, Japan), who made major contributions to the knowledge of *Trichogalumna* species in Japan.

Material examined. Holotype (female, NSMT-Ac-13968), and one paratype (female, NSMT- Ac-13969) from soil and litter collected in Sueyoshi-Park, Naha, Okinawa Island, Japan, 26°23'N, 127°71'E, 54 m a.s.l., 26th July 2014, collected by W.

Hagino. All type specimens are deposited in the National Museum of Nature and Science, Tsukuba, Japan.

Description.

Measurements. Body length of holotype 316 μm, width of notogaster 234 μm (paratype not measured due to damaged body).

Integument. (Fig. 9) Body color brown to light brown. Body surface faintly microtuberculated; prodorsum laterally with longitudinal striations; distal part of pteromorph with striations, its proximal part smooth; notogaster and ventral plate with transverse granular bands; genital plate with longitudinal striations on its central part.

Prodorsum. (Figs. 9) Rostrum rounded, slightly protruding. Tutorial and lamellar ridges (lines *S* and *L*) distinct. Rostral setae (approx. 21 μm) fairly long, smooth. Lamellar setae slightly longer (approx. 25 μm), smooth. Interlamellar setae very short (6 μm) thin, smooth. Sensillus with a long, thin, smooth stalk and a lanceolate head with dense spicules. Dorsosejugal porose areas (*Ad*) oval, located posterolateral to setae *in*.

Notogaster. (Figs. 9) Anterior margin of notogaster not developed. Dorsophragmatic apophysis (*D*) medium in size, elongated longitudinally. Notogastral setae short (approx. 5 μm), thin, smooth. Notogastral porose areas *Aa*, *A1*, *A2* and *A3* almost circular in shape; *A1* and *A2* closely situated to each other; *A3* situated posterolaterally to setae *h*1. Four pairs of notogastral lyrifissures (*ia*, *im*, *ih*, and *ip*) and opisthonotal gland opening (*gla*) well developed.

Gnathosoma. Morphology of subcapitulum, palp and chelicera typical for genus, and same as those in previous species.

Epimeral region. (Fig. 9) Seven pairs of short, but distinct epimeral setae (*1a*, *1c*, *3a*, *3c*, *4a*, *4b*, *4c*) (approx. 5 μm) thin, smooth. Setal formula of epimera 2-0-2-3. Discidium broadly triangular; pedotectum II scalelike, subtriangular in ventral view.

Ano-genital region. (Fig. 9) All ano-genital setae short, thin, smooth; g_1, g_2, and g_3 inserted on the anterior margin of genital plate, g_4, g_5 arranged longitudinally, g_6 inserted on the posterior margin of genital plate; adanal setae ad_1 and ad_2 inserted

posteriorly to the anal plates; ad_3 inserted in paraanal position; lyrifissure *iad* situated laterally to the anal plate. Postanal porose area (*Ap*) elongate oval, transversely oriented.

Legs. (Fig. 10, Table. 2) Morphology of leg segments, setae and solenidia typical for *Trichogalumna*. Lateral claws serrated dorsally, but median claw smooth. 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) [1-1-0]; IV, (1-2-2-3-12) [0-1-0] homology of setae and solenidia as indicated in Table 2.

Remarks. *Trichogalumna ohkuboi* is most similar to *T. lineata* Ohkubo, 1984 in the ornamentation of pteromorphs comprising densely arranged striations, and the granular bands on notogaster and ventral plate. However, *T. ohkuboi* differs from *T. lineata* in the relatively short lamellar and interlamellar setae (distinctly longer in *T. lineata*), the smooth surface of the proximal part of the pteromorph (whichc have fine granules aligned on the hinge in *T. lineata*), the distantly located porose areas of *A1* and *A2* (which are very closely situated in *T. lineata*), the striated genital plates (which are smooth in *T. lineata*), the absence of the granular ornamentation on the humeral organ

of notogaster, the narrower granular band on the ventral plate (which is much broader in *T. lineata*), and different number of epimeral setae (all five pairs in *T. lineata*).

Habitat ecology. This species inhabits the soil and litter in forest area in the park of the Okinawa Island, southern Japan. The vegetation was dominated by *Elaeocarpus sylvestris* and *Cinnamomum tenuifolium*, and the forest floor was covered with a thin litter layer and limestone boulders.

***Trichogalumna imperfecta* Ohkubo, 1984**

pp. 304–305, fig. 7.

[Japanese name: Hayashi-Chibige-Furisodedani]

(Figs. 11 and 12, Table. 2)

Diagnosis. Body length 297 μm, width of notogaster 234 μm; rostrum weakly protruding; rostral and lamellar setae fairly long, smooth; interlamellar setae short, thin; sensillus with a thin stalk and lanceolate head, smooth or sparsely barbed; pteromorph

with granular ornamentation on its proximal part; anterior margin of notogaster not developed; notogaster and ventral plate with transverse granular bands; lateral part of prodorsum and anterior tectum of epimere I with longitudinal striations; genital plate smooth.

Material examined. Two females from soil and litter, collected at the Miroku-benzaiten Shrine, Kimino-cho, Wakayama Prefecture, Japan, 34°07'N, 135°21'E, 452 m a.s.l., 23rd December 2012, collected by Y. Yamamoto.

Description.

Measurements. Body length 297 μm, width of notogaster 234 μm (only one specimen measured).

Integument. (Fig. 11) Body color brown to light brown. Body surface nearly smooth; prodorsum laterally, anterolaterally of genital aperture and anterior tectum of epimere I with longitudinal striations; pteromorph with granular ornamentation on its inner part; notogaster and ventral plate with transverse granular bands; genital plate smooth.

Prodorsum. (Fig. 11) Rostrum broadly rounded. Tutorial and lamellar ridges (lines *S* and *L*) distinct. Rostral setae (28 μm) nearly smooth or finely barbed. Lamellar (23 μm) and interlamellar setae (8 μm) thin, smooth. Sensillus smooth, with a thin stalk and lanceolate head. Dorsosejugal porose area (*Ad*) oval, posterolateral to seta *in*.

Notogaster. (Fig. 11) Anterior margin of notogaster not developed. Dorsophragmatic apophysis (*D*) medium in size, elongated longitudinally. Notogastral setae short (7 μm), thin, smooth. Notogastral porose areas *Aa* and *A3* oval, *A1*, *A2* nearly circular in shape; *A1* and *A2* closely situated to each other; *A3* situated posterolaterally to setae *h*1. Four pairs of notogastral lyrifissures (*ia*, *im*, *ih*, and *ip*) and opisthonotal gland opening (*gla*) well developed.

Gnathosoma. (Fig. 11) Morphology of subcapitulum, palp and chelicera typical for the genus, and same as those in *T. boninensis*.

Epimeral region. (Fig. 11) Seven pairs of short, but distinct epimeral setae (*1a*, *1c*, *3a*, *3b*, *3c*, *4a*, *4c*) about 7 μm long, thin, smooth. Setal formula of epimera

2-0-3-2. Discidium broadly triangular; pedotectum II scalelike, subtriangular in ventral view.

Ano-genital region. (Fig. 11) All ano-genital setae short, thin, smooth; g_1, g_2, and g_3 inserted on the anterior margin of genital plate, g_4, g_5 arranged longitudinally, g_6 inserted on the posterior margin of genital plate; adanal setae ad_1 and ad_2 inserted posterior to the anal plates; ad_3 inserted in paraanal position; lyrifissure *iad* situated anterolateral to the anal plate. Postanal porose area (*Ap*) oval, transversely oriented.

Legs. (Fig. 12, Table. 2) Morphology of leg segments, setae and solenidia typical for *Trichogalumna*. All claws serrated dorsally. Formulas of leg setation and solenidia: I (1-4-3-4-20) [1-2-2]; II (1-4-3- 4-15) [1-2-2]; III (1-2-1-3-15) [1-2-2]; IV (1-2-2-3-12) [1-2-2]; homology of setae and solenidia as indicated in Table 2.

Remarks. The characters of the present material correspond well with those of the type specimens studied by Ohkubo (1984). The only slight differences we observed are the smooth sensillus in our material as opposed to the sparsely barbed

sensillus in the type specimens, and the relatively narrow granular band on the notogaster in our specimens rather than the fairly broad band of the type specimens.

Habitat ecology. This species inhabits the soil, litter and fallen wood in the secondary forest in the Mie and Wakayama Prefectures, Honshu Island, Japan.

***Trichogalumna lineata* Ohkubo, 1984**

pp. 298–300, fig. 4.

［Japanese name: Suji-Chibige-Furisodedani］

(Figs. 13–15, Table 2)

Diagnosis. Female body length and width: 410 (358) 321 × 308 (262) 214 μm. Interlamellar setae smooth, thin, distinctly short. Sensillus consists of a smooth, thin stalk and asymmetrically swollen head with dense spicules. Surface of notogastral porose area ornamented with dense lines. Dense granular ornamentation near ginglymus

on the outer pteromorph. Dense linear ornamentation on the distal half of the outer pteromorph. Thin granule belt present on notogaster and ventral plate.

Material examined. Holotype, females, NSMT-Ac-9435. Three paratypes, females, NSMT-Ac-9436–9438. Fourteen females, collected from soil and litter in a grassland along the Sorachi River, Takikawa City, Hokkaido, 43°33'N, 141°56'E, 35.1 m a.s.l., 18th September 2013, by W. Hagino. Four females collected from litter and soil in a deciduous broadleaved forest in Nopporo Forest Park, Ebetsu, Hokkaido, 43°01'N, 141°30'E, 65.5 m a.s.l., 14th August 2013, W. Hagino.

Description. Body length and width: 410 (358) 321 × 308 (262) 214 μm. Body color brown to light brown, body surface smooth, except for the outer side of pteromorph, granule belts of notogaster and the ventral plate.

Prodorsum. (Fig. 13) Rostrum broadly rounded, moderately protruding. Rostral trowel present. Rostral setae (approx. 26 μm, ro/ro–ro: 0.38) difficult to observe from ventral side. Lamellar setae (aprox. 36 μm, le/le–le: 0.50) smooth, inserted between ridges L. Interlamellar setae (aprox. 7 μm, in/in–in: 0.10) thin, smooth, very

short. Sensillus with a smooth, thin stalk and asymmetrically swollen, slightly spiculate head. Dorsosejugal porose area (*Ad*) oval in shape, located posterior to setae *in*.

Notogaster. (Figs. 13 and 15) Dorsosejugal suture absent. Dorsophragmatic apophysis (*hy*) near the anterior notogastral margin. Ten pairs of notogastral setae; setae approx. 6 μm. Notogaster with four pairs of porose areas; *Aa* slightly transversely elongate; *A1* and *A2* circular, situated close to each other; *A3* posterior to setae *r1*. Four pairs of notogastral lyrifissures (*ia*, *im*, *ih*, and *ip*); *ip* posterior to porose area *A3*. Opitsthonotal gland opening (*gla*) posterior to lyrifissure *im*. Notogastral surface smooth, except for the outer surface of pteromorph and the granule belt. Dense granular ornamentation near the ginglymus on the outer pteromorph. Distal part of the outer pteromorph ornamented with densely arranged lines. Granule belt on notogaster, with individual granules sparse and inconspicuous.

Ventral side. (Fig. 14) Six pairs of thin, short, smooth, genital setae; g_1, g_2, and g_3 inserted on the anterior margins of the genital plate; g_4, g_5, and g_6 arranged longitudinally. A pair of aggenital setae inserted posteriorly to genital plates. Two pairs of thin, short, smooth, anal setae arranged longitudinally. Three pairs of adanal setae;

*ad*1 and *ad*2 inserted posteriorly to anal plates, *ad*3 situated laterally to anal plates. Adanal lyrifissures *iad* located near the lateral ridge of anal plates. Epimeral setae *1b*, *3a*, *3b*, *4a*, and *4b* present; setal formula 1–0–2–2. Surface of anal plates smooth. Granule belt present; granules sparsely scattered, inconspicuous. Posterior porose area (*Ap*) oval, near posterior margin of anal plate. Two types of mentum plates; one with smooth surface, another having surface ornamented with large granules.

Legs. All legs heterotridactylous. Solenidia *ω1* and *ω2* on tarsus I subequal in length and thickness. Solenidion *φ1* on tibia II 1.5 times as long as solenidion *φ2* on tibia I. Solenidion *φ2* on tibia I longest among all legs. Solenidion *σ* on genu I curved posteriorly. Leg setation (Tr–Fe–Ge–Ti–Ta) excluding solenidia: Leg I, (1–4–3–4–17); 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).

Remarks. While the mentum plate in the holotype has a smooth surface (Ohkubo 1984), that in five of the 19 specimens collected in Takikawa and Nopporo were ornamented with large granules. This character state has not been previously reported for this species.

Genus *Cosmogalumna* Aoki, 1983

***Cosmogalumna centroclathrata* Hagino and Shimano, 2017**

[Japanese name: Harakazari-furisodedani]

(Figs. 16–21, Table. 2)

Diagnosis. Body length and width: 339 – 356 × 252 – 299 μm. Sexual dimorphism not observed. Sensillus with a long stalk and short, distally rounded 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, the remaining part minutely foveolated throughout. Notogastral porose areas with densely spotted surface. Medial pore (*mp*) on notogaster present. Surface of pteromorph ornamented centrally with conspicuous granules. Genital plates with conspicuous linear sculpture centrally.

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

Material examined. 12 specimens (two males, six females and four not sexed specimens) collected from mosses growing in rocks near a 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., 20th November 2014, by W. Hagino.

Type deposition. Holotype (NSMT–Ac 14208, female) on slide: collected on mosses growth on the rocks by a stream in a *Cryptomeria* forest, Misatocho, Tsu city, Mie Prefecture, 34°45’49.8”N, 136°21’11.1”E, a.s.l., 419.4 m, 20 November 2014, collected 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 the holotype, are kept in the collections of W. Hagino.

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

Integument. (Figs. 16–18, 20–21) Body color brown to dark brown. Body surface minutely punctate. Prodorsum with faint longitudinal striations along its lateral margins. Surface of pteromorph centrally ornamented with a conspicuous granules centrally. Middle parts of notogaster and ventral plate ornamented with a polygonal network. Surface of all porose areas densely spotted. Surface of mentum plate smooth. Genital plate centrally ornamented with conspicuous linear structure.

Prodorsum. (Figs. 16, 18, 21) Rostrum broadly rounded. Lamellar (*L*) and sublamellar (*S*) lines distinct, parallell, curving backwards. Rostral setae (*ro*) (approx. 29 μm) thin, 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 a long stalk and short, distally rounded head, covered with minute spicules. Exobothridial setae not observed. Dorsosejugal porose areas (*Ad*) oval, posterior to setae *in*. Dorsophragmata (*hy*) near the anterior notogastral margin.

Notogaster. (Figs. 16, 18, 20 and 21) Dorsosejugal suture well developed. Ten pairs of minute (approx. 3 μm) notogastral setae present, hard to observe under an optical microscope. Four pairs of circular porose areas present: *Aa* (diameter 14–16 μm) largest, *A2* (diameter 8 – 10 μm) smallest, *A1* and *A3* (diameter 11–12 μm) approximately of same size. Four pairs of lyrifissures (*ia*, *im*, *ih*, and *ip*) present; *im* anterior to setae *lp*, surrounded by a polygonal network structure. A pair of opisthonotal gland openings (*gla*) anterior to *A2*. 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 a long stalk and short, distally rounded head, covered with minute spicules. Exobothridial setae not observed. Dorsosejugal porose areas (*Ad*) oval, posterior to setae *in*. Dorsophragmata (*hy*) near the anterior notogastral margin.

Gnathosoma. (Fig. 18) Morphology of subcapitulum, palps and chelicera typical for subgenus (see Ermilov and Corpuz-Raros 2015). Setation of palp and chelicera typical for the genus.

Ventral side. (Figs. 17, 20, 21) 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. One pair of minute aggenital setae (approx. 3 μm) posterior to genital plates. Two pairs of thin, smooth anal setae (approx. 5 μm) arranged longitudinally. 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 (*Ap*) large (8 μm wide), oval, posterior to anal plate.

Legs. (Fig. 19, Table. 2) 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).

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

Remarks. Among the 11 species of *Cosmogalumna*, *Cosmogalumna centroclathrata* most closely resembles *C. praeoccupata* Subías, 2004 (=*Cosmogalumna imperfecta* Aoki and Hu, 1993) from Yunnan Province, China in 1) long sensillus with a distally rounded 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, *Cosmogalumna centroclathrata* differs from *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*) and extending transversely until the mid-distance between notogastral setae *la* and *gla* at both side of notogaster. In *C. praeoccupata* Subías, 2004, this sculpture forms it has a form of straight band terminating on each side with a large cloud-like expansion, entended longitudinally between notogastral setae *lm* and nearby *gla*, and extending transversely beyond the mid-distance between notogastral setae *la* and *gla*, 3) conspicuous linear sculpture on the genital plates.

***Cosmogalumna kirishimaensis* Hagino and Shimano, 2017**

[Japanese name: Kirishima kazari-furisodedani]

(Figs. 22–28)

Diagnosis. Body length and width: 333 – 368 × 268 – 286 μm. Sensillus with a long stalk and short, distally rounded head with minute spicules. Lamellar line bifurcated just above the lamellar seta. Lamellar seta inserted between lamellar lines. Middle part of notogaster and ventral plate ornamented with a distinctive pattern, suggestive of a neural network. Notogastral porose area *Aa* slightly depressed, containing several conspicuous nodules, *A1*, *A2* and *A3* slightly depressed, containing a single conspicuous nodule. Medial pore *mp* on notogaster present in male and female represented by one pore. Surface of pteromorph ornamented with conspicuous granules except in its marginal section. Genital plate with conspicuous linear sculpture in central part. Adanal lyrifissure *iad* situated anteromedially to adanal setae *ad*3.

Material examined. Fifteen specimens (three males, 10 females, and two of unknown sex) were collected from soil and litter in a *Cryptomeria* forest, Kirishima

City, Kagoshima Prefecture, 31°42’34.6” N, 130° 48’ 45.4” E, 260 m a.s.l., 27th September 2015, by W. Hagino and S. F. Hiruta.

Etymology. The specific name ‘*kirishimaensis’* refers to the site of origin, Kirishima City, Japan.

Description.

Measurements. Body length and width: 333–368 × 268–286 μm (n = 12).

Integument. (Figs. 22, 23, 24, 26 and 27) Body color brown to dark brown. Body surface microfoveolate. Prodorsum with faint longitudinal striations along its dorsolateral margins. Middle part of notogaster ornamented with distinctive pattern, suggestive of a neural network. Surface of pteromorph fully ornamented with conspicuous granules except in its basal part. Area between the genital plates and anal plates ornamented with densely, distinctive pattern, suggestive of a neural network. Genital plate with conspicuous linear structure in central part.

Prodorsum. (Figs. 22, 24 and 27) Rostrum rounded. Lamellar (*L*) and sublamellar (*S*) lines distinct, parallel, curving backwards. Lamellar line bifurcated in

the part upper to above lamellar seta, forming lateral (*Ll*) and medial (*Lm*) lines. Lateral structure (*N*) well seen, connected with basal parts of *S* line. Rostral seta (*ro*) (approx. 22 μm) smooth, setiform. Lamellar seta (*le*) (approx. 20 μm) smooth, setiform, inserted slightly anteriorly from line *L*. Interlamellar seta (*in*) minute (approx. 2 μm), thin, smooth, setiform, hardly visible. Sensillus (*ss*) with a long stalk and short, distally rounded head, sparsely covered with minute barbs. Exobothridial seta and alveoli absent. Dorsosejugal porose area (*Ad*) oval, located lateroposteriorly to setae *in*.

Notogaster. (Figs 22, 24, 27 and 28) Anterior notogastral margin well developed. Dorsophragmata (*D*) near anterior notogastral margin. Ten pairs of minute (approx. 2 μm) notogastral setae present, hardly visible. Four pairs of circular porose areas present: *Aa* (diameter 12 μm), *A1*, *A2*, and *A3* (diameter 9 μm). Surface of porose area *Aa* slighly depressed, containing conspicuous nodules of unknown origin: *Aa* with several nodules, *A1*, *A2* and *A3* with one central nodule each. Medial pore present in male and female, located between porose areas *A2*, represented by one circular pore (approx. 3 μm). Four pairs of lyrifissures (*ia*, *im*, *ih*, *ip*, and *ips*) present; *im* anterior to setae *lp*, surrounded by a distinctive pattern suggestive of a neural network, *ip* between

setae p_1 and p_2, *ih* and *ips* close to each other, posterior to p_3. A pair of opitsthonotal gland openings (*gla*) located anterior to *A2*.

Gnathosoma. (Fig. 24) Subcapitulum size: 69–75 × 70–73 μm. Three pairs of subcapitular setae setiform, smooth; *a* (approx. 17 μm) longer and thicker than *h* (approx. 14), *m* shortest (approx. 7 μm) and thinnest. Length of palp: 74–88 μm. Axillary saccule (*sac*) distinct. Length of chelicera: 105–108 μm. Two cheliceral setae setiform, barbed; *cha* (approx. 31 μm) longer than *chb* (approx. 26 μm). Trägårdh's organ (*Tg*) long, triangularly elongated.

Epimeral region. (Fig. 23) Pedotectum I (Pd I) broadly rounded, pedotectum II (Pd II) elongated with round tip. Discidium (*dis*) sharply triangular. Circumpedal carina (*cp*) thin, interrupted posteriorly to *3a*. Setal formula of epimera: 1–0–1–1.

Anogenital region. (Figs. 23 and 28) Six pairs of thin, short, smooth genital setae; g_1, g_2, and g_3 (approx. 6 μm) inserted on anterior margin of genital plate; g_4, g_5, and g_6 (approx. 3 μm) shorter than the previous ones, arranged longitudinally. A pair of aggenital setae *ag* (approx. 3 μm) in the posterior region of genital plates. Two pairs of

anal setae an_1 and an_2 (approx. 5 μm) thin, smooth. Three pairs of adanal setae; ad_1 and ad_2 (approx. 4 μm) short, posterior to anal plates, ad_3 (approx. 4 μm) short, situated on paraanal position, posterior to *iad*. Adanal lyri ssure *iad* situated anteromedially to adanal setae ad_3. Posterior porose area (*Ap*) single, large (approx. 6 × 17 μm), oval, posterior to anal plate.

Legs. (Figs. 24, 25; Table 2) All legs tridactylous, median claw distinctly thicker than laterals, all claws smooth. Morphology of leg segments, setae and solenidia generally typical for species of the subgenus *Cosmogalumna* and the other members of Galumnidae (Engelbrecht 1972, Ermilov and Anichkin 2013). Porose area on all femora and on trochanters III, IV slightly visible. 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). Homology of setae and solenidia indicated in Table 1. Solenidion of tibiae IV inserted in the anterior part of segment. Famulus inserted anteriorly to solenidion ω_1.

Remarks. Among the 12 species of the subgenus *Cosmogalumna*, there is one new species described by Hagino & Shimano (2017). *Cosmogalumna*

kirishimaensis n. sp. most closely resembles *Cosmogalumna praeoccupata* Subías, 2004 (= *Cosmogalumna imperfecta* Aoki & Hu, 1993) from China, and *Cosmogalumna areticulata* Ermilov, Sandmann, Klarner, Widyastuti & Scheu, 2015 from Indonesia similarities are 1) shape of sensilli, 2) presence of medial pore, and 3) middle part of notogaster and ventral plate ornamented with integumental patterns. However, *Cosmogalumna kirishimaensis* differs from *C. praeoccupata* and *C. areticulata* in 1) bifurcate lamellar lines, 2) distinctive pattern, suggestive of a neural network on the middle part of the notogaster and the ventral plate, 3) presence of several nodules (*Aa*) or a single central nodule (*A1, A2* and *A3*) on the surface of the porose areas, 4) conspicuous granular ornamentation on the surface of the pteromorphs except in its basal part, 5) conspicuous linear structure on the middle part of the genital plates, 6) adanal lyrifissure *iad* anteriorly to adanal setae *ad*3.

***Cosmogalumna ornata* Aoki, 1988**

pp. 31–32, figs. 1–3.

[Japanese name: Kazari-furisodedani]

(Figs. 29–32)

Material examined. Five males and five females collected from soil and litter in an evergreen forest, Nakanoshima Island, Toshima Village, Kagoshima Prefecture, 29°50’03.5”N, 129°54’01.6”E, 67 m a.s.l., 30th September 2015, by S. Shimano. More than 50 specimens collected from soil and litter in an evergreen forest, Takarajima Island, Toshima Village, Kagoshima Prefecture, 29°9’13.5”N, 129°11’53.7”E, 25 m a.s.l., 28th September 2015, by W. Hagino. Two specimens collected from soil and litter in an evergreen forest, Mt. Nishime, Okinawajima Island, Okinawa Prefecture, 26°48’14.1”N, 128°15’37.5”E, 302 m a.s.l., 19th April 2006, by S. Shimano.

Description.

Measurements. Body length and width: 320 (336) 348 × 259 (266) 285 μm (n = 10).

Integument. (Figs. 29–32) Body color brown to dark brown. Body surface fully minutely foveolated. Prodorsum with dense granules and striations; especially

central part with especially large granules, faint longitudinal striations along its lateral margins. Surface of pteromorph fully ornamented with conspicuous granules, and finer granules in anterior part. Notogaster fully ornamented with polygonal network. Surface of all porose areas ornamented with multiple conspicuous granules (approx. 3 μm) (see Aoki (1988), Fig. 3). Anterior margin of ventral plate granulated, posterior to genital aperture ornamented with polygonal network except for the 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. 29 and 31) Rostrum broadly rounded. Lamellar and sublamellar lines distinct, parallel, curving backwards. Rostral setae (approx. 26μm) thin, slightly barbed, hard to observe from dorsal side. Lamellar setae (approx. 15 μm) thin, slightyly barbed, inserted just anterior to line L. Interlamellar setae minute (approx. 2 μm) thin, smooth, hard to discern. Sensillus with a long stalk and short, distally rounded head, covered by minute spicules. Exobothridial setae not observed.

Dorsosejugal porose areas oval, posterior to seta *in*. Dorsophragmata near the anterior notogastral margin.

Notogaster. (Figs. 29, 31 and 32) Dorsosejugal suture well developed. Ten pairs of minute (approx. 3 μm) notogastral setae present, hard to observe under an optical microscope. Four pairs of circular porose areas present: *Aa* (diameter 12 – 13 μm) largest, *A2* (diameter 5 – 6 μm) smallest, *A1* and *A3* (diameter 10 – 11 μm) almost of the same size. Four pairs of lyrifissures (*ia*, *im*, *ih*, and *ip*) present. Opisthonotal gland openings anterior to *A2*.

Gnathosoma. (Fig. 31) 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. (Figs. 30–32) 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. One 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 the lateral side of anal aperture. Adanal lyrifissures *iad* along the 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. 2) 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).

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).

General Discussion

In this study, I collected more than 1,200 oribatid individuals from 14 sites across Japan. Material was identified and eight species (of which five were described as new during my Ph.D. course) in three genera belonging to two families were found. They are: *Neoribates incisus* Hagino, Shimano, and Aoki, 2016 (Parakalummidae); *Trichogalumna boninensis* Hagino, Bayartogtokh and Shimano, 2017 (Galumnidae); *Trichogalumna ohkuboi* Hagino, Bayartogtokh and Shimano, 2017 (Galumnidae); *Trichogalumna imperfecta* Ohkubo, 1984 (Galumnidae); *Trichogalumna lineata* Ohkubo, 1984 (Galumnidae); *Cosmogalumna centroclathrata* Hagino and Shimano, 2017 (Galumnidae); *Cosmogalumna kirishimaensis* Hagino and Shimano, 2017 (Galumnidae); and *Cosmogalumna ornata* Aoki, 1988 (Galumnidae).

Previous to this study, Japanese species of *Cosmogalumna* were reported only from the Nansei Islands (Nakamura and Fujikawa, 2004; Aoki, 2009). As a result of this faunal investigation, I described two new species, *C. kirishimaensis* from Kyushu and *C. centroclathrata* from Honshu (Mie Prefecture), thus expandhing northward the known distribution range of the genus. Indeed, the record of the latter species represents the

northern-most representative of this genus. Still, *Cosmogalumna* appears to be 'endemic' in terms of its geographic distribution, because I was unable to find any specimens in either northerner of Mie Prefecture (Honshu Island), nor in Hokkaido. Therefore, the distribution range of *Cosmogalumuna* is evidently narrower than that of *Neoribates* and *Trichogalumna*. In general, the extent of a genus-level geographic distribution range is proportional to the antiquity of its divergence time, if the following three assumptions are met: 1) the genus is monophyletic, 2) its distribution is not limited by environments, and 3) there is no difference in distribution-expansion potential between species. Given these assumptions, the most recent common ancestor of *Cosmogalumna* must have appeared later than those of *Neoribates* and *Trichogalumna*. Future studies employing molecular phylogenetic analyses and divergence-time estimation could help test this hypothesis.

Acknowledgements

I thank my supervisor Dr. Hiroshi Kajihara for his help and guidance; Prof. Satoshi Shimano, Hosei University, for introducing me to oribatid taxonomy and for his support in many ways; Dr Hirotsugu Ono, National Museum of Nature and Science, Tokyo, for loaning of specimens; and my colleagues in the laboratory for providing technical advice and sharing their precious time. Last but not the least, I thank my family and my friends for supporting me spiritually throughout my life.

References

Aoki, J. (1961) On six new oribatid mites from Japan. Sanitary Zoology, 12: 233–238.

Aoki, J. (1966) The large-winged mites of Japan (Acari: Cryptostigmata). Bulletin of the National Science Museum, 9(3): 257–275.

Aoki, J. (1988) Oribatid mites (Acari: Oribatida) from the Tokara Islands, Southern Japan–II. Bulletin of the Biogeographical Society of Japan, 43(6): 31–33.

Aoki, J. (2009) Oribatid Mites of the Ryukyu Islands. (in Japanese) 222 p., Tokai University Press. Kanagawa.

Aoki, J. and S. Hu (1993) Oribatid mites from tropical forests of Yunnan Province in China. II. Families Galumnidae and Galumnellidae. Zoological Science, 10: 835–848.

Balogh, J. (1958) Oribatides nouvelles de l'Afrique tropicale. Revue de Zoologie et Botanique Africaines, 58(1–2): 1–34.

Balogh, J. (1960a) Oribates (Acari) nouveaux d'Angola et du Congo Belge (2ème série). Companhia de Diamantes de Angola, Lisboa, 51: 14–40.

Balogh, J. (1960b) Oribates (Acari) nouveaux de Madagascar (1ère serie). Mémoires de L'Institut Scientifique Madagascar, Série A, 14: 7–37.

Balogh, J. (1962) Mission zoologique de 1'I.R.S.A.C. en Afrique orientale In: Basilewsky, P. & Leleup, N. (eds.) Acari Oribates. LXXV. Annales of the Royal Museum for Central Africa, pp. 90–131.

Balogh, J. (1970) New Oribatids (Acari) from Ceylon. The scientific results of the Hungarian Soil Zoological expeditions. Opuscula Zoologica, Budapest, 10: 33–67.

Balogh, J. and P. Balogh (1990) Identification key to the genera of the Galumnidae Jacot, 1925 (Acari: oribatei). Acta Zoologica Hungarica, 36: 1–23.

Balogh, J. and P. Balogh (1992) The Oribatid Mites Genera of the World. Vol. 1. 263 p., Hungarian National Museum Press, Budapest.

Balogh, J. and P. Balogh (2002) Identification Keys to the Oribatid Mites of the Extra-Holarctic Regions. Vol. 1. 453 p., Well Press Publishing Limited, Miskolc.

Balogh, J. and S. Mahunka (1967) New Oribatids (Acari) From Vietnam. Acta Zoologica Academiae Scientiarum Hungaricae, 13: 39–74.

Berlese, A. (1915) Acari nuovi. Manipulus IX. Redia, 10: 113–150.

Block, W. (1980) Survival strategies in polar terrestrial arthropods. Biological Journal of the Linnaean Society, 14: 29–38.

Brockner, A., Wehner, K., Neis, M., and M. Heethoff (2016) Attack and defense in a gamasid-oribatid mite predator-prey experiment sclerotization outperforms chemical repellency. Acarologia, 56(4): 451–461.

Denegri, G. M. (1993) Review of oribatid mites as intermediate hosts of tapeworms of the Anoplocephalidae Experimental and Applied Acarology, 17: 567–580.

Engelbrecht, C. M. (1972) Galumnids from South Africa (Galumnidae, Oribatei). Acarologia, 14(1): 109–140.

Engelbrecht, C. M. (1973) South African Galumnoidea (Oribatei: Acari): new taxa and records. Navorsinge Nasionale Museum, Bloemfontein, 2: 394–415.

Ermilov, S. G. and A. E. Anichkin (2013) Checklist of oribatid mites (Acari: Oribatida) from two forest plantations of Southern Vietnam, including new records and description of a new species of the genus *Suctobelbata* (Suctobelbidae). Systematic and Applied Acarology, 18: 225–232.

Ermilov, S. G. and L. Corpuz-Raros (2015) New species of oribatid mites with auriculate pteromorphs (Acari, Oribatida, Galumnidae) from the Philippines. Zootaxa, 3905(4): 311–528.

Ermilov, S. G. and L. Corpuz-Raros (2016) New species and records of Galumnidae (Acari, Oribatida) from the Philippines. Zootaxa, 4171: 77–100.

Ermilov, S. G. and S. Friedrich (2016) New species and records of *Galumna* (Acari, Oribatida, Galumnidae) from Peru. Acarologia, 56(2): 183–193.

Ermilov, S. G. and S. Kalúz (2013) Two new species of *Neoribates* (*Neoribates*) (Acari, Oribatida, Parakalummidae) from India. International Journal of Acarology, 39: 408–413.

Ermilov, S. G. and J. Martens (2014) Three new species of the subgenus *Neoribates* (*Neoribates*) (Acari, Oribatida, Parakalummidae) from Nepal. Zookeys, 431: 19–32.

Ermilov, S. G., Sandmann, D., Klarner, B., Widyastuti, R. and S. Scheu (2015) Contributions to the knowledge of oribatid mites (Acari, Oribatida) of Indonesia. 3. The genus *Galumna* (Galumnidae) with description of a new subgenus and seven new species. Zookeys, 539: 11–51.

Ermilov, S.G. and A. V. Tolstikov (2015) Additions to the galumnid oribatid mite fauna of Brazil, with description of two new species of *Trichogalumna* (Acari, Oribatida, Galumnidae). International Journal of Acarology, 41: 170–180.

Ermilov S. G., Vu, Q. M. and H. T. Nguyen (2011) *Galumna* (*Cosmogalumna*) *tenensis*, a new species of oribatid mite from northwestern Vietnam (Acari; Oribatida: Galumnidae). International Journal of Acarology, 37: 53–60.

Grandjean, F. (1936) Les Oribates de Jean Frédéric Hermann et de son père (Arachn. Acar.). Annales de la Société Entomologique de France, 105: 27–110.

Hammer, M. (1971) On some Oribatids from Viti Levu, the Fiji Islands. Biologiske Skrifter Kongelige Danske Videnskabernes Selskab, 10: 1–94.

Hammer, M. (1977) Investigations on the oribatid fauna of North-West Pakistan. Biologiske Skrifter Kongelige Danske Videnskabernes Selskab, 21: 1–104.

Hagino, W., Satoshi, S. and J. Aoki (2016) A new species of genus *Neoribates* (Oribatida: Parakalummidae) from Okinawa Island. Edaphologia, 99: 25–29.

Hagino, W., Bayartogtokh, B., Shimano, S., and S. F. Hiruta (2017) Three species of the genus *Trichogalumna* (Acari: Oribatida: Galumnidae) from Japan. Systematic and Applied Acarology, 22(6): 858–873.

Hagino, W. and S. Shimano (2017) One new species of the subgenus *Cosmogalumna* (Acari: Oribatida:Galumnidae: *Galumna*) from Japan with supplementary description of *Galumna* (*Cosmogalumna*) *ornata* Aoki, 1988. Acarologia, 57(4): 765–777.

Hagino, W., Shimano, S. and S. F. Hiruta (2017) A new species of the subgenus *Cosmogalumna* (Acari: Oribatida: Galumnidae: *Galumna*) from Japan. Soil Organisms, 89(2): 111–118.

Harada, H (1980) Investigation on Oribatid Mite Fauna of Mt. Karakunidake in Kirishima Mountains. Bulletin of the Institute of Environmental Science and Technology, Yokohama National University, 6(1): 127–136. (In Japanese, with English summary.)

Heyden, C. (1826) Versuch einer Systematischen Eintheilung der Acariden. Isis, Oken 1: 607–613.

Hunt, H. W. and D. H. Wall (2002) Modelling the effects of loss of soil biodiversity on ecosystem function. Global Change Biology, 8: 33–50.

Jacot, A. P. (1925) Phylogeny in the Oribatoidea. American Naturalist, 59: 272–279.

Kubota, N. (1987) Himejima (Fukuokaken) ni okeru sasaradani rui no gunshuu kouzou. Seibutsu Fukuoka 27: 9–16. [In Japanese]

Lindquist, E. E., Krantz, G. W. and D. E. Walter (2009) Classification. Chapter eight. In: Krantz, G.W. & D. E. Walter (eds): A Manual of Acarology. Texas Tech University Press, Lubbock: 97–103.

Mahunka, S. (1987) A survey of the Oribatid (Acari) fauna of Vietnam, I. Annales Historico-naturales Musei Nationalis Hungarici, 79: 259–279.

Nakamura, K., Nakamura, Y. and T. Fujikawa (2013) Oribatid mites (Acari, Oribatida) from Tohoku (Northeast Japan), collected after a tidal wave in 2011. Acarologia, 53, 41–76.

Norton, R. A. (1977) A review of F. Grandjean's system of leg chaetotaxy in the Oribatei (Acari) and its application to the family Damaeidae. In: Dindal, D. L. (eds): Biology of oribatid mites. SUNY College of Environmental Science and Forestry, Syracuse: 33–61.

Norton, R. A. and V. M. Behan-Pelletier (2009) Suborder Oribatida. Chapter 15. In: Krantz, G.W. & D. E. Walter (eds): A Manual of Acarology. Texas Tech University Press, Lubbock: 430–564.

Ohkubo, N. (1984) Several species of *Trichogalumna* (Acarina, Oribatida) from Japan. Acarologia, 25, 293–306.

Ohkubo, N., Shimano, S and J. Aoki (2015) Suborder Oribatida. In: Pictorial Keys to

Soil Animals of Japan (The 2nd Edition).

Sellnick, M. (1937) Eine neue Milbe aus Ostafrika. Zoologischer Anzeiger, 117: 130–132.

Subías, L. S. (2004) Listado sistemático, sinonímico y biogeográfico de los ácaros oribátidos (Acariformes: Oribatida) del mundo (excepto fósiles). Graellsia, 60 (número extraordinario): 3–305.

Subías, L. S. (2008) Listado sistemático, sinonímico y biogeográfico de los Ácaros Oribátidos (Acariformes: Oribatida) del mundo (excepto fósiles). Online at http://escalera.bio.ucm.es/usuarios/bba/cont/docs/ RO_1.pdf (Accessed in 7th May 2008)

Subías, L. S. (2017) Listado sistemático, sinonímico y biogeográfico de los Ácaros Oribátidos (Acariformes: Oribatida) del mundo (excepto fósiles). Online at http:// escalera.bio.ucm.es/usuarios/bba/cont/docs/RO_1.pdf (Accessed in 25th February, 2017)

Subías, L. S., Shtanchaeva, U. Y. and A. Arillo (2017) Listado de los ácaros oribátidos (Acariformes, Oribatida) de las diferentes regiones biogeográficas del mundo. Monografías electrónicas S.E.A., No 4. Online at http://sea-entomologia.org/Publicaciones/MonografiaElectronica4/ACARI_ORIBATIDA_MESEA4.pdf (accessed in 25th February 2017)

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

Villagomez, F. and J. G. Palacios–Vargas (2013) A new species of *Trichogalumna* (Acari: Oribatida: Galumnidae) from Mexico. Brenesia, 79: 71–280.

Wallwork, J. A. (1965) Some Oribatei (Acari: Cryptostigmata) from Tchad (2nd. series). Revue de Zoologie et de Botanique Africaines, 72: 83–108.

Schatz, H. (1985) The life cycle of an alpine oribatid mite, *Oromurcia sudetica* Willmann. Acarologia 26 (1): 95–100.

Schatsz, H. (2005) Diversity and global distribution of oribatid mites – evaluation of the present state of knowledge. In: Weigmann *et al.* (2005): 485–500.

Schatz, H., Behan-Pelletier V. M., O'Connor, B. M., and R. A. Norton (2011) Suborder Oribatida van der Hammen, 1968. In: Zhang, Z. Q. (Eds). Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness. Zootaxa, pp. 141–148.

Schneider, K. and M. Maraun (2009) Top-down control of soil microarthropods – Evidence from a laboratory experiment. Soil Biology and Biochemistry, 41: 170–175.

Shimano, S. (2004) Oribatid mites (Acari: Oribatida) as an intermediate host of Anoplocephalid cestodes in Japan. Applied Entomological Zoology, 39(1): 1–6.

Wehner, K., Norton, R. A., Blüthgen, N. and M. Heethoff (2016) Specialization of oribatid mites to forest microhabitats – the enigmatic role of litter. Ecosphere, 7(3): e01336.

Tables

Table 1. Leg setation of adult *Neoribates incisus*, Roman letters refer to normal setae (*ε* 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	*v*′	*d*, (*l*), *bv*″, *v*″	(*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*″, *v*″	(*l*), *v*′, *σ*	(*l*), (*v*), *φ*	(*ft*), (*tc*), (*it*), (*p*), (*u*), (*a*), *s*, (*pv*), ω_1, ω_2
III	*l*′, *v*′	*d*, *l*′, *ev*′	*l*′, *v*′, *σ*	*l*′, (*v*), *φ*	(*ft*), (*tc*), (*it*), (*p*), (*u*), (*a*), *s*, (*pv*)
IV	*v*′	*d*, *ev*′	*d*, *l*′	*d*, *l*′, (*v*)	*ft*″, (*tc*), (*p*), (*u*), (*a*), *s*, (*pv*)

Table. 2. Leg setation of adult *Trichogalumna boninensis***.** (same data for *Trichogalumna ohkuboi, Trichogalumna imperfecta, Trichogalumna lineata ,Csomogalumna centroclathrata, Cosmotalumna kirishimaensis,* and *Cosmogalumna ornata*), Roman letters refer to normal setae (ε 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	*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*)

Figures

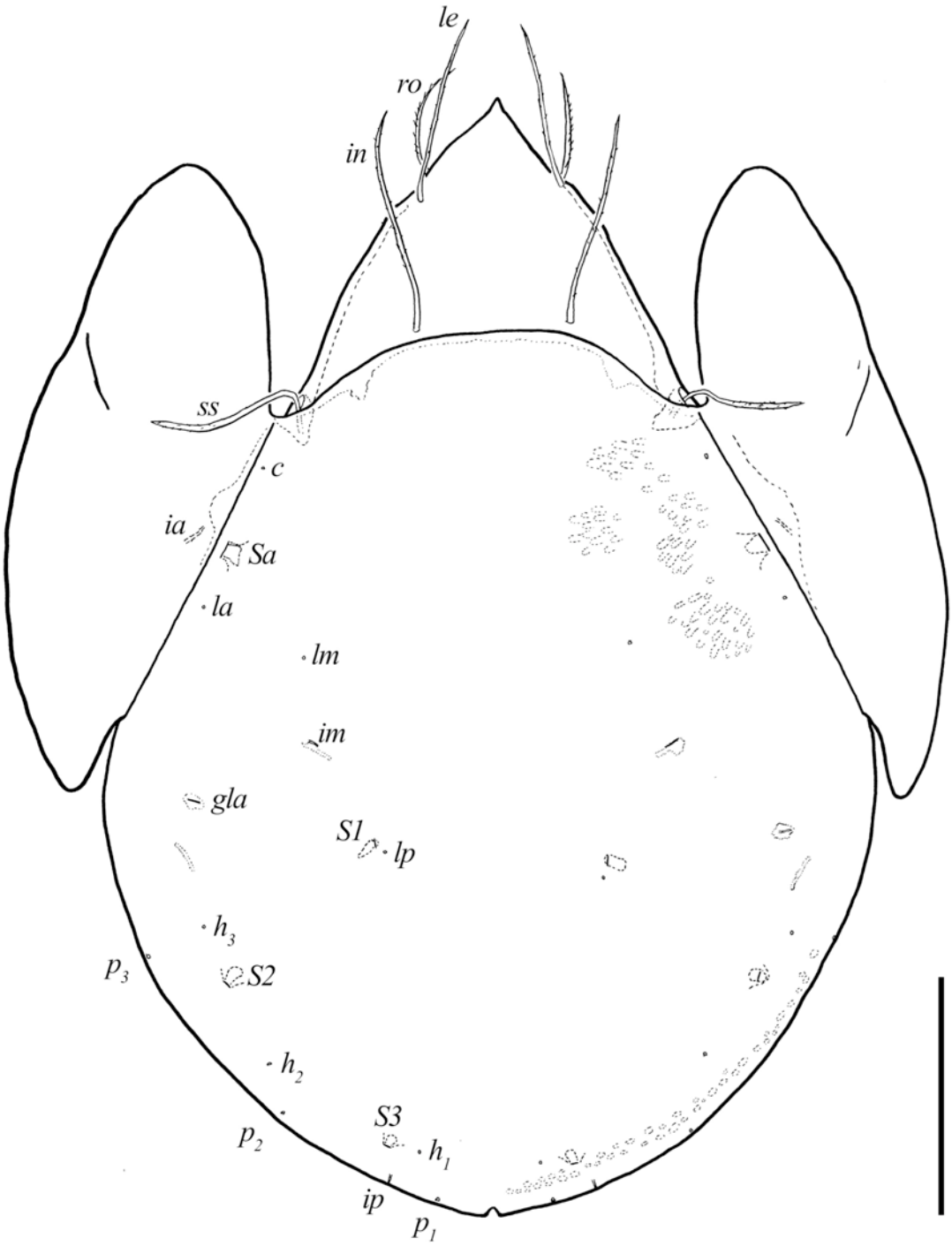


Figure 1. Adult *Neoribates incisus*, holotype, dorsal view. Scale bar: 200 μm.

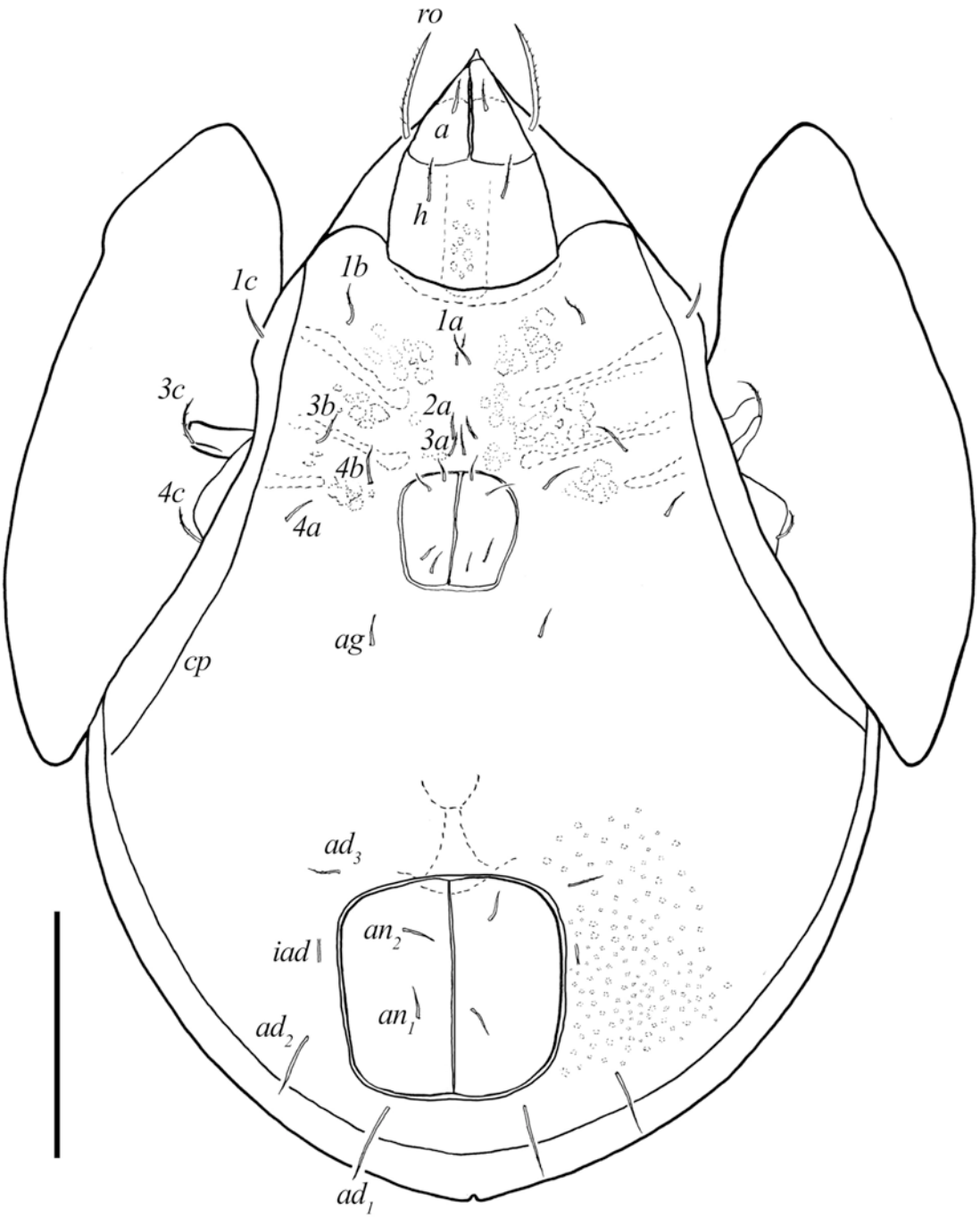


Figure 2. Adult *Neoribates incisus*, holotype, ventral view. Scale bar: 200 μm.

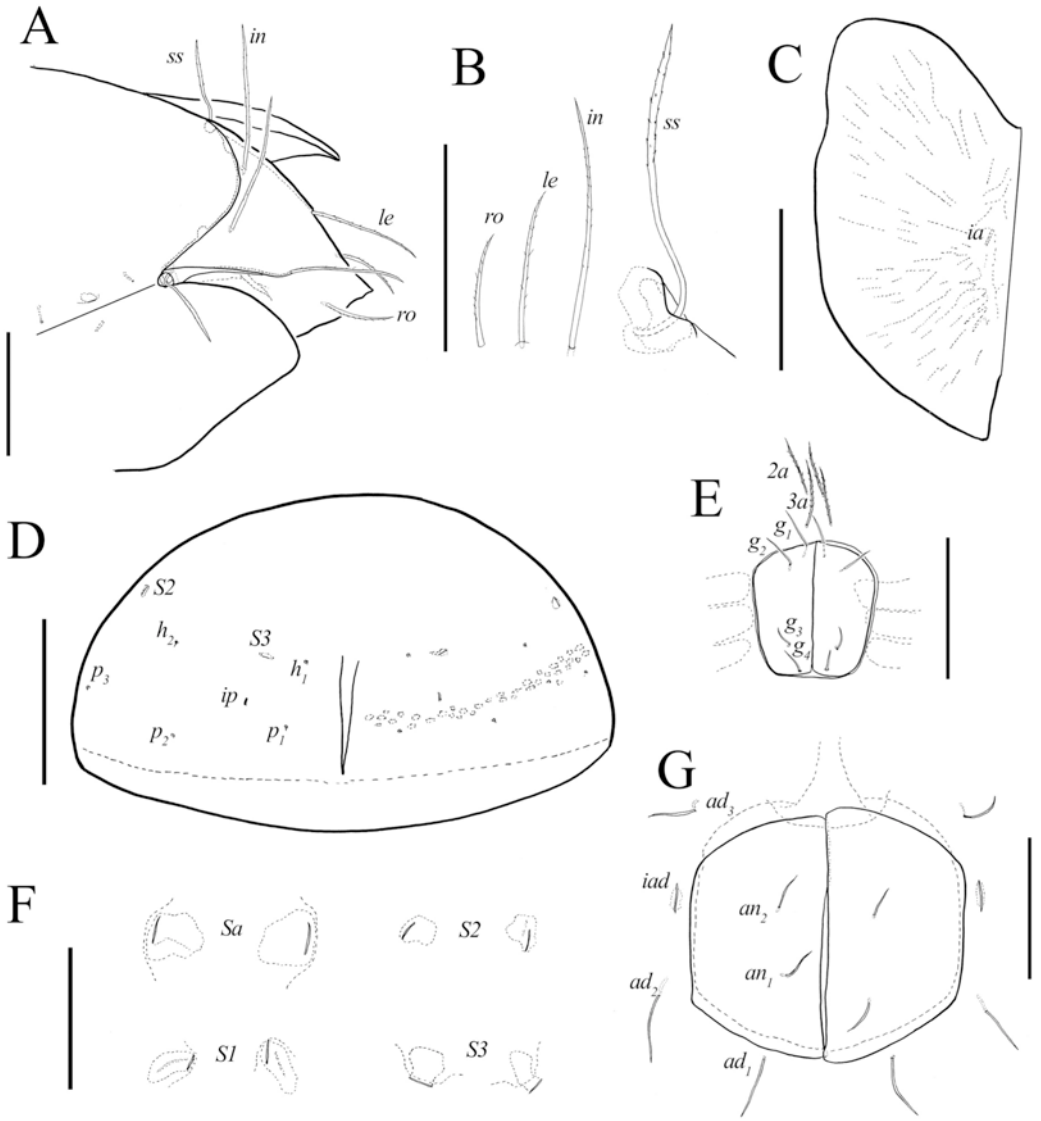


Figure 3. Adult *Neoribates incisus*, paratype (NSMT-Ac 13971, female). A–prodorsum, lateral view, B–setae on prodorsum, C–pteromorph, D–notogaster, posterior view, E–genital plates, F–notogastral sacculi, G–anal plates. Scale bar: 200 μm for Figs. A, C, D; 100 μm for Figs. B, E, G: 50 μm for Fig. F.

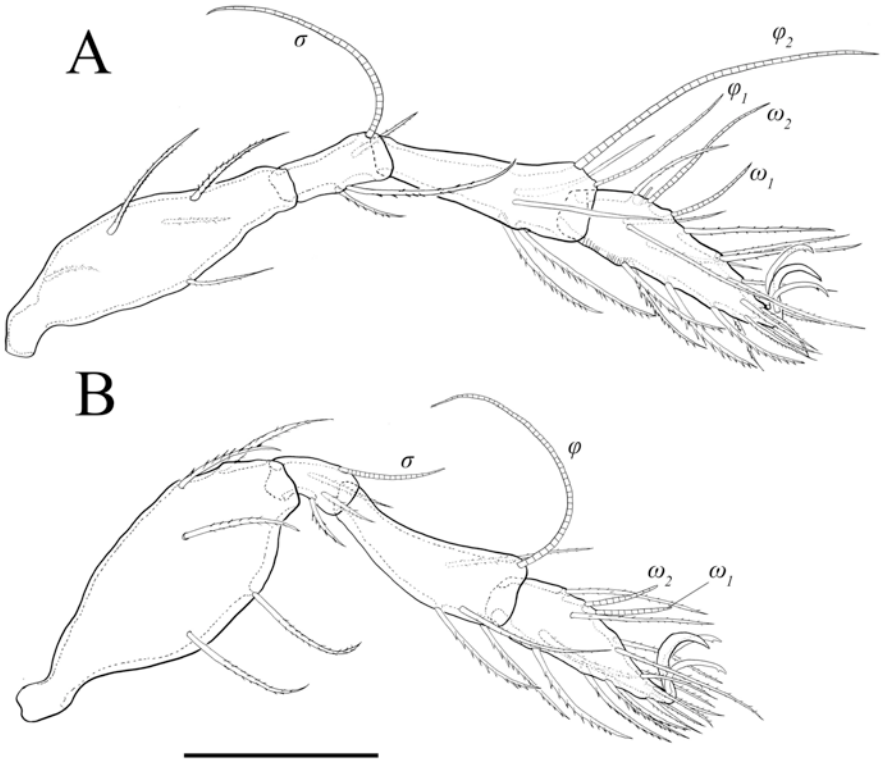


Figure 4. Adult *Neoribates incisus*. paratype (NSMT-Ac 13971, female). A–leg I, without trochanter, left, paraxial view, B– leg II, without trochanter, right, antiaxial view. Scale bar: 100 μm.

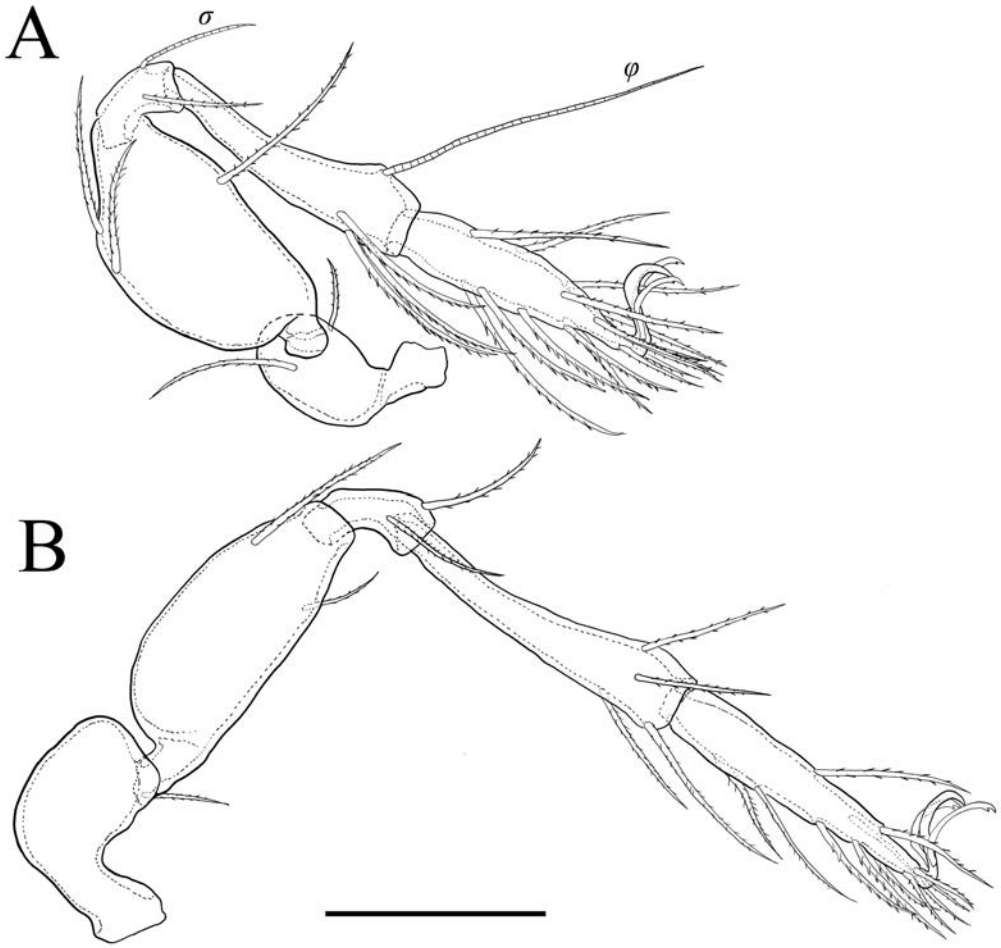


Figure 5. Adult *Neoribates incisus*, paratype (NSMT-Ac 13971, female). A–leg III, left, paraxial view, B–leg IV, left, paraxial view. Scale bar: 100 μm.

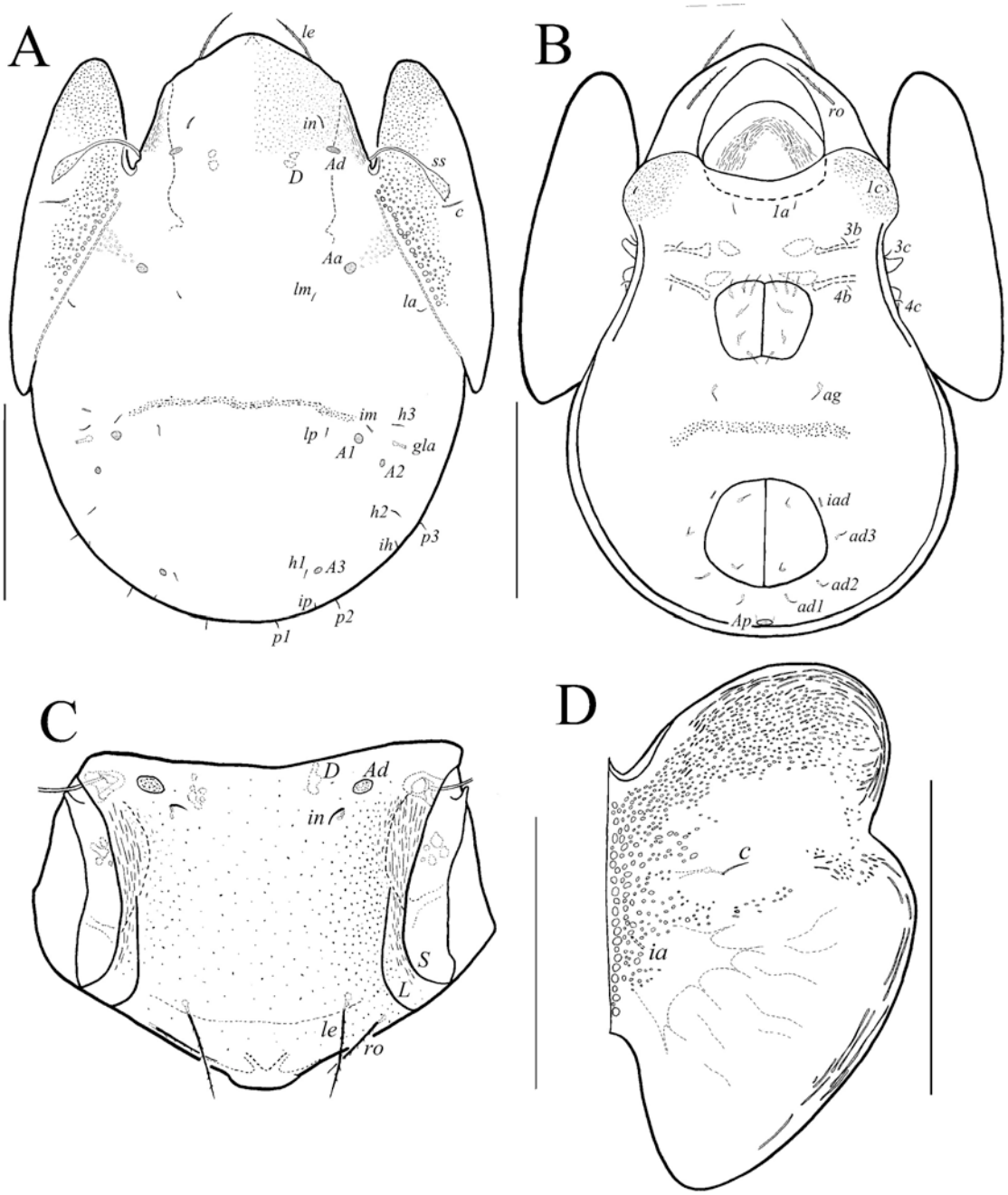


Figure 6. Adult of *Trichogalumna boninensis*. A—Dorsal view, B—Ventral view, C—Dorso-frontal view of aspidosoma, D—Dorsal view of pteromorph. Scale bar (A, B, D) 100 μm, (C) 50 μm.

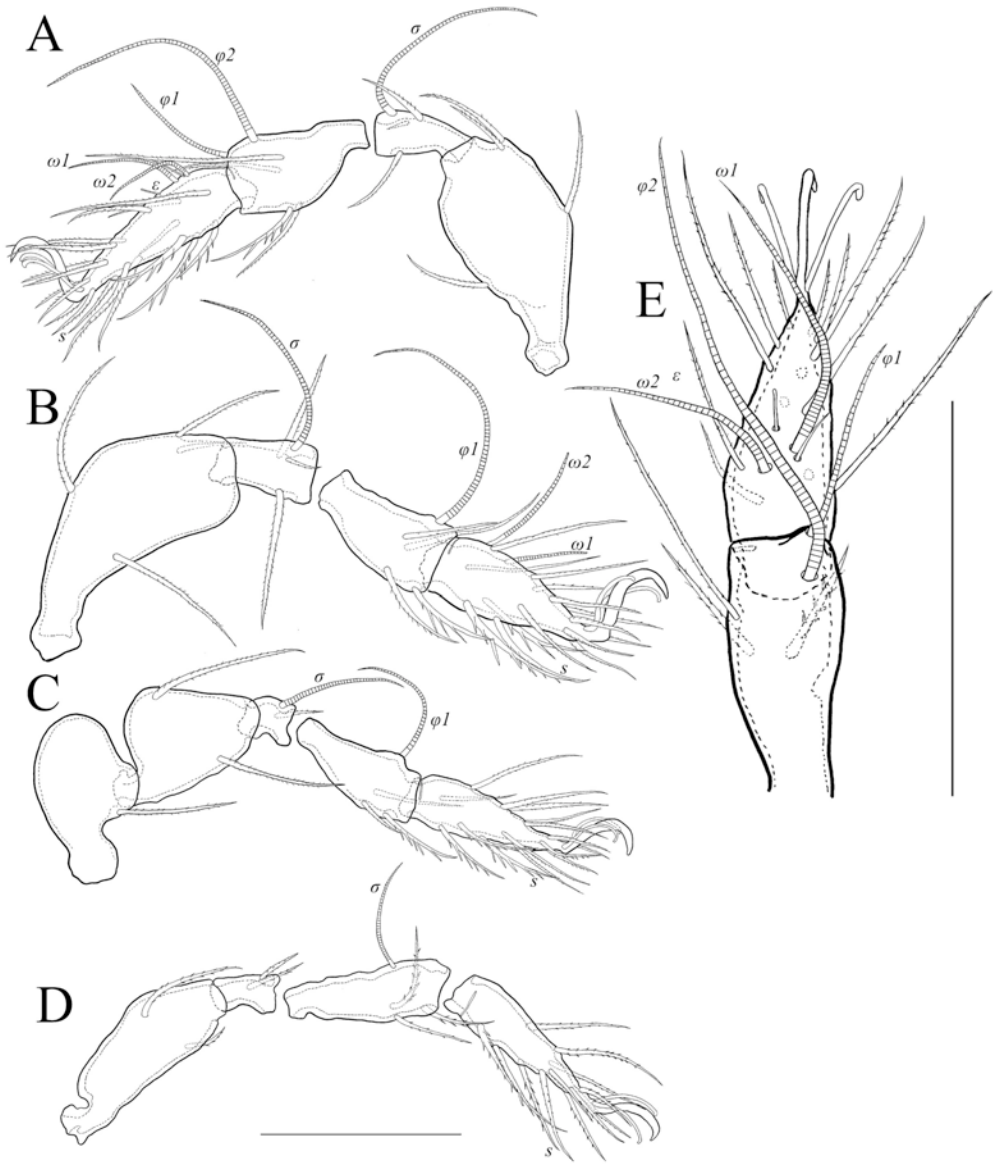


Figure 7. Adult of *Trichogalumna boninensis*. A—Leg I, without trochanter, right, paraxial view, B—Leg II, without trochanter, right, antiaxial view, C—Leg III, right, paraxial view, D—Leg IV, without trochanter, right, paraxial view, E—Tarsus and tibia of leg I, right, dorso-lateral view. Scale bar 50 μm.

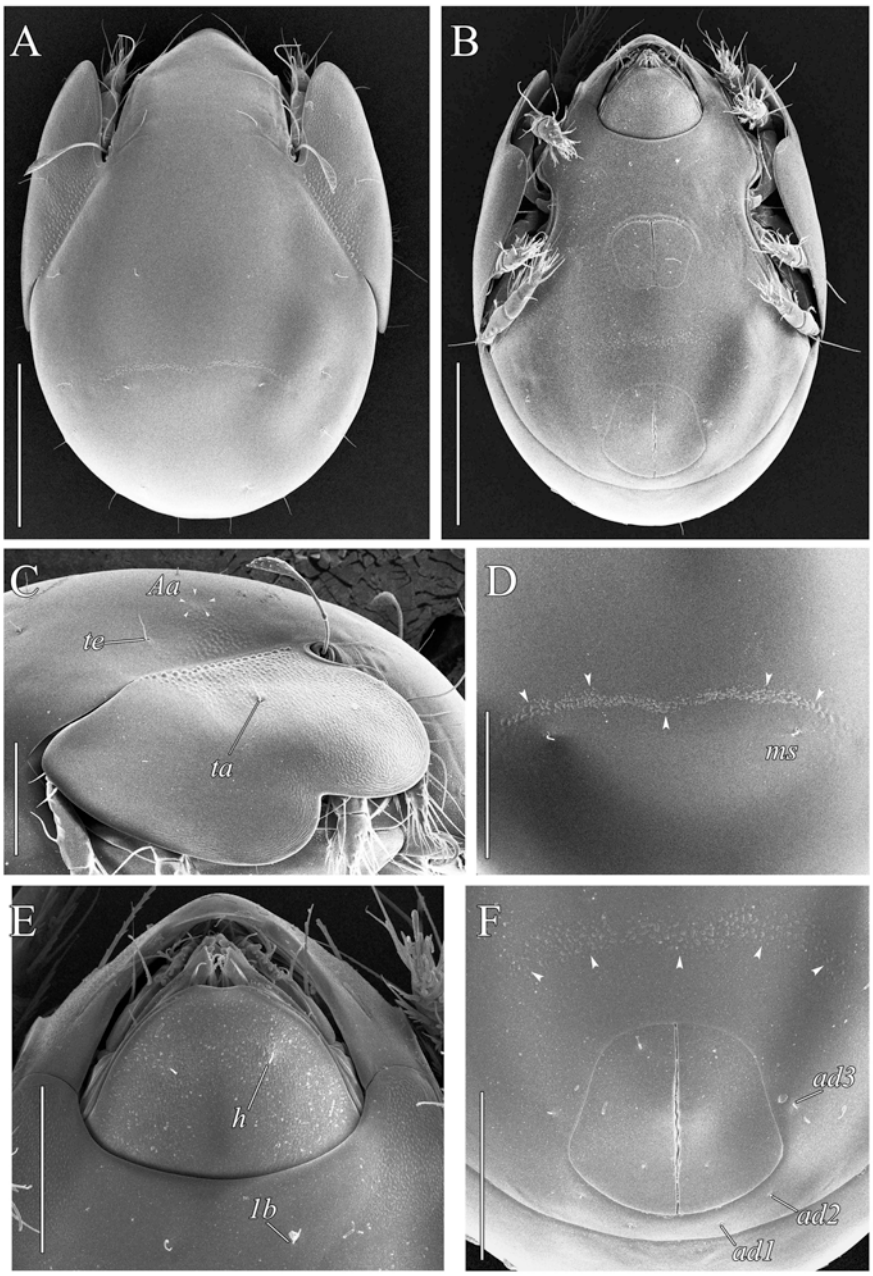


Figure 8. Scanning electron micrographs of adult of *Trichogalumna boninensis*. A—Dorsal view, B—Ventral view, C—Lateral view of part of the prodorsum and notogaster, arrows indicate porose area *Aa*, D—Central part of notogaster, arrows indicate notogastral granular band, E—Ganthosomal region, F— Posterior part of ventral plate, arrows indicate granular band on ventral plate. Scale bars: (A, B) 100 μm, (C, D, E, F) 50 μm.

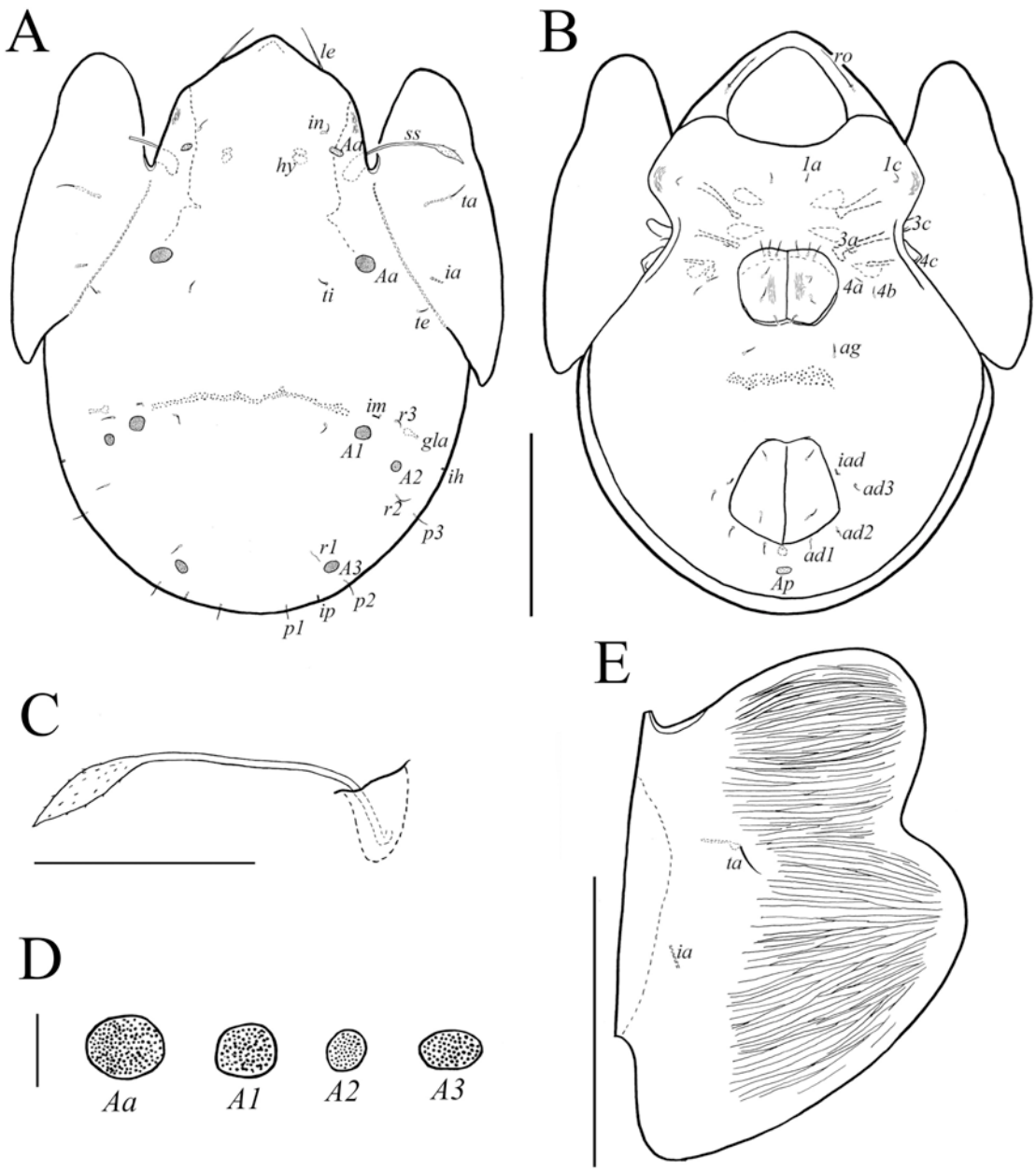


Figure 9. Adult of *Trichogalumna ohkuboi*. A—Dorsal view, B—Ventral view, C—Sensillus, D—Notogastral porose areas, E—Dorsal view of pteromorph, scale bar (A, B, E) 100 μm, scale bar (C) 50 μm, scale bar (D) 10 μm.

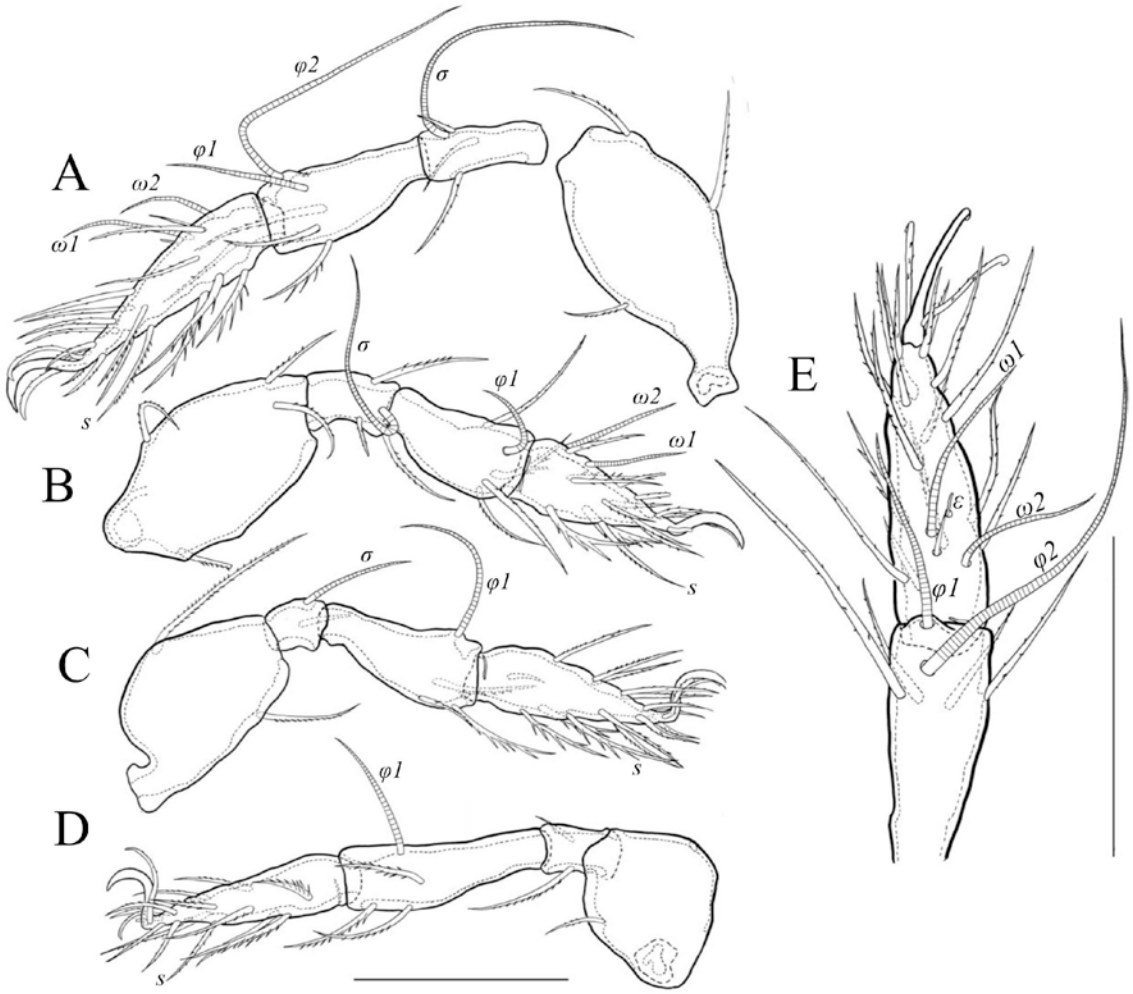


Figure 10. Adult of *Trichogalumna ohkuboi*. A—Leg I, without trochanter, right, paraxial view, B—Leg II, without trochanter, right, antiaxial view, C—Leg III, without trochanter, left, antiaxial view, D—Leg IV, without trochanter, right, antiaxial view, E—Leg I, right tarsus and tibia, dorsal view. Scale bars 50 μm.

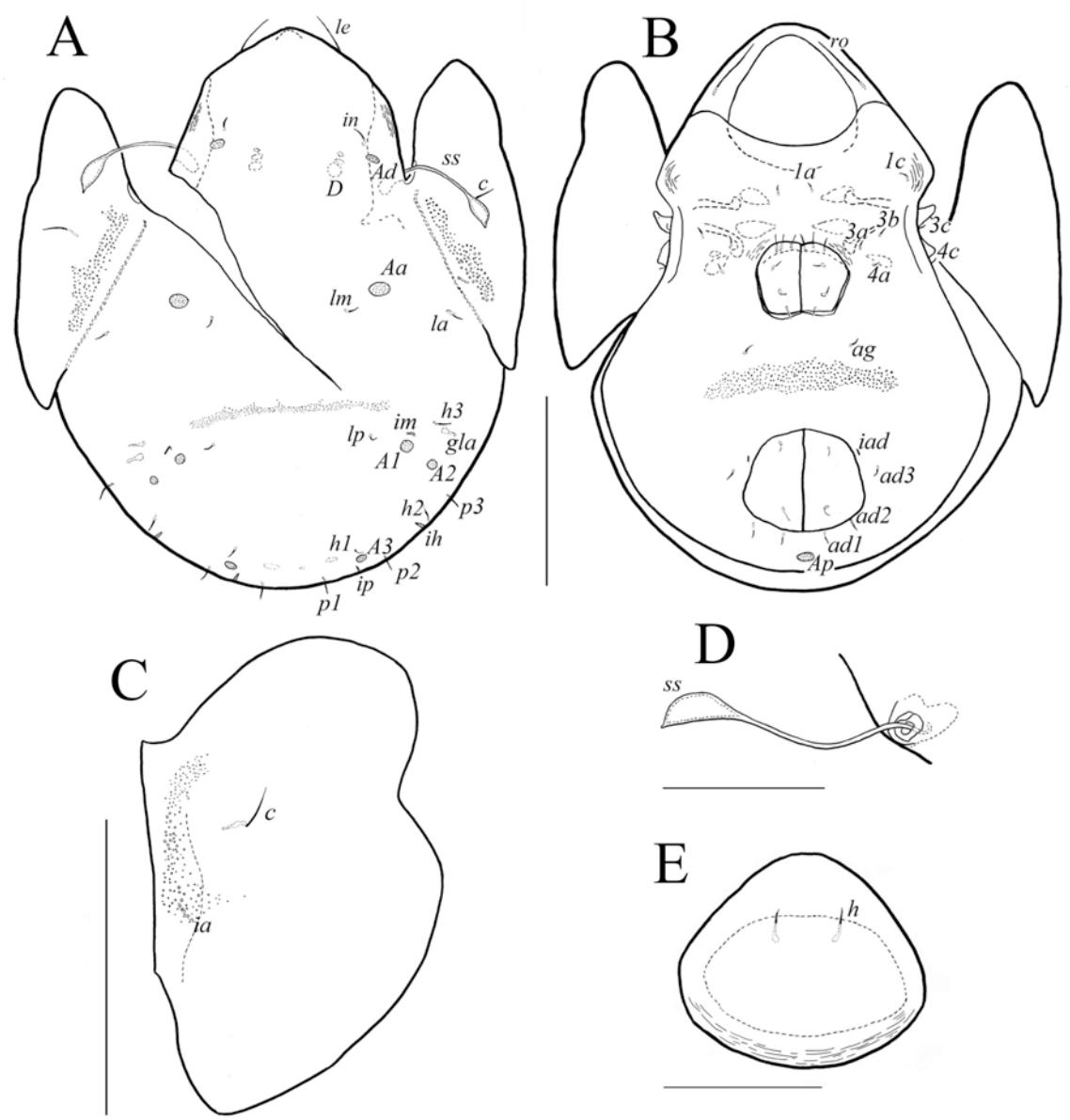


Figure 11. Adult of *Trichogalumna imperfecta*. A—Dorsal view, B—Ventral view, C—Dorsal view of pteromorph, D—Sensillus, E—Mentum. Scale bars (A, B, C) 100 μm, scale bars (D, E) 50 μm.

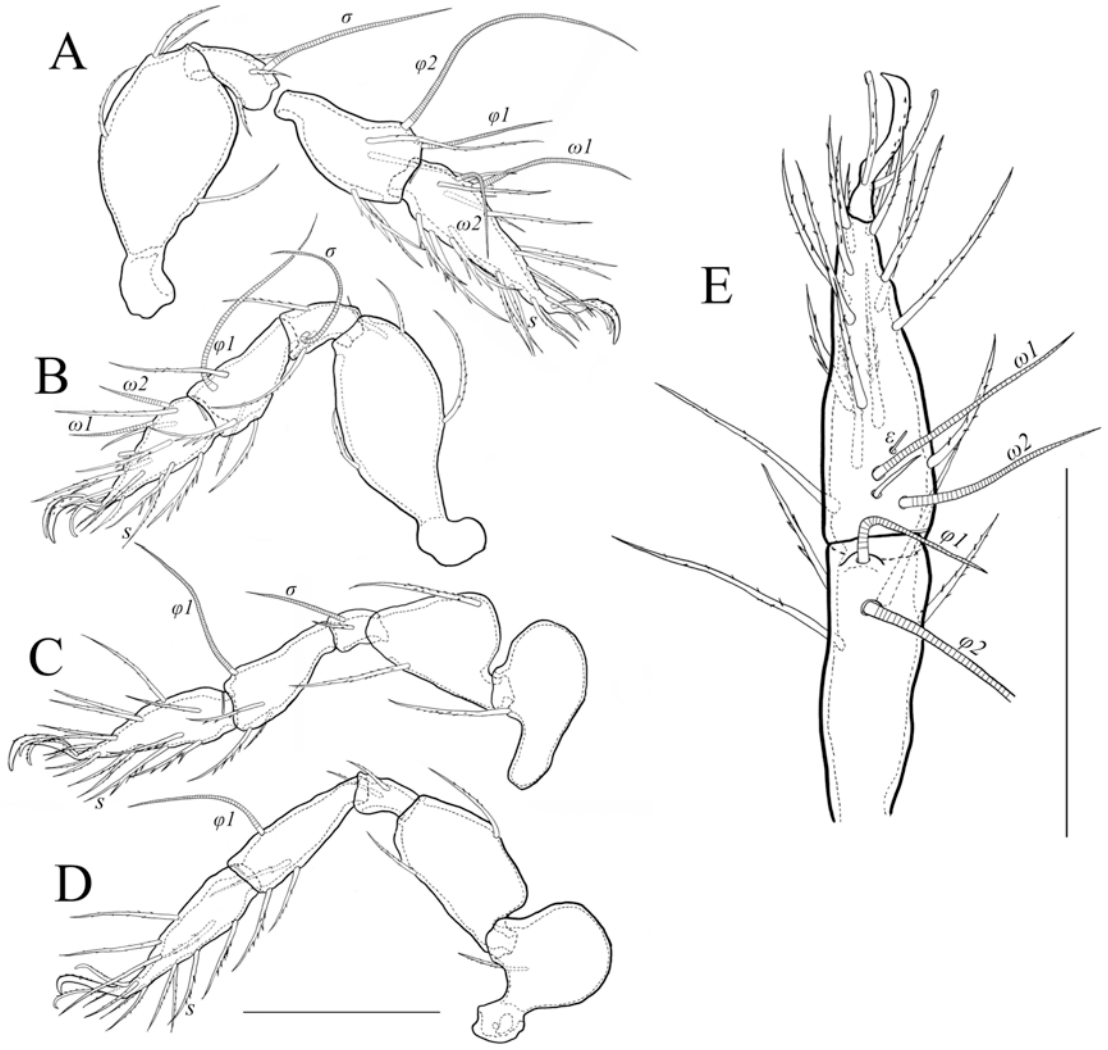


Figure 12. Adult of *Trichogalumna imperfecta*. A—Leg I, without trochanter, left, paraxial view, B— Leg II, without trochanter, left, antiaxial view, C—Leg III, right, antiaxial view, D—Leg IV, left, paraxial view, E—Tarsus and tibia of leg I, right, dorso-lateral view. Scale bar 50 μm.

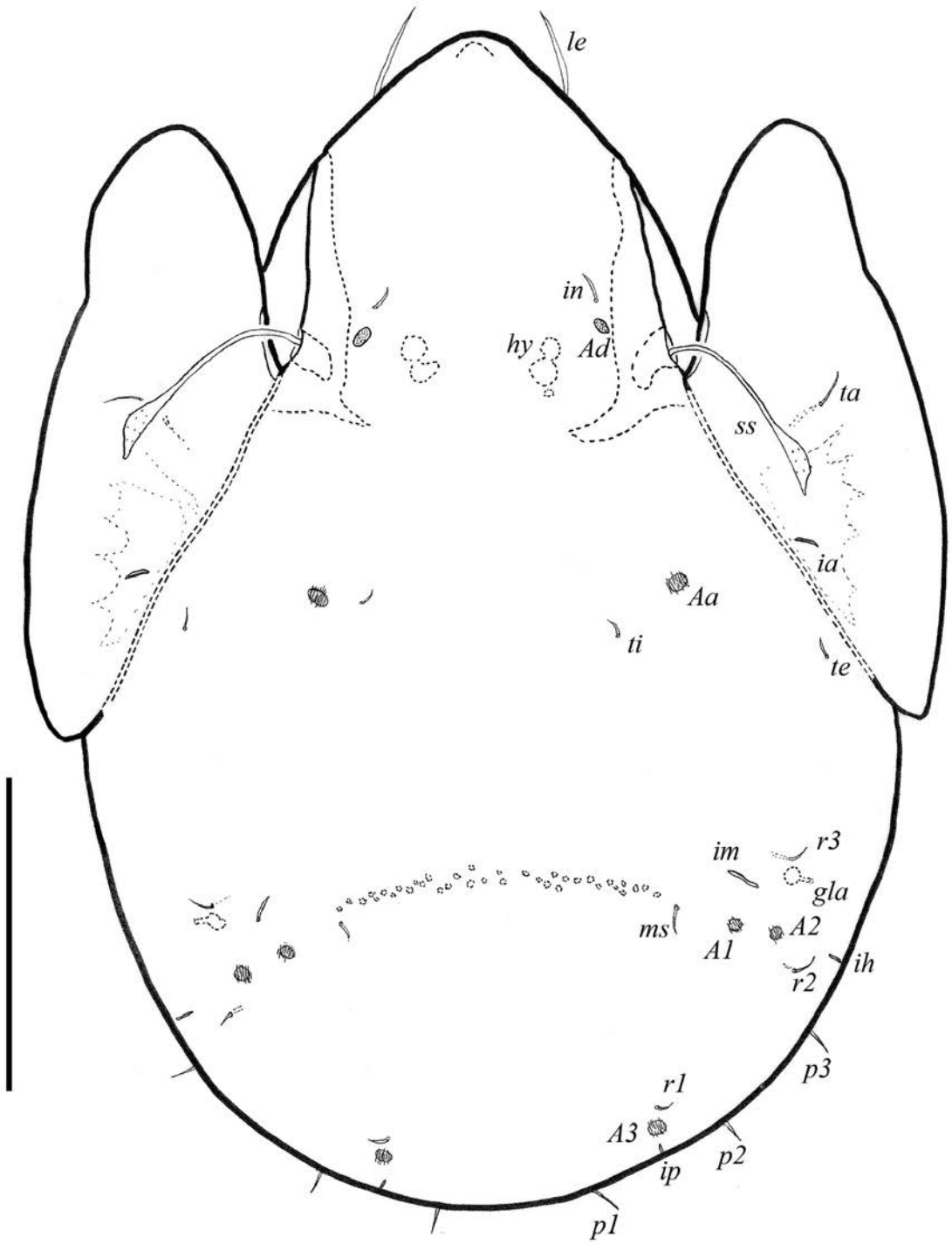
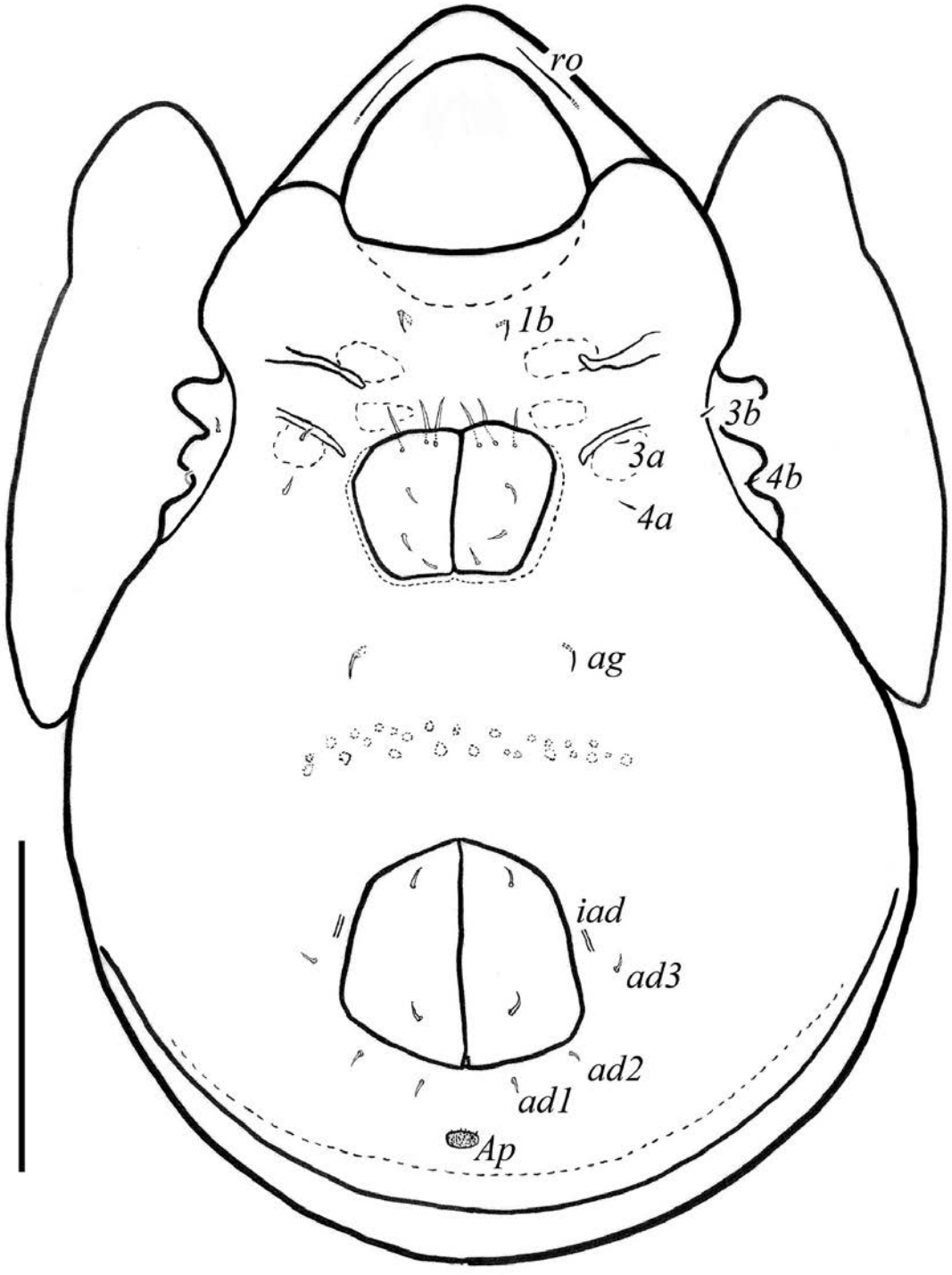


Fig. 13. *Trichogalumna lineata* Ohkubo, 1984, female, dorsal view. Scale bar: 100 μm.

Figure 14. *Trichogalumna lineata* Ohkubo, 1984, female, ventral view. Scale bar: 100



μm.

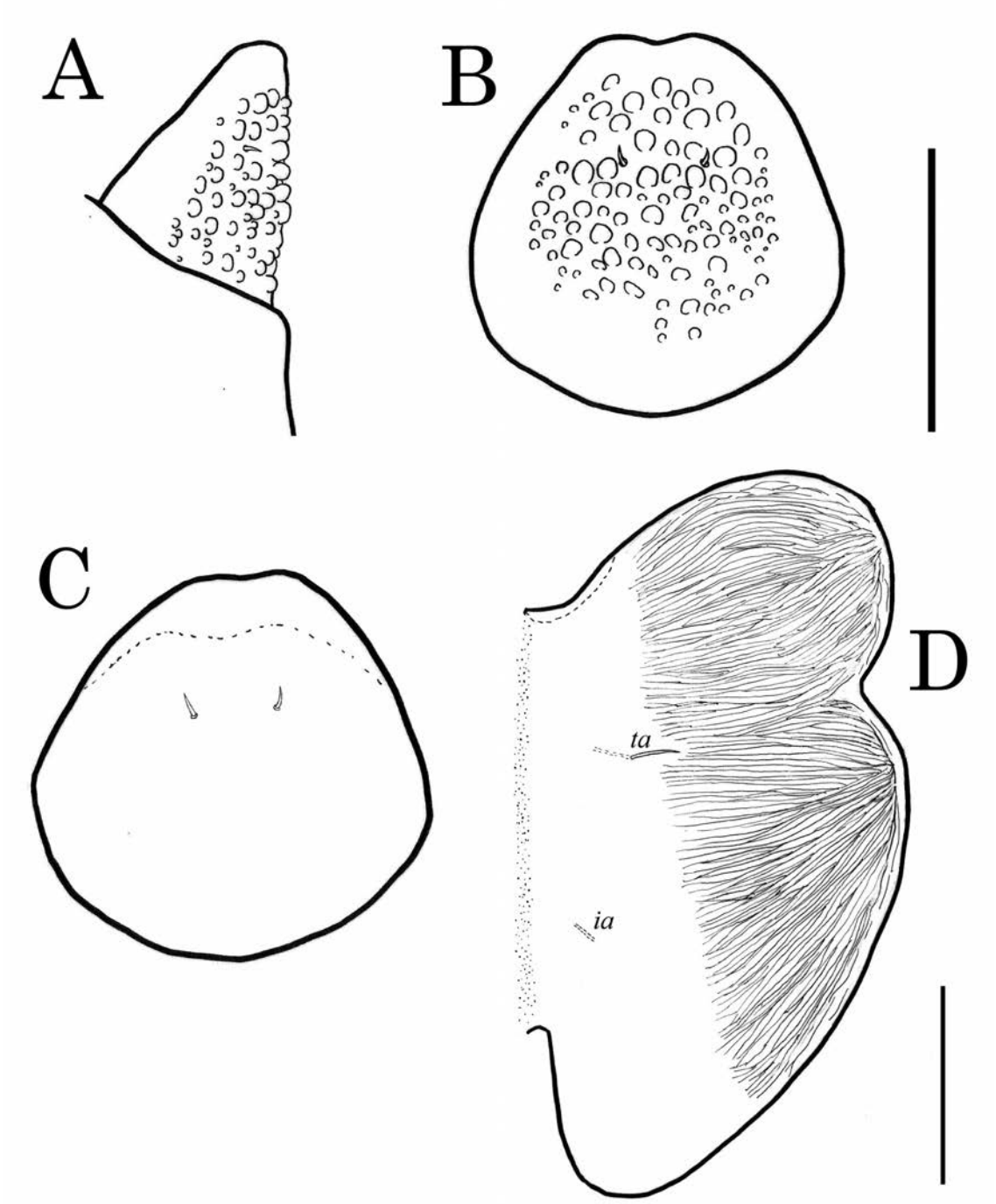


Fig. 15. *Trichogalumna lineata* Ohkubo, 1984, female. A, Mentum plate with granular surface. B, Mentum plate with smooth surface. C, Pteromorph. Scale bars: A–C, 100 μm; D, 50 μm.

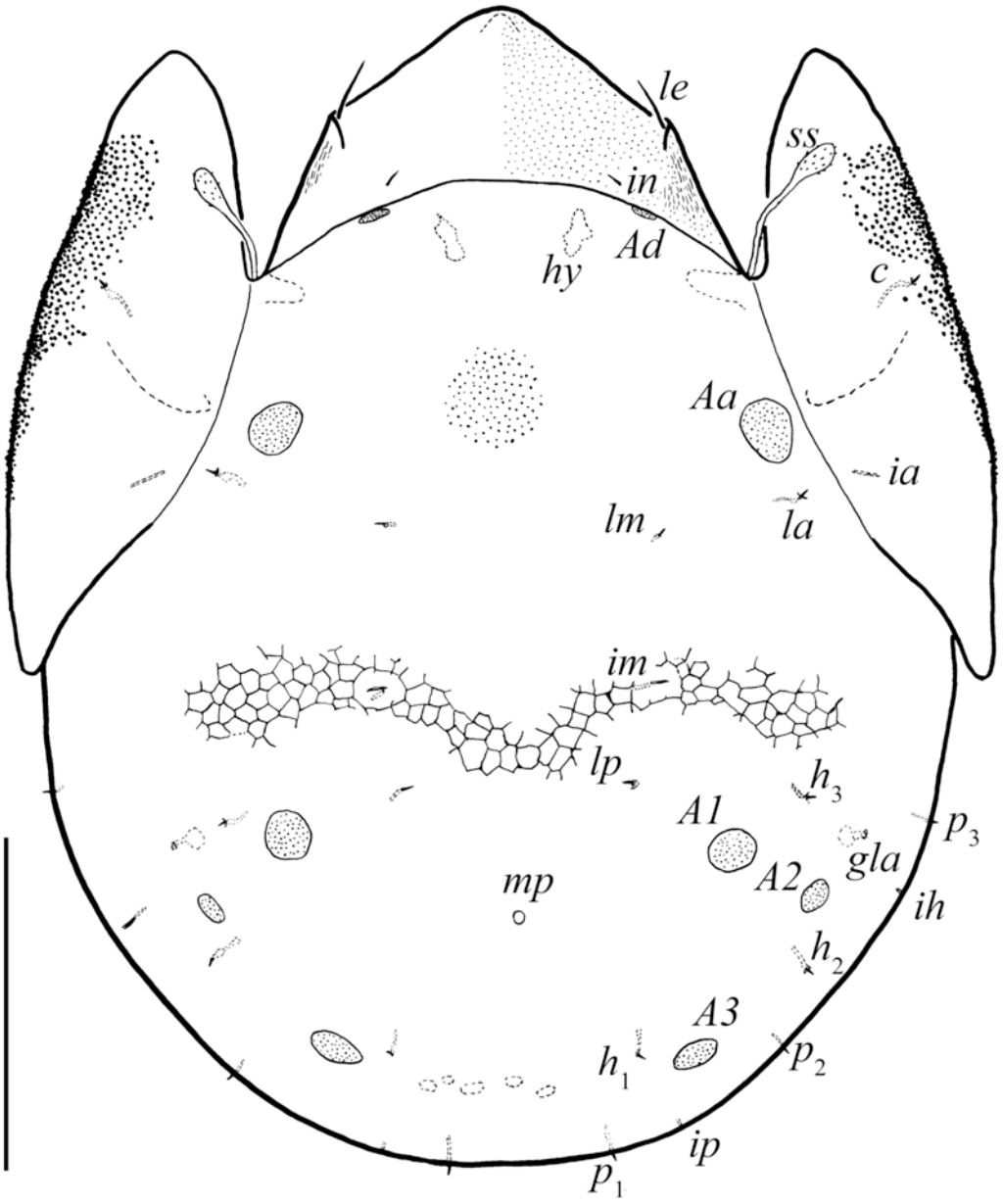


Fig. 16. Adult *Cosmogalumna centroclathrata***,** holotype, dorsal view. Scale bar 100 μm.

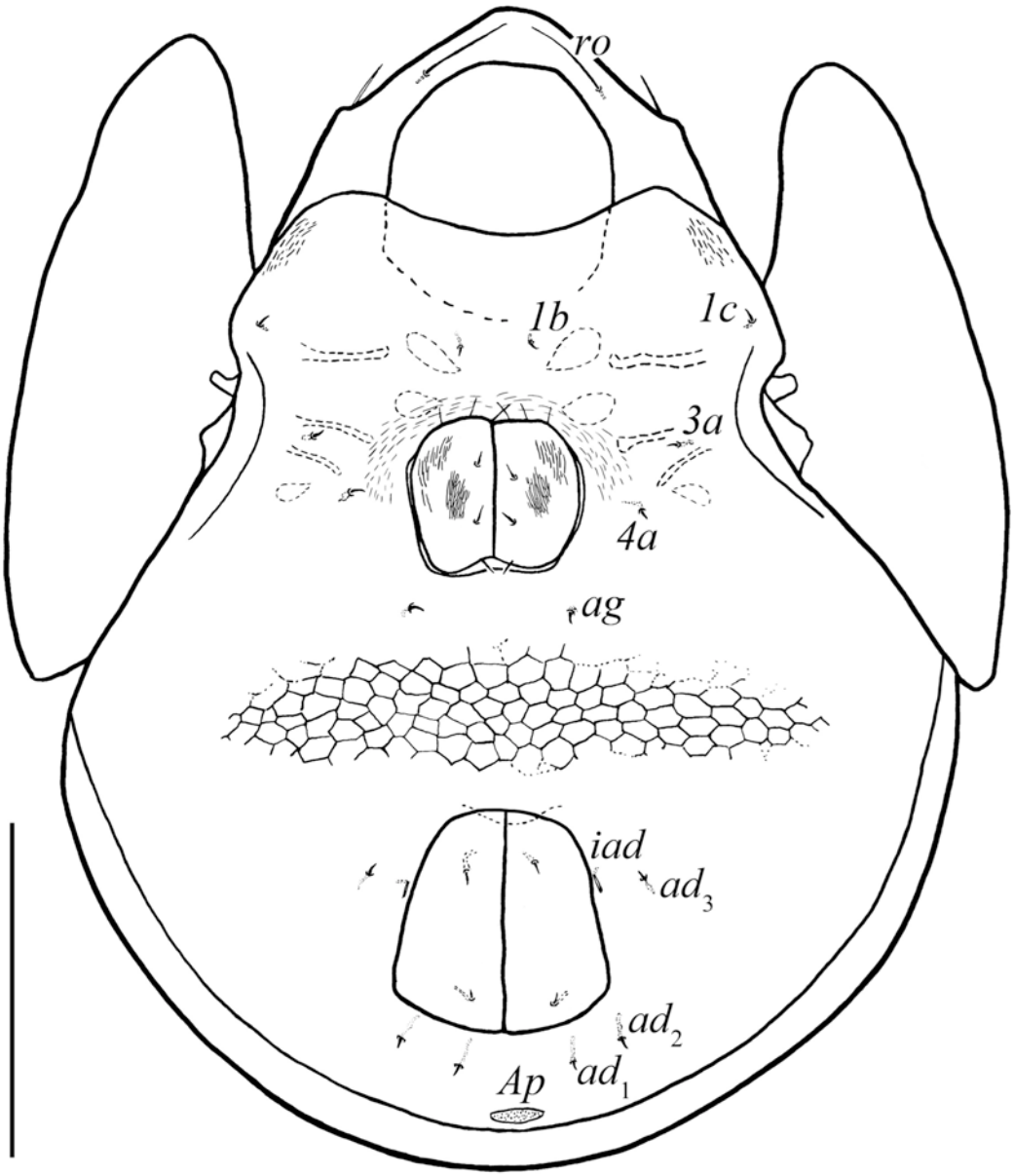


Fig. 17. Adult *Cosmogalumna centroclathrata*, holotype, ventral view. Scale bar 100 μm.

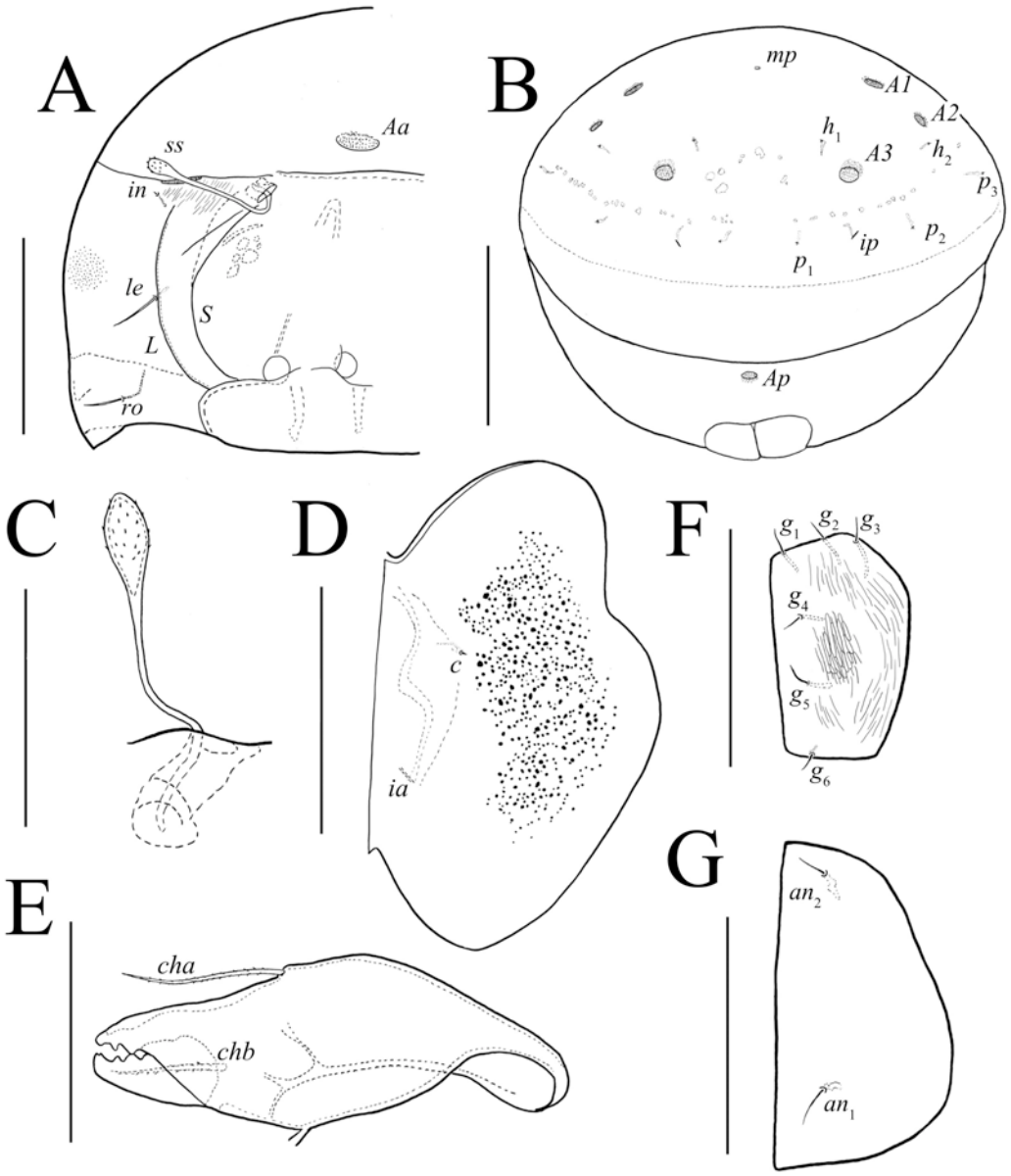


Fig. 18. Adult *Cosmogalumna centroclathrata*. Holotype for A, B, C, and D, paratype (NSMT–Ac 13969) for E, F, and G: A – aspidosoma, lateral view; B – opisthosoma, posterior view; C – sensillus; D – pteromorph; E – chelicera; F – genital plate; G – anal plate. Scale bar (A, B, D) 100 μm, (C, E, F, G) 50 μm.

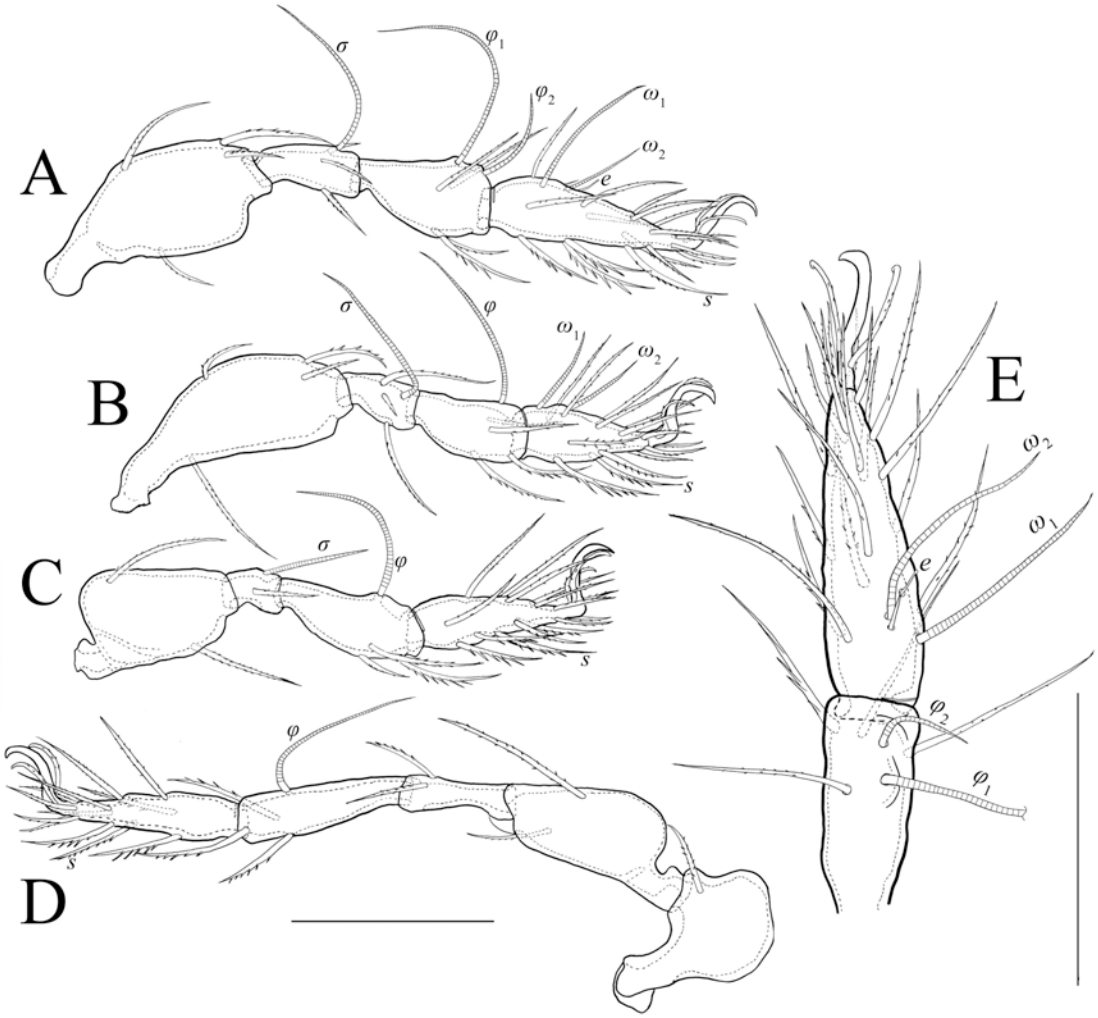


Fig. 19. Legs of adult *Cosmogalumna centroclathrata*. Holotype for A, and E, paratype (NSMT–Ac 14210) for B, C, and D: A – leg I, without trochanter, right, paraxial view; B – leg II, without trochanter, left, paraxial view; C – leg III, left, antiaxial view; D – leg IV, left, antiaxial view; E – leg I, right tarsus and tibia, dorsal view. Scale bar 50 μm.

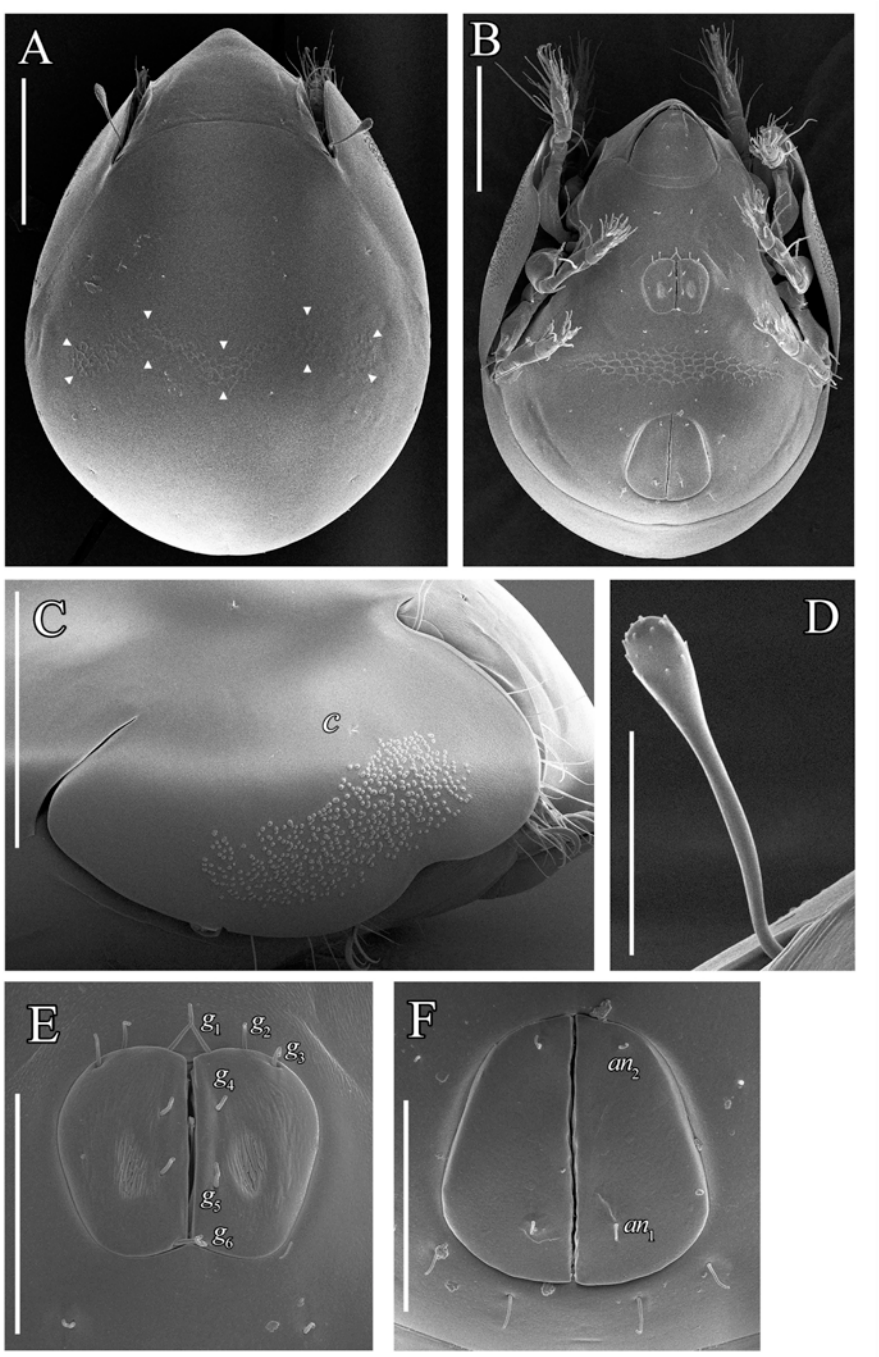


Fig. 20. Scanning electron micrographs of adult *Cosmogalumna centroclathrata*, non-type specimens: A – dorsal view, arrow heads indicate polygonal sculpture on notogaster; B – ventral view; C – lateral view of pteromorph; D – sensillus; E – genital plates; F – Anal plates Scale bar (A, B, C) 100 μm, (D) 30 μm, (E, F) 50 μm.

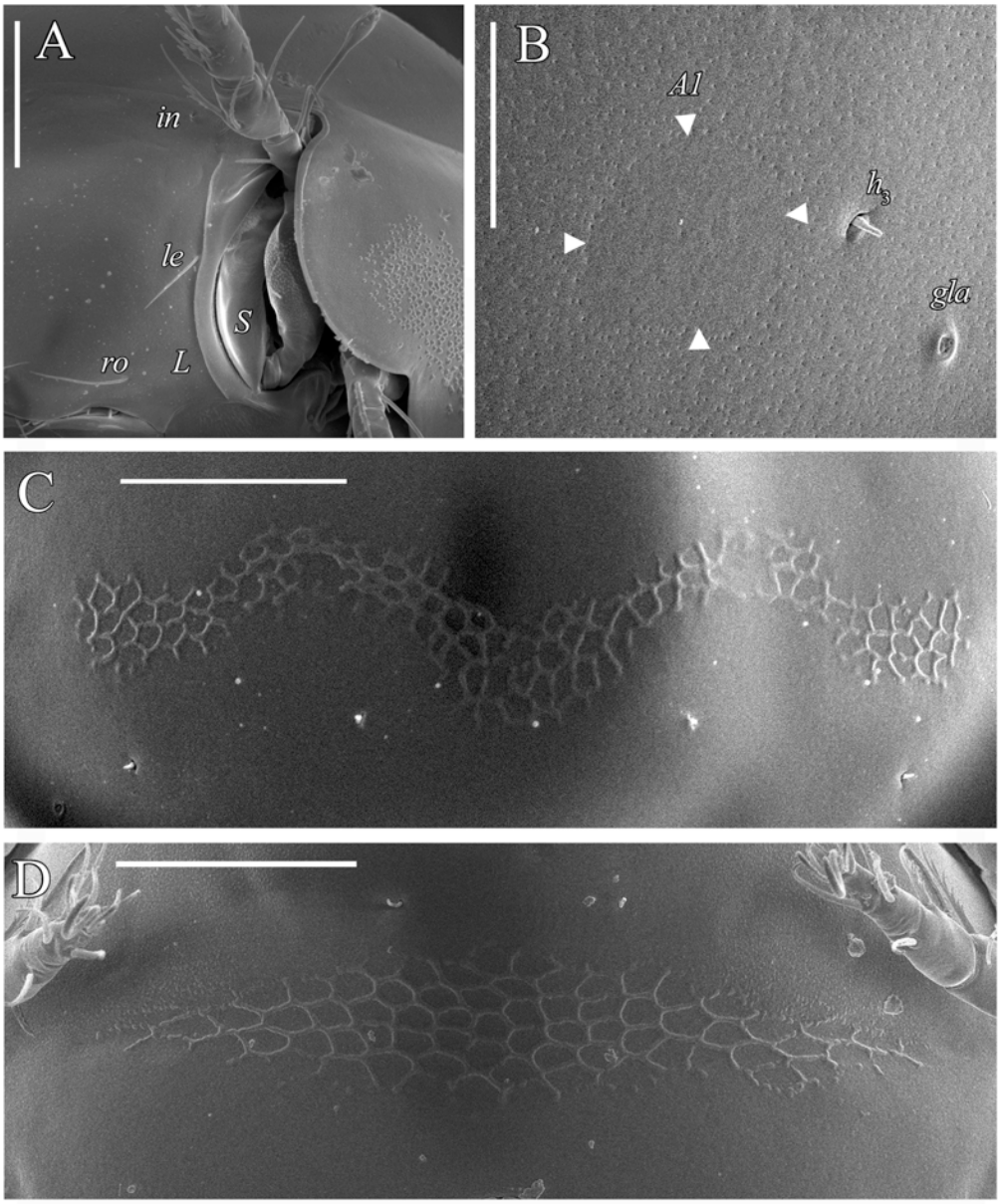


Fig. 21. Scanning electron micrographs of adult *Cosmogalumna centroclathrata* **n. sp.**, non-type specimens: A – partial ante- rior view; B – porose area *A1* and setae *h*3 (arrow heads indicate porose area *A1*); C – area of notogaster showing polygonal sculpture; D – area of ventral plate showing polygonal sculpture. Scale bar (A) 50 μm, (B) 20 μm, (C, D) 50 μm.

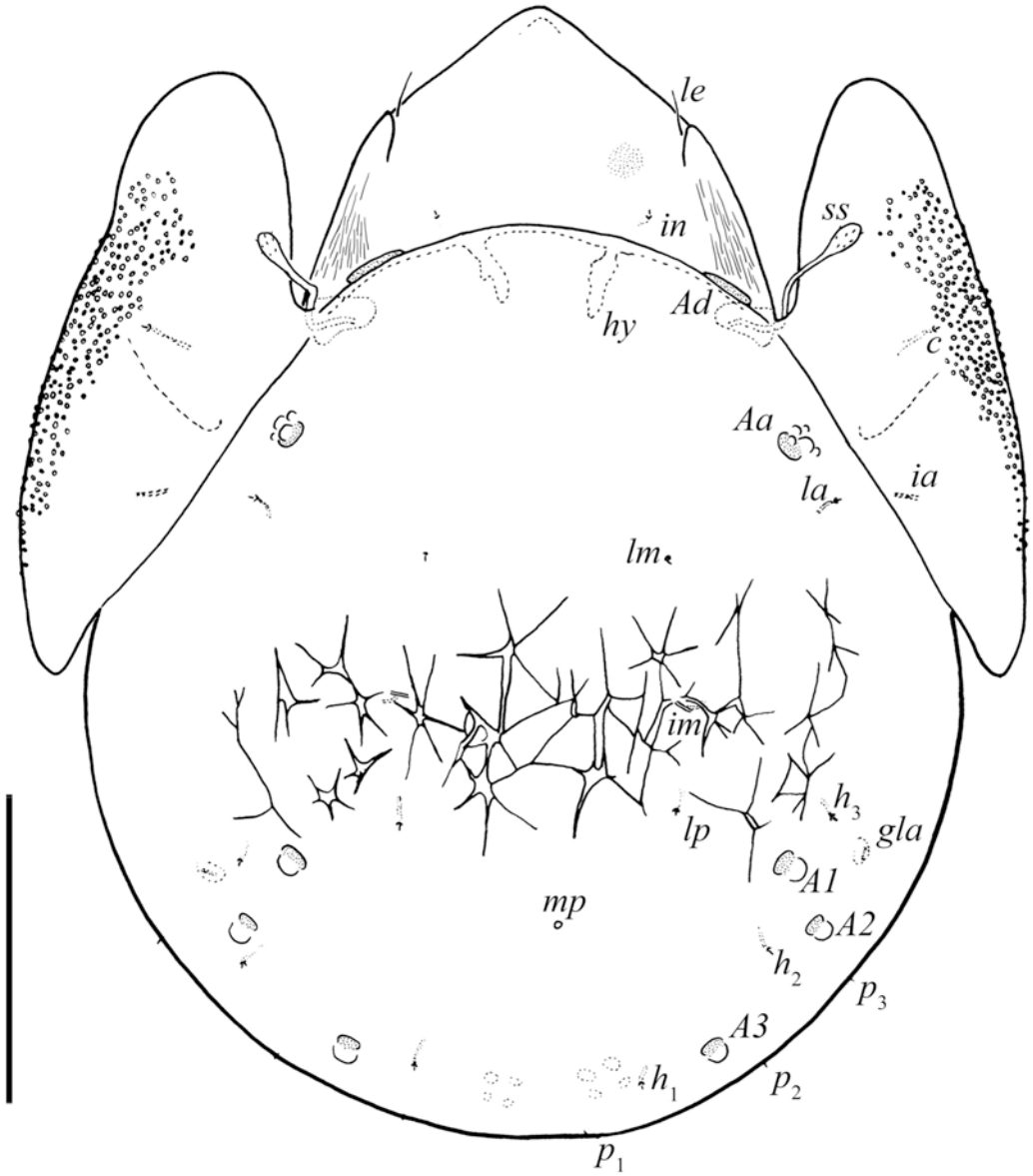


Fig. 22. Adult *Cosmogalumna kirishimaensis*, holotype, dorsal view. Scale bar 100 μm.

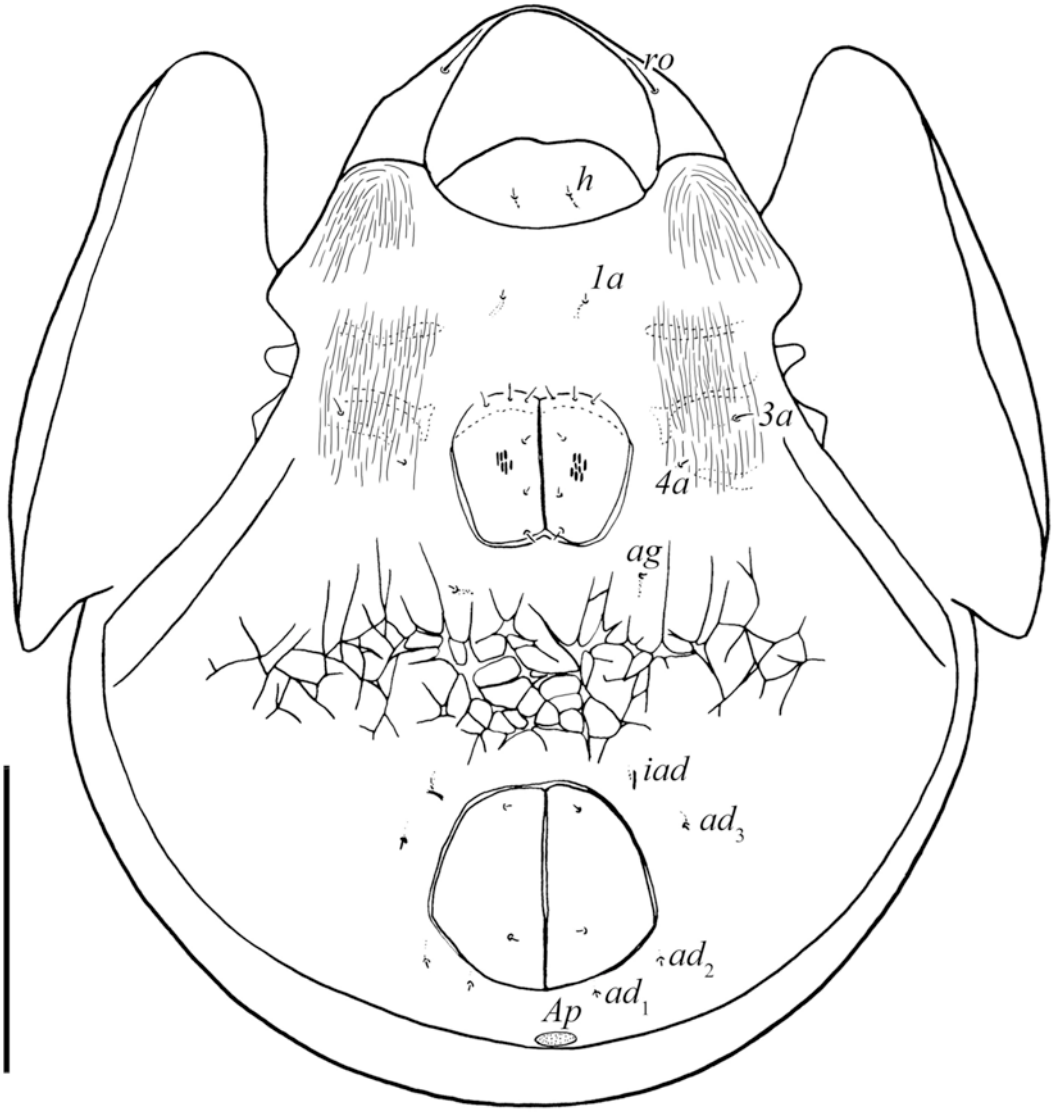


Fig. 23. Adult *Cosmogalumna kirishimaensis*, holotype, ventral view. Scale bar 100 μm.

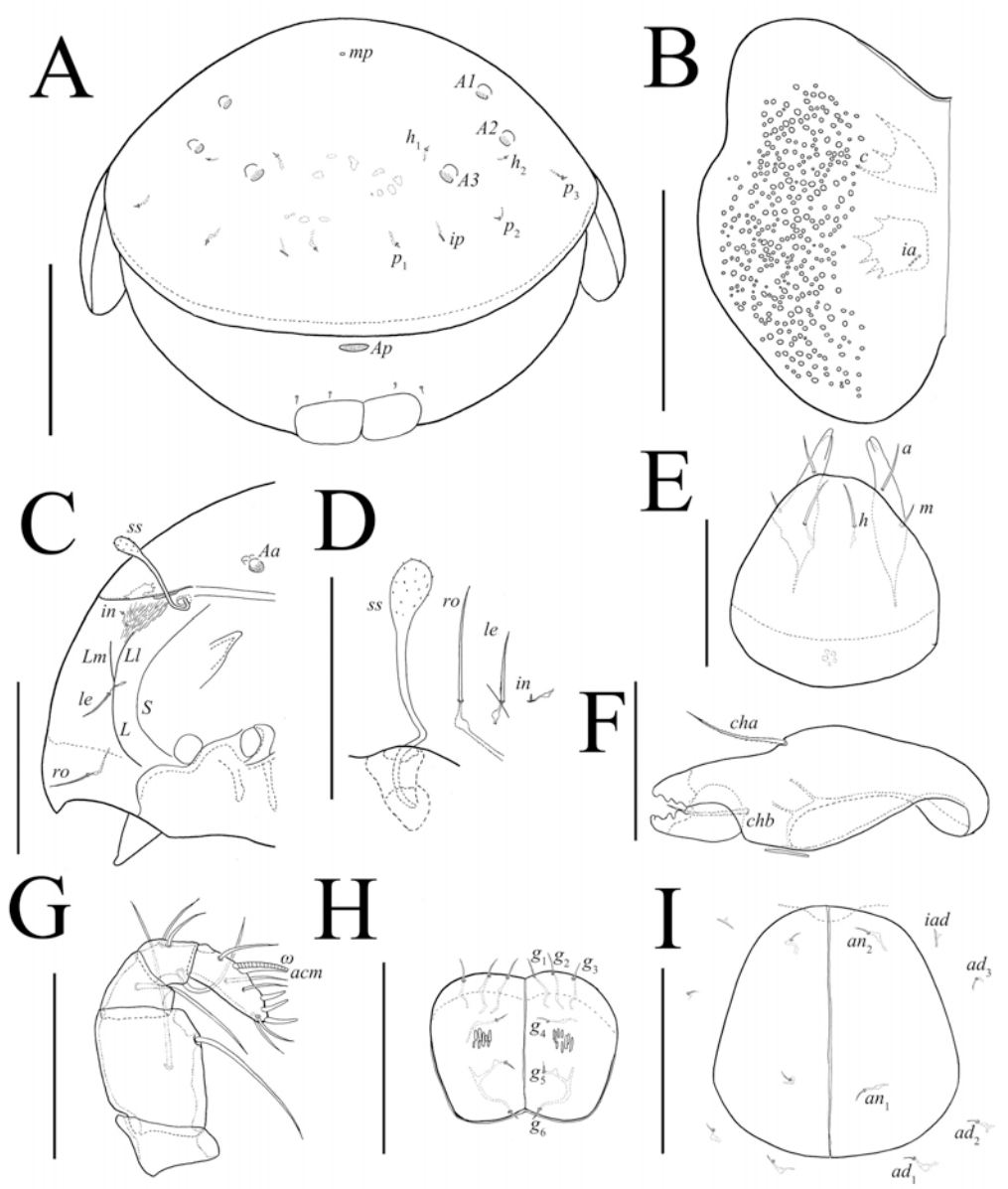


Fig. 24. Adult *Cosmogalumna kirishimaensis*, holotype for **A**, **C**, and **D**, paratype (NSMT–Ac 14214) for **B**, **E**, **F**, **G**, **H**, and **I**. **A**– posterior view, **B**– pteromorph, left, **C**– anterior part of body (pteromorph, gnathosoma except subcapitular mentum, and legs), lateral view, **D**– rostral seta, lamellar seta, interlamellar seta, and sensillus, **E**– subcapitulum, ventral view, **F**– chelicera, left, antiaxial view, **G**– palp, left, paraxial view, **H**– genital plates, **I**– anal plates. Scale bar (**A**, **B**, **C**) 100 μm, (**D**, **E**, **F**, **G**, **H**, **I**) 50 μm.

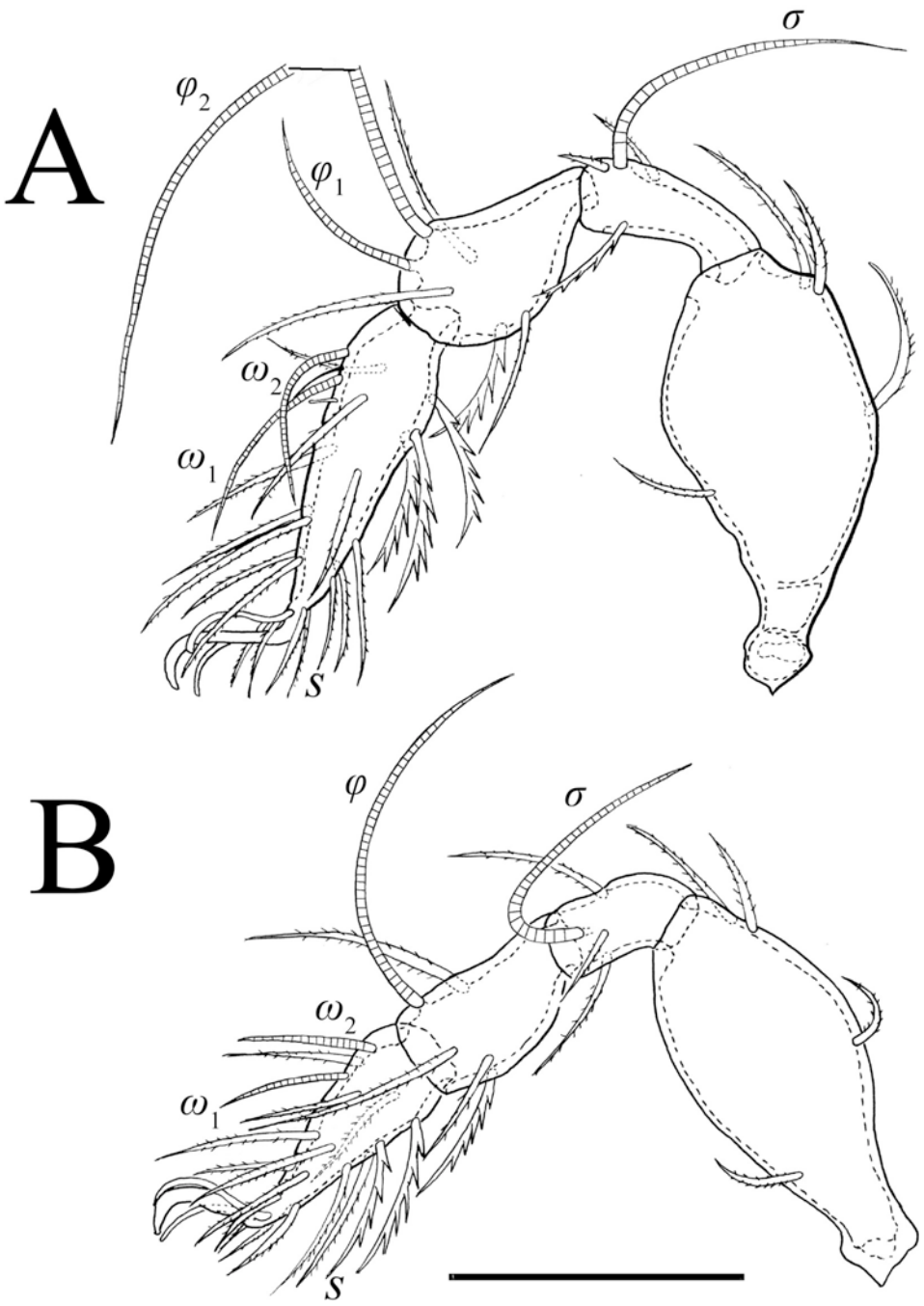


Fig. 25. Legs (without trochanters) of adult *Cosmogalumna kirishimaensis*, paratype (NSMT–Ac 14215). **A**– leg I, left, antiaxial view, **B**– leg II, left, antiaxial view, Scale bar 50 μm.

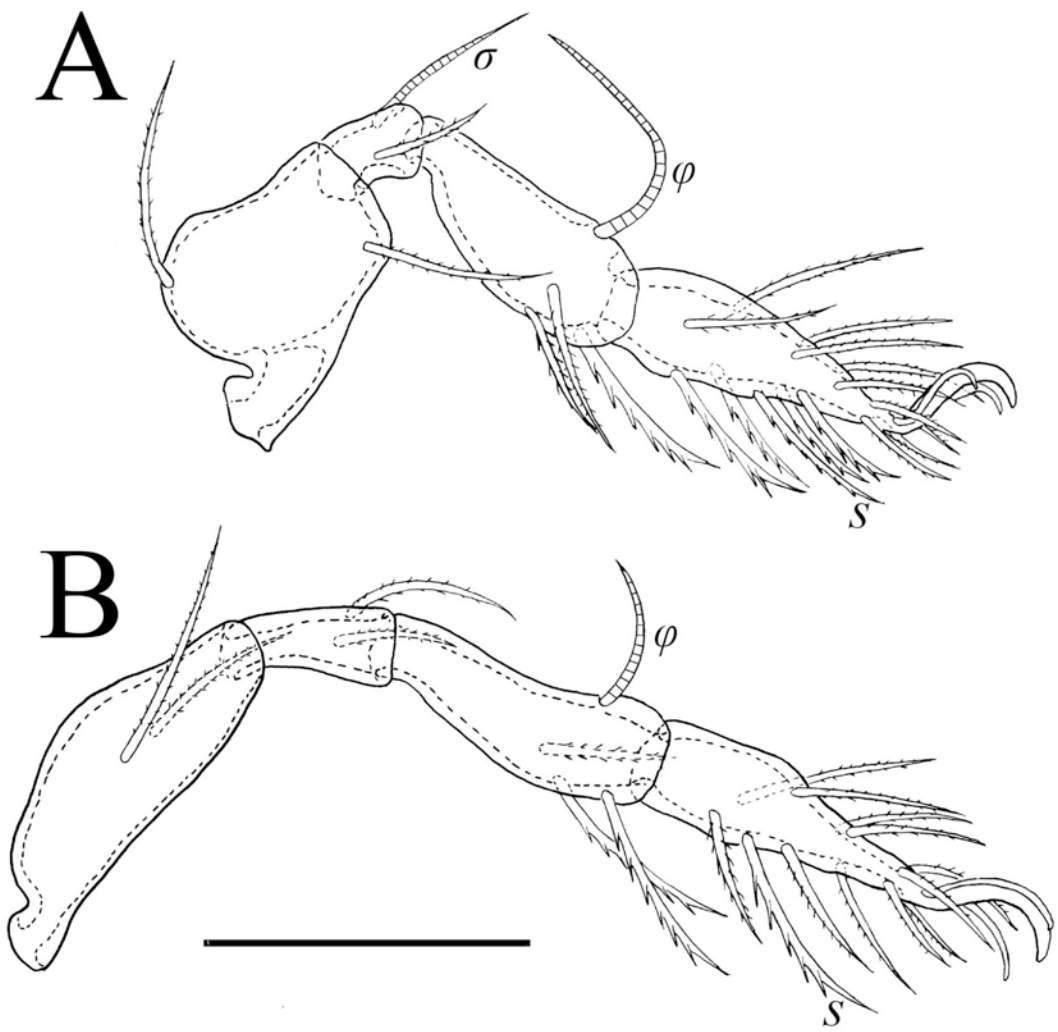


Fig. 26. Legs (without trochanters) of adult *Cosmogalumna kirishimaensis*, holotype. **A**– leg III, left, antiaxial view, **B**– leg IV, right, paraxial view, Scale bar 50 μm.

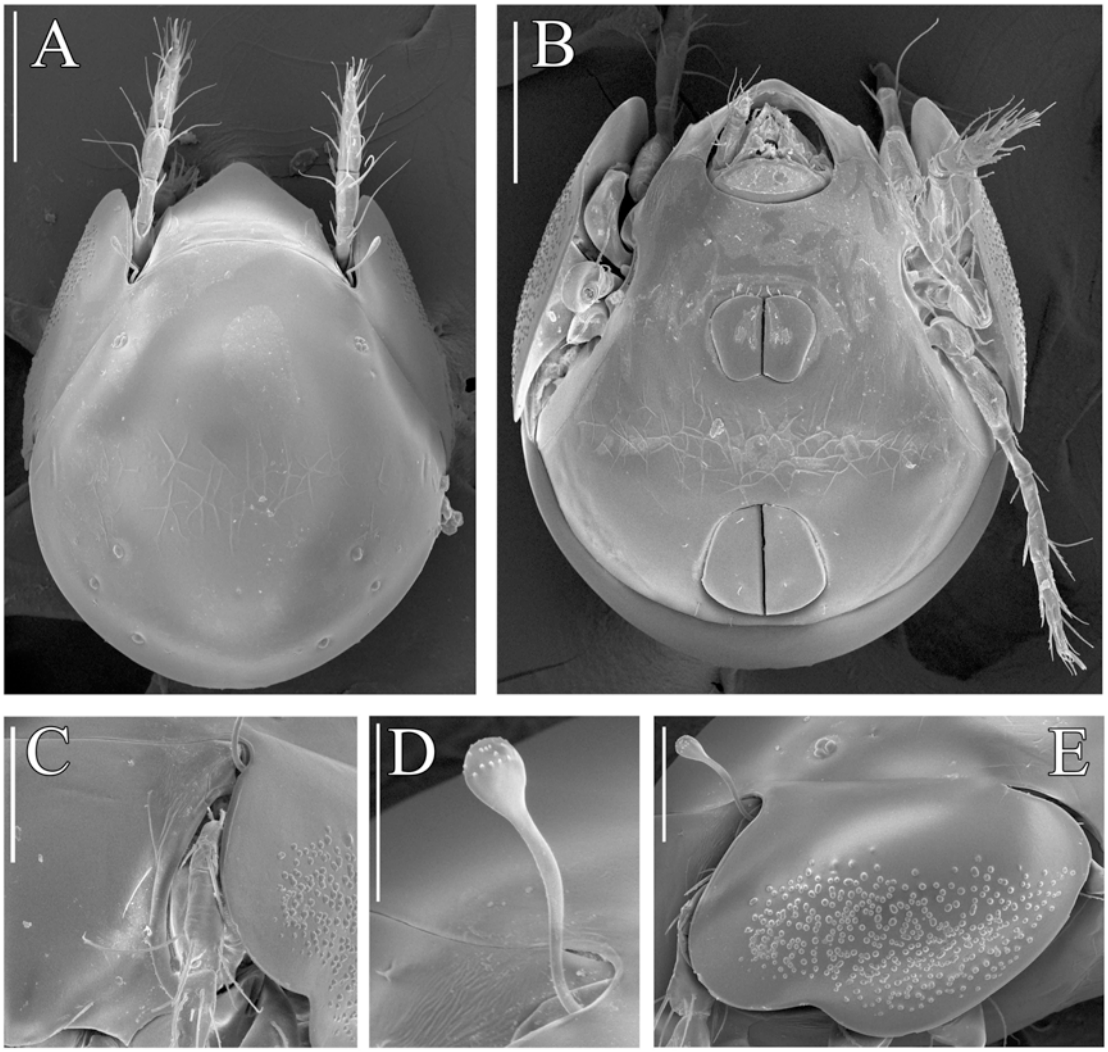


Fig. 27. Scanning electron micrographs of adult *Cosmogalumna kirishimaensis*, non-type specimens. **A**– dorsal view, **B**– ventral view, **C**– partial anterior view, **D**– sensillus, **E**– lateral view of pteromorph. Scale bar (**A**, **B**) 100 μm, (**C**, **E**) 50 μm, (**D**) 30 μm.

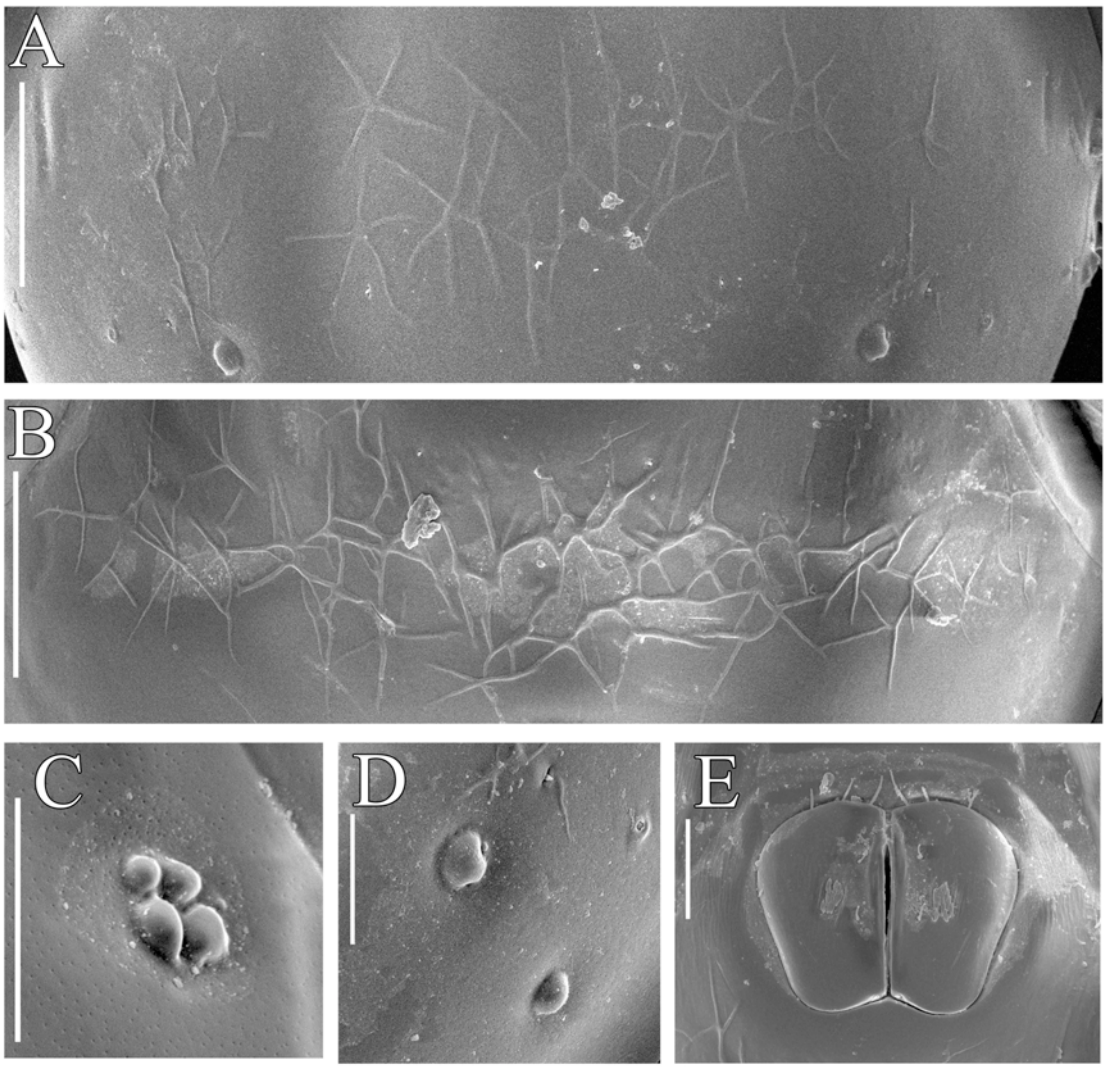


Fig. 28. Scanning electron micrographs of adult *Cosmogalumna kirishimaensis*, non-type specimens. **A**– area of notogaster showing distinctive pattern, suggestive of a neural network, **B**– area of ventral plate showing distinctive pattern, suggestive of a neural network, **C**– notogastral porose area *Aa*, **D**– notogastral porose areas *A1* and *A2*, **E**– genital plates. Scale bar (**A**, **B**) 50 μm, (**C**, **D**, **E**) 20 μm.

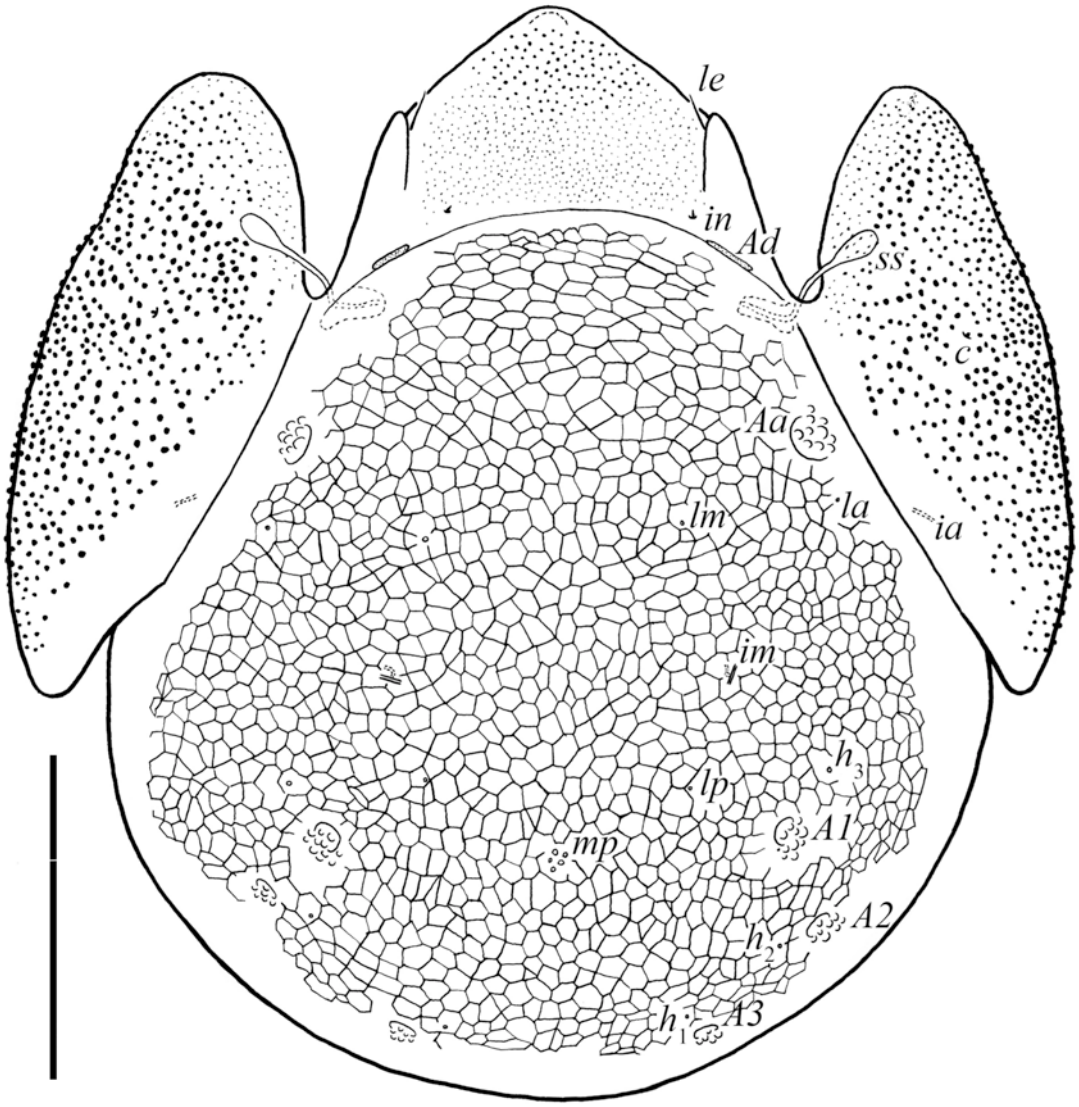


Fig. 29. Adult *Cosmogalumna ornata*, dorsal view. Scale bar 100 μm.

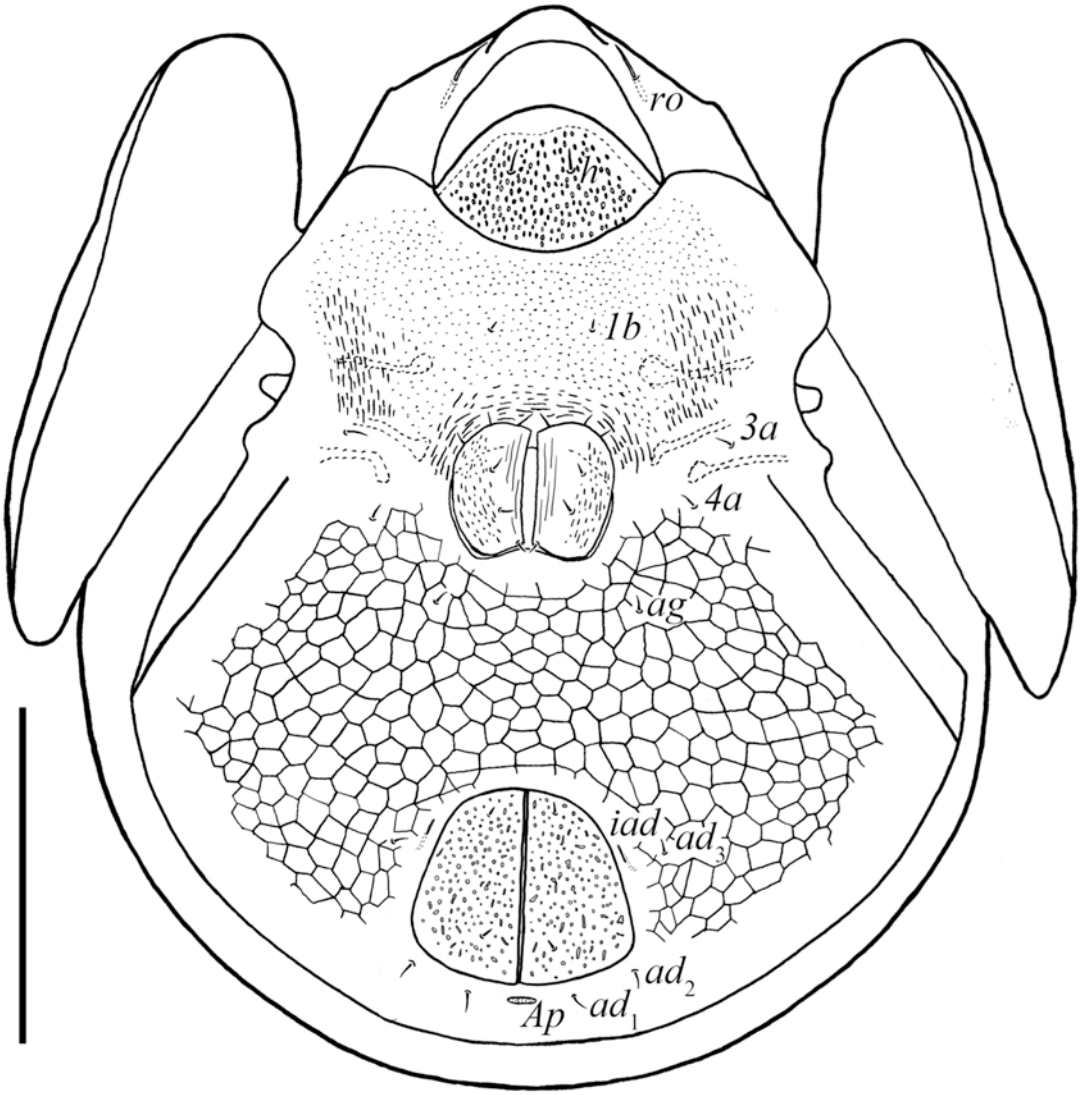


Fig. 30. Adult *Cosmogalumna ornata*, ventral view. Scale bar 100 μm.

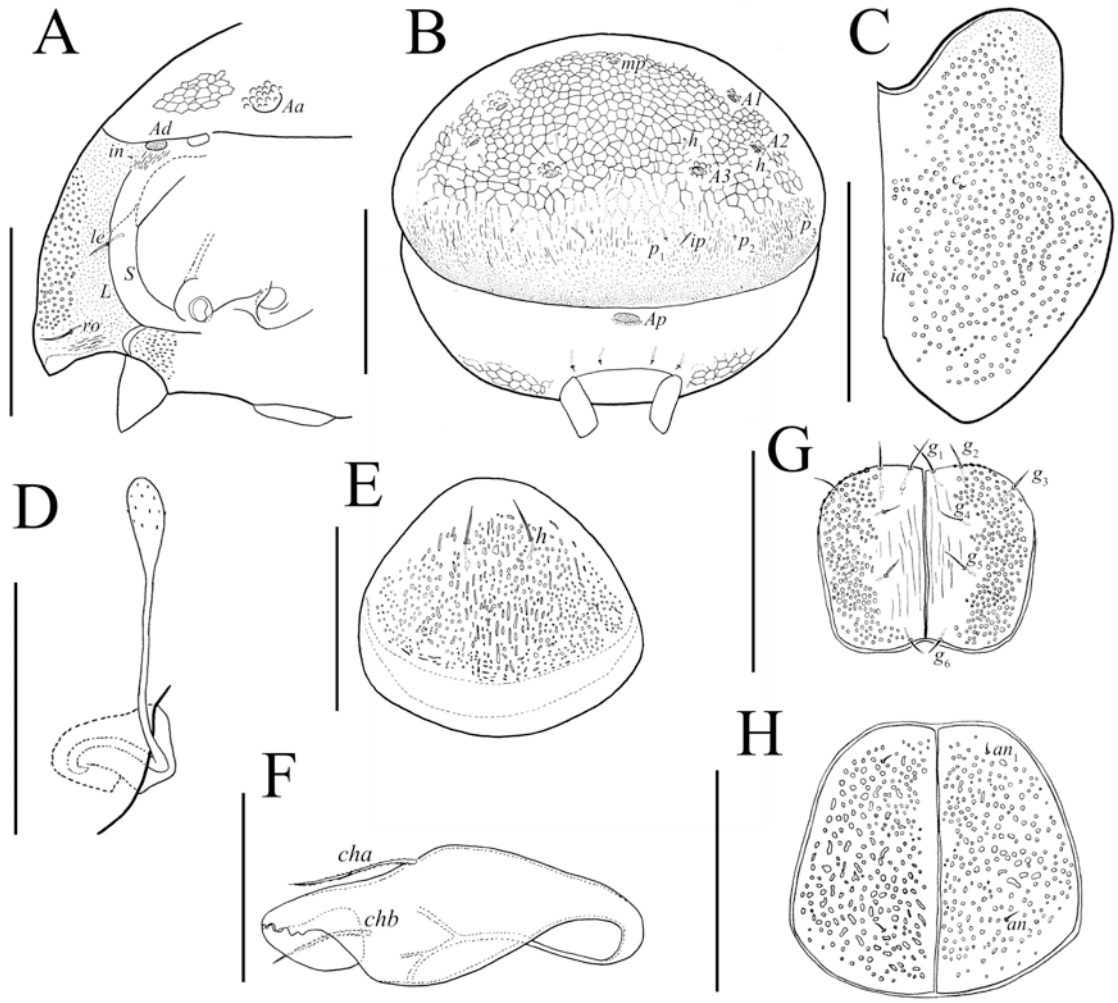


Fig. 31. Adult *Cosmogalumna ornata*. A – aspidosoma; B – opisthosoma, posterior view; C – pteromorph; D – sensillus; E – mentum plate; F – chelicera; G – genital plates; H – anal plates. Scale bar (A, B, C) 100 μm, (D, E, F, G, H) 50 μm.

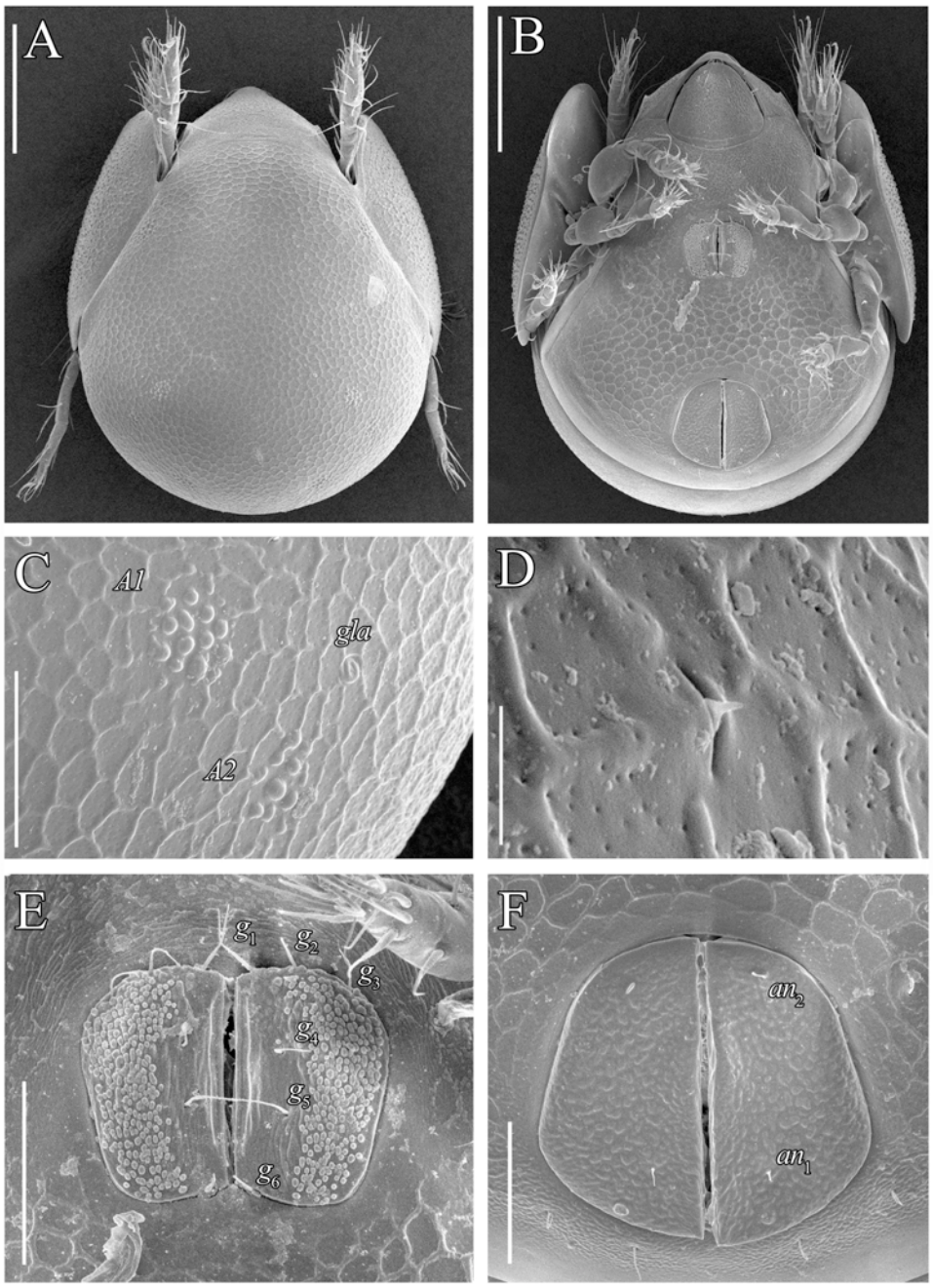


Fig. 32. Scanning electron micrographs of adult *Cosmogalumna ornata*. A – dorsal view; B – ventral view; C – porose area *A1* and *A2*; D – notogastral seta *lp*; E – genital plates; F – anal plates. Scale bar (A, B) 100 μm, (C, E, F) 30 μm, (D) 5 μm.