To the knowledge of the genus *Sadocepheus* (Acari, Oribatida, Compactozetidae)

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**Abstract**
The oribatid mite genus *Sadocepheus* Aoki, 1965 is recorded for the first time from the Philippines; one new species is described from the leaf litter of secondary forest in Mindanao Island. *Sadocepheus donvictorianoensis* Ermilov & Corpuz-Raros **sp. nov.** differs from the most similar species, *S. elevatus* Mahunka, 1987 by the larger body size, long medial and short lateral teeth of the lamellae and shorter adanal setae. Revised generic diagnosis and the data on distribution and ecology of *Sadocepheus* species are presented.

**Key words:** systematics, morphology, new species, distribution, ecology, *Sadocepheus*, Philippines.

**Introduction**
The oribatid mite genus *Sadocepheus* (Acari, Oribatida, Compactozetidae) was proposed by Aoki (1965) with *Sadocepheus undulatus* Aoki, 1965 as type species. At present, the genus comprises 12 species and one subspecies, which collectively have a semicosmopolitan distribution (Subías 2004, updated 2017).

During taxonomic study of the Philippine mite material, we found a new species of *Sadocepheus*. This genus is recorded for the first time from this country. The main goal of the paper is to describe and illustrate a new species, revise generic diagnosis and give information on distribution and ecology of *Sadocepheus* species in the world.

This work is part of our study on the oribatid fauna of the Philippines (e.g. Ermilov & Corpuz-Raros 2015, 2016, 2017).

**Material and Methods**
Holotype (female) and two paratypes (female and male): Mt. Malindang, Barangay Lake Duminagat, Don Victoriano municipality, Misamis Occidental Province, Mindanao Island, Philippines, sample of leaf litter from secondary forest, extracted with Berlese funnel, 16.VIII.2001, collected by William Sm. Gruezo.

Specimens were mounted in lactic acid on temporary cavity slides for measurement and illustration.
Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate. Notogastral width refers to the maximum width of notogaster in dorsal view. Lengths of body setae were measured in lateral aspect. All body measurements are presented in micrometers. Formulas for leg setation are given in parentheses according to the sequence trochanter–femur–genu–tibia–tarsus (famulus included). Formulas for leg solenidia are given in square brackets according to the sequence genu–tibia–tarsus. Drawings were made with a camera lucida using a Leica transmission light microscope “Leica DM 2500”. Morphological terminology used in this paper follows that of F. Grandjean: see Trévé & Vachon (1975) for references, Norton (1977) for leg setal nomenclature, and Norton & Behan-Pelletier (2009), for overview.

The following abbreviations are used on the figures: lam – lamella; mtl, ltl – medial and lateral teeth of lamella, respectively; irt – inner rostral tooth; tu – tutorium; ro, le, in, bs – rostral, lamellar, interlamellar and bothridial setae, respectively; la, lm, lp, h, p – notogastral setae; ht – humeral tooth; im, ip, ih, ips – notogastral lyrifissures; gla – opisthonal gland opening; sac – saccule; h, m, a – subcapitular setae; or – adoral seta; cm, acm, ul, sul, vt, lt – palp setae; cha, chb – cheliceral setae; 1a, 1b, 1c, 2a, 3a, 3b, 3c, 4a, 4b, 4c – epimeral setae; Pd I, Pd II – pedotecta I and II, respectively; dis – discidium; g, ag, an, ad – genital, aggenital, anal and adanal setae, respectively; iad – adanal lyrifissure; p.o. – preanal organ; p.a. – porose area; trt – trochanteral tooth; ω, σ, φ – solenidia; v, ev, l, d, ft, tc, p, u, a, s, pv – leg setae; Tr, Fe, Ge, Ti, Ta – leg trochanter, femur, genu, tibia, tarsus, respectively.

The following collection is used: TSUMZ – Tyumen State University Museum of Zoology, Tyumen, Russia.

Revised generic diagnosis

Genus Sadocepheus Aoki, 1965

Type species: *Sadocepheus undulatus* Aoki, 1965

*Adul*. Compactozetidae (as Cepheidae in Sitnikova 1975b and Norton & Behan-Pelletier 2009). Body broad, medium sized or large, covered by thick layer of amorphous cuticula, surface without heavy ornamentation and sculpture. Rostrum rounded. Lamellae long and very broad, located dorsolaterally and usually well separated, rounded, truncate or bifurcate distally. Translamella absent or present. Tutoria present. Prodorsal setae setiform, ro inserted on prodorsum, le on the lamellar ends, in mediobasally on the lamellae or in the interlamellar region. Bothridial setae of medium size or long, lanceolate, fusiform, clavate, bacilliform or brush-shaped. Anterior notogastral margin present or absent. Humeral regions of notogaster with triangular, quadrangular or bifurcate expansions. Notogaster with nine or ten pairs of setiform setae inserted on notogastral surface or tubular apophyses, dorsal setae c, la, lm, lp, h3, h3, located laterally, setae h1, p1–p3 posteriorly on the notogaster, centrodorsal notogastral part without setae. Subcapitular setae setiform. Palps setation 0–2–1–3–9(+ω), solenidion fused to distal seta mediodistally. Axillary saccules present. Chelicerae with two setiform setae inserted close to each other dorsally. Trägårdh’s organ tapered. Epimeral setal formula 3–1–3–3. Pedotecta I represented by large laminae, pedotecta II quadrangular in ventral view. Discidia strong, elongate triangular. Six to nine pairs of genital, one pair of aggenital, two pairs of anal and three pairs of adanal setae setiform. Adanal lyrifissures located close to anal aperture, in paraanal or inverse apoanal positions. Legs monodactylyous.

*Juvenile instars*. Not known.

Description of new species

*Sadocepheus donvictorianoensis* Ermilov & Corpuz-Raros sp. nov.

(Figs 1–10)

**Diagnosis.** Body size: 747–780 × 630. Lamellae bifurcate distally, with long medial and short lateral teeth. Bothridial setae long, brush-shaped. Humeral regions of notogaster triangularly pointed. Notogastral setae smooth, p2, p3, h1, p1, short, other setae of medium size. Epimeral and anogenital setae setiform, smooth.
Adanal setae long, shorter than length of anal plates. Leg claws slightly barbed on dorsal side. Leg trochanters III, IV with strong tooth dorsoanteriorly.

**Description.** Measurements. Body length: 780 (holotype, female), 747, 780 (two paratypes, female and male, respectively); notogaster width: 630 (holotype and two paratypes).

**Integument** (Figs 1, 4). Body color light dark brown. Amorphous cerotegument well-developed. Body surface densely microfoveolate (visible under high magnification in dissected specimens). Lamellae indistinctly rugose. Subcapitular mentum with several ridges. Notogaster with granulate band (diameter of granules up to 4) posterolaterally, humeral regions also granulate.

Figure 1. *Sadocepheus donvictorianoensis* Ermilov & Corpuz-Raros **sp. nov.**, adult: Dorsal view (legs not illustrated). Scale bar 100 μm.
**Figure 2.** *Sadocereus donvictorianoensis* Ermilov & Corpuz-Raros sp. nov., adult: Ventral view (legs not illustrated). Scale bar 100 μm.

**Prodorsum** (Figs 1, 3, 5). Rostrum narrowly rounded. Lobe with large median inner rostral tooth. Lamellae bifurcate distally, with long medial and short lateral teeth and semi-oval indentation between them. Rostral setae (28–32) setiform, thin, smooth, pressed to surface of the prodorsum. Lamellar setae (86–94) setiform, thickened, barbed, directed medially. Interlamellar setae (32–41) setiform, smooth. Exobothridial setae and their alveoli absent. Bothridial setae (102–114) with long stalk and short, brush-like head. Exobothridial setae and their alveoli absent. Tutoria ridge-like.
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Figures 3–4. Sadocepheus donvictorianoensis Ermilov & Corpuz-Raros sp. nov., adult: 3 – anterior part of body, lateral view (legs, gnathosoma and epimeral region not illustrated); 4 – posterior view. Scale bar 100 μm.

Notogaster (Figs 1, 3, 4). Anterior margin of notogaster slightly developed, concave medially. Humeral regions triangularly pointed. Ten pairs of notogastral setae, setiform, smooth, inserted on the notogastral surface; \( p_2, p_3 \) (20–24), \( h_1, p_1 \) (28–32) shorter and thinner than others (65–69). Lyrifissures \( im, ip, ih, ips \) and opisthonotal gland openings well visible, \( ia \) not evident.
Figures 5–10. *Sadocepheus donvictorianoensis* Ermilov & Corpuz-Raros sp. nov., adult: 5 – rostrum, anterior view; 6 – subcapitulum, ventral view; 7 – palptasus, left, paraxial view; 8 – chelicera, left, paraxial view; 9 – trochanter, femur and genu of leg III, left, antiaxial view; 10 – leg IV (tibial solenidion broken), left, antiaxial view. Scale bars 60 μm (5, 9, 10), 15 μm (6–8).
Gnathosoma (Figs 2, 6–8). Subcapitulum longer than wide (180–192 × 123–139). Subcapitular setae setiform, smooth, m (20–24) shorter and thinner than a and h (32). Adoral setae (16) setiform, smooth. Palps (82) with typical setation 0–2–1–3–9 (+oa). Postpalpal setae (6) spiniform, smooth. Axillary sacculi distinct, slightly elongated. Chelicerae (159–168) with two setiform, barbed setae (32). Trägårdh’s organ distinct, granulate.

Epimeral and lateral podosomal regions (Figs 2, 3). Apodemal border II and sejugal border complete, apodemal border III not visible. Epimeral setae setiform, smooth, 1a, 1b, 1c, 2a, 3a (16–20) shorter and thinner than 3b, 4a (45–53), 3c, 4a, 4c (57–65). Pedotecta I, II and discidia of typical morphology for the genus.

Anogenital region (Figs 2, 4). Six pairs of genital (16–20), one pair of aggenital (16–20), three pairs of anal (ad1, ad2, 61–69, ad3, 49–53) and two pairs of anal (10–12) setae setiform, smooth. Adanal lyrifissures located slightly inverse apoanal.

Legs (Figs 9–10). Claw of each leg slightly barbed on dorsal side. Trochanters III, IV with strong tooth dorsoanteriorly. Porose areas on femora I, II, femora III, IV and trochanters III, IV poorly visible. Formulas of leg setation and solenidia: I (1–4–3–4–19) [1–2–2], II (1–4–3–4–16) [1–1–2], III (2–3–1–3–15) [1–1–0], IV (1–2–2–2–12) [0–1–0]; homology of setae and solenidia indicated in Table 1. Majority of solenidia were broken. Famuli short, erect, swollen and blunt distally, inserted lateral to solenidia \( \omega_1 \). Setae setiform, smooth or slightly barbed.

| Leg | Tr | Fe | Ge | Ti | Ta |
|-----|----|----|----|----|----|
| I   | \( v' \) | \( d, (l), bv'' \) | \( l, v', \sigma \) | \( l, (v), \varphi_1, \varphi_2 \) | \( ft, (tc), (it), (p), (a), (a), s, (pv), (pl), l'', \varepsilon, \) \( \omega_1, \omega_2 \) |
| II  | \( v' \) | \( d, (l), bv'' \) | \( l, v', \sigma \) | \( l, (v), \varphi \) | \( ft, (tc), (it), (p), (a), (a), s, (pv), l'', \omega_1, \omega_2 \) |
| III | \( l', v' \) | \( d, l', ev' \) | \( l', \sigma \) | \( l', (v), \varphi \) | \( ft, (tc), (it), (p), (a), (a), s, (pv) \) |
| IV  | \( v' \) | \( d, ev' \) | \( d, l' \) | \( l', (v), \varphi \) | \( ft'', (tc), (p), (a), (a), s, (pv) \) |

Roman letters refer to normal setae, Greek letters refer to solenidia (except \( \varepsilon - \) famulus). One apostrophe (’) marks setae on anterior and double apostrophe (”) setae on posterior side of the given leg segment. Parentheses refer to a pair of setae.

Type deposition. The holotype (female) and two paratypes (female and male) are deposited (ethanol with drop of glycerol) in TSUMZ.

Etymology. The specific name “donvictorianoensis” refers to Don Victoriano, the Philippine municipality (in Misamis Occidental Province, Mindanao Island), where holotype and one paratype of the new species were discovered.

Remarks. Sadocephus donvictorianoensis Ermilov & Corpuz-Raros sp. nov. is morphologically most similar to Sadocephus elevatus Mahunka, 1987 from Borneo in having bifurcate lamellae and long adanal setae. However, the new species differs from the latter by the larger body size (747–780 × 630 versus 542–591 × 486–518), long medial and short lateral teeth of the lamellae (versus teeth similar in length) and setiform adanal setae shorter than length of anal plates (versus adanal setae flagellate, longer than length of anal plates).

Distribution and ecology of Sadocephus

Representatives of the genus Sadocephus were recorded from the Australian (New Zealand), Nearctic (U.S.A.), Neotropical (Brazil, Chile, Colombia, Paraguay), Oriental (Borneo, Java, Philippines, southern China), Palaeartic (Southeastern Russia, Japan) regions.

The species S. breviseta (Balogh, 1986) was described from Bogota, Columbia without information on sample type (Balogh 1986); S. dubius Hammer, 1979 was collected from ferns, liverworts, Selaginella, mosses on branches and roots, different small plants and dead leaves on mountain slope with scattered, tall trees and shrubs in the Selecta Park, Java (Hammer 1979); S. elevatus Mahunka, 1987 was found in dry and decaying leaf litter in forests of Sepilok, Borneo (Mahunka 1987); S. foveolatus Luxton, 1988 was recorded...
from wet moss beneath beech in Canaan Road, Takaka Hill, Nelson, New Zealand (Luxton 1988); *S. franzi* (Balogh, 1986) was described from soil in Cuesta la Starria, Chile (Balogh 1986); *S. granulatus* (Balogh & Mahunka, 1969) was collected from decaying leaves interwoven with hyphae in forest about 20 km from Manaus, Brazil (Balogh & Mahunka 1969), also known from Paraguay without information on sample type (Balogh & Mahunka 1981) and different Brazilian localities (see summarized data from Oliveira et al. 2017); *S. longisetus* (Balogh, 1986) was reported from litter or rain forest in eastern Cordilles at Monterredondo, Colombia (Balogh 1986); *S. makarchevae* Sitnikova, 1975 was found from litter and dust of stub of forest in Primorsky Kray, Russia (Sitnikova 1975a); *S. subniger* (Ewing, 1917) was collected from ground under old pieces of forest in Iowa, U.S.A. (Ewing 1917); *S. tohokuensis* Fujikawa, 2003 was described from lichens and misses on the trunks of living beech trees in Nippon, Japan (Fujikawa 2003); *S. undulatus undulatus* Aoki, 1965 was reported from Sado Island, Japan without information on sample type (Aoki 1965), some localities in Japan (e.g. Aoki et al. 2004; Harada et al. 2008) and China (see summarized data from Chen et al. 2010); *S. undulatus setiger* Fujita & Fujikawa, 1986 was collected from shady place, covered with bamboo-grass, and fern in mixed forest of Naroyo, Japan (Fujita & Fujikawa 1986); *S. yakuensis* Aoki, 2006 was described from Shiratani Unsui Valley, Yaki Island, the Okinawa Islands, Japan without information on sample type (Aoki 2006).

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**References**

Aoki, J. (1965) Neue Oribatiden von der Insel Sado (Acarina, Oribatei). *Japanese Journal of Zoology*, 14 (3), 1–12.

Aoki, J. (2006) New and newly recorded oribatid mites (Arachnida, Acari, Oribatida) from the Ryukyu Islands, Japan. *Bulletin of the National Museum of Natural Science, Tokyo, Serie A*, 32 (3), 105–124.

Aoki, J., Yano, M. & Yano, K. (2004) Oribatid Mites of Sanshin Shrine in Odawara. *Natural history report of Kanagawa*, 25, 41–46 [in Japanese].

Balogh, P. 1986. The species of the genus *Hamotegaeus* Balogh & Mahunka, 1969 (Oribatei, Cepheoidea). *Opuscula Zoologica Budapest*, 22, 51–57.

Balogh, J. & Mahunka, S. (1969) The scientific results of the Hungarian soil zoological expeditions to South America. 10. Acari: Oribatids, collected by the second expedition. I. *Acta Zoologica Academiae Scientiarum Hungaricae*, 15 (1–2), 1–21.

Balogh, J. & Mahunka, S. (1981) New data to the knowledge of the oribatid fauna of the Neogaea, VI. (Acari). *Acta Zoologica Academiae Scientiarum Hungaricae*, 27 (1–2), 49–102.

Chen, J., Liu, D. & Wang, H.-F. (2010) Oribatid mites of China: a review of progress, with a checklist. *Zoosymposia*, 4, 186–224.

Ermilov, S.G. & Corpuz-Raros, L. (2015) A new subgenus and two new species of oribatid mites of the genus *Neoribates* (Acari, Oribatida, Parakalummidae) from the Philippines. *Zootaxa*, 3956 (2), 224–238.

Ermilov, S.G. & Corpuz-Raros, L.A. (2016) Contribution to the knowledge of carabodid oribatid mites (Acari, Oribatida, Carabodiidae) of the Philippines. *Systematic and Applied Acarology*, 21 (8), 1055–1068.

Ermilov, S.G. & Corpuz-Raros, L. (2017) New data on the Philippine oribatid mite fauna, with a contribution to knowledge of the genus *Drymobatoides* (Acari, Oribatida, Mochlozetidae). *Acarologia*, 57 (2), 295–308.

Ewing, H.E. (1917) New Acarina. Part II. Description of new species and varieties from Iowa, Missouri, Illinois, Indiana, and Ohio. *Bulletin of the American Museum of Natural History*, 37, 149–172.
Fujikawa, T. (2003) Thirteen new species from the Shirakami-sanchi World Heritage Area, Nippon (Acari, Oribatida). *Acarologia*, 44 (4), 369–392.

Fujita, M. & Fujikawa, T. (1986) List and description of oribatid mites in the forest litter as materials introducing soil animals into crop field of Nayoro (I). *Edaphologia*, 35, 5–18.

Hammer, M. (1979) Investigations on the oribatid fauna of Java. *Det Kongelige Danske Videnskaben Selskab Biologiske Skrifter*, 22 (9), 1–78.

Harada, H., Ichisawa, K. & Nurmamat, G. (2008) List of oribatid mites found in the Hakone area of Central Japan. *Natural History Report of Kanagawa*, 29, 151–158 [in Japanese].

Luxton, M. (1988) Mites of the family Compactozetidae (Cryptostigmata: Eutegaeoidea) in New Zealand. *Zoologischer Anzeiger*, 221 (5–6), 303–313.

Mahunka, S. (1987) Neue und interessante Milben aus dem Genfer Museum L.X. Oribatids from Sabah (East Malaysia) II. (Acari: Oribatida). *Revue Suisse de Zoologie*, 94 (4), 765–817.

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. (Editor). Biology of oribatid mites. SUNY College of Environmental Science and Forestry, Syracuse, 33–61.

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

Oliveira A.R., Argolo P.S., de Moraes G.J., Norton R.A. & Schatz H. (2017) A checklist of the oribatid mite species (Acari: Oribatida) of Brazil. *Zootaxa*, 4245 (1), 1–89.

Sitnikova, L.G. (1975a) Revision of oribatid mites of the family Cepheidae Berlese, 1896 with description of new species from USSR. *Entomologicheskoe Obozrenie*, 54 (31), 446–462 [in Russian].

Sitnikova, L.G. (1975b) The family Cepheidae Berlese, 1896. In: Ghilyarov, M.S. (Editor). Key to soil inhabiting mites. Sarcopiformes. Nauka Press, Moscow, 143–155 [in Russian].

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. Online version accessed in February 2017, 598 pp.

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