Species Diversity **26**: 93–99
Published online 22 March 2021
DOI: 10.12782/specdiv.26.93

Ameronothrus twitter sp. nov. (Acari, Oribatida) a New Coastal Species of Oribatid Mite from Japan

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(Received 1 July 2020; Accepted 8 February 2021)

http://zoobank.org/8753BCD8-5C14-497E-8749-3E8DF1998BB1

We describe a new species of marine associated oribatid mite, *Ameronothrus twitter* Pfingstl and Shimano, sp. nov., from a wharf of fishing port (Choshi Outer Fishing Port), Chiba, Honshu, Japan. This species was spotted for the first time ever on photographs posted on Twitter. *Ameronothrus twitter* Pfingstl and Shimano, sp. nov. is characterized by a specific cuticular notogastral pattern consisting of distinct nodules that are fused to irregular ridges in the median anterior and the median posterior region. Additionally, it features a unique combination of fused lamellar keels, presence of primilateral setae on tarsus I, presence of dorsal companion setae on genu I, II, III and all tibiae and tarsal distal setae ending with a small nodule. *Ameronothrus twitter* Pfingstl and Shimano, sp. nov. is the second species of this genus found on Japanese islands, which represents the southernmost occurrences of this taxon in the Asian Pacific region.

Key Words: Ameronothridae, morphology, Honshu, temperate zone, littoral.

Introduction

The genus *Ameronothrus* Berlese, 1896 consists of a group of marine associated oribatid mites which show varying degrees of relevance to the intertidal ecosystem. Some species are exclusively intertidal taxa dwelling in the zone between low and high tide, others are so called 'transition-species' that can be found in a wider range of coastal habitats, e.g., salt marshes, river estuaries, and a few are confined to coastal terrestrial habitats (Schulte et al. 1975; Schulte and Weigmann 1977). These animals feed on a wide variety of food, including lichen, algae and fungi (Schulte 1976), and most species are ovoviviparous with the larvae hatching soon after the deposition of the eggs (e.g., Søvik 2003). Presently, the genus comprises 14 species, and all of them are distributed in cold temperate and polar areas of the Northern Hemisphere (Schulte 1975; Pfingstl 2017). Three of these species are known to occur on Asian Pacific shorelines, i.e., *Ameronothrus nidicola* Sitnikova, 1975 and *Ameronothrus oblongus* Sitnikova, 1975 were found both on Kamchatka and the Kuril Islands (Sitnikova 1975; Klimov 1998), additionally, the latter was also reported on Sakhalin Island (Ryabinin 2015), and *Ameronothrus yoichi* Pfingstl and Shimano, 2019 was recently found in an embankment on the coast of Hokkaido (Pfingstl et al. 2019). The report of *A. yoichi* was the first record of any ameronothrid species from a Japanese island and represented the southernmost occurrence of an *Ameronothrus* in the Asian Pacific region (Pfingstl et al. 2019).

By coincidence, one of the authors (SS) of this work recently discovered photographs of marine associated mites posted on social media (https://twitter.com/yatsume_project/status/1125014185417383937?s=20) by TN (@yatsume_project) and immediately recognized them to be *Ameronothrus*. Consequently, he went to the place where the photographs were taken and found the exact same population (colony) with the help of Twitter messages from TN (because they, SS and TN, did not know each other in real world at that time). Surprisingly, the found specimens represented an undiscovered species that is distributed on the coast of Choshi, Chiba, Japan. Therefore, aim of the present paper is to provide a detailed description of this species and to update knowledge about the biogeography of the genus *Ameronothrus*.

Materials and Methods

Samples. Japan, Honshu, Chiba Prefecture, Choshi City, Choshi Outer Fishing Port (Choshi-Gaikou) on a wharf; coordinates (DD) 35.738853N, 140.867088E; 8 May 2019; leg.

S. Shimano.

Main sand samples, from the corner of car chocks on the embankment, were taken with a small shovel and some additional samples of littoral algae and lichens were scraped off concrete walls with the same shovel. Afterwards the samples were put in Berlese-Tullgren funnels for about 24 hours to extract mites. For a part of sand samples, floating method (Schwinghamer 1981) modified with 1g centrifugation and standing for 15 minutes was used to isolate mites by Ludox HS-40 colloidal silica (Sigma-Aldrich Co. LLC).

Drawings and photographs. Preserved animals were embedded in Berlese mountant for microscopic investigation in transmitted light. Drawings were made with an Olympus BH-2 Microscope equipped with a drawing attachment, and then processed and digitized with the free and open-source vector graphics editor Inkscape (https://inkscape.org).

For photographic documentation, specimens were air-dried and photographed with focus-stack function of a Keyence VHX-5000 digital microscope. In the field, macro photographs of habitats were taken with an Olympus OM-D E-M1 Mark II with Laowa 25 mm F2.8 2.5–5× Ultra Macro lens.

Morphological terminology used in this paper follows that of Grandjean (1953), Schubart (1975) and Norton and Behan-Pelletier (2009).

Taxonomy

Family **Ameronothridae** Vitzthum, 1942
Genus ***Ameronothrus*** Berlese, 1896
[Japanese name: Hamabe-dani-zoku]

Type species. *Eremaeus lineatus* Thorell, 1871.

Ameronothrus twitter Pfingstl and Shimano, sp. nov.
[New Japanese name: Choshi-hamabe-dani]
(Figs 1–3)

Type material. Holotype: adult female (length 766 µm, width 500 µm), Japan, Honshu, Choshi, 8 May 2019, coll. S. Shimano. Four paratypes: two males (length 613–625 µm, width 344–369 µm) and two females (length 703–750 µm, width 438–488 µm); same data as for holotype. All type specimens preserved in ethanol, and deposited at the Collection of Arachnida, Department of Zoology, National Museum of Nature and Science, Tokyo (NMST) [collection numbers: holotype NSMT-Ac 14675 and measured four paratypes NSMT-Ac 14676–14679]. Additional two paratypes [coll. nr. 63985] are deposited in the collection of the Senckenberg Museum für Naturkunde Görlitz (SMNG).

Etymology. The specific name '*twitter*' refers to the social media platform, Twitter on which this species was spotted for the first time ever. The name is treated as indeclinable.

Differential diagnosis. Colour dark brown, nearly black. Body length 613–766 µm. Notogastral cuticle with nodules, which are fused to large irregular ridges in anterior and especially posterior median notogastral areas. Prodorsal lamellar keels converging, anteriorly fused by a semicircular translamella. Sensilli short, capitate. Interlamellar and exobothridial setae absent. Labiogenal articulation complete. Primilateral setae on tarsus I present. Dorsal companion seta *d* on genu I, II and III and all tibiae present. Tarsal distal setae ending with a small nodule.

Description. *Integument.* Cuticle thin, easily deformable, showing nodular appearance. In central notogastral area, these nodules loosely distributed, but in anterior and lateral notogastral parts densely packed and mostly fused to larger irregular ridges in anterior and posterior median area of notogaster. Cerotegument densely covering whole body. Colour dark brown, nearly black in stereomicroscope.

Prodorsum (Figs 1A, 2A). Rostrum rounded in dorsal view, demarcated from remainder of prodorsum by transverse caudally arched ridge *ct*. Obvious lamellar keels (*cl*) converging, anteriorly fused by a semicircular translamella. Interbothridial area with larger irregular ridges. Rostral seta (*ro*) spiniform, long and smooth (37–60 µm). Lamellar seta (*le*) short, thickened, blunt and smooth (12–15 µm). Interlamellar seta (*in*) and exobothridial seta (*ex*) absent. Bothridium cup-like, orifice circular. Sensillum (*ss*) short (approx. 37 µm), strongly clavate, globular head with inconspicuous irregular elevations.

Gnathosoma. Palp pentamerous 0-2-1-3-9 (solenidion not included). Solenidion *ω* on palptarsus associated with eupathidium *acm*. Atelebasic rutellum. Distal part with wide paraxial tooth followed by smaller tooth merging into an undulating membranous edge. Incision between rutellar teeth stronger sclerotized. Setae *a* (~18 µm) and *m* (~23 µm) long, robust and smooth. Mentum regular, seta *h* setiform, robust (~30 µm). Labiogenal articulation complete. Chelicera chelate, mobile digit darker sclerotized; distinct strong interlocking teeth. Trägårds organ slender blunt lamella, slightly upward orientated. Seta *cha* and *chb* robust and finely barbed, similar in length (~46 µm).

Gastronotic region (Figs 1A, 2A). Oval in dorsal view, convex in lateral view; no distinct border between anterior median notogastral and prodorsal region. Ascleritic incision *pgn* visible along lateral humeral area. Fifteen pairs of short, thickened notogastral setae (17–23 µm), $c_{1–3}$, *da*, *dm*, *dp*, *la*, *lm*, *lp*, $h_{1–3}$, $p_{1–3}$. Notogastral lyrifissures difficult to trace due to rough cuticular surface; *ia* between seta c_2 and c_3; *im* between seta *lm* and *lp*; others could not be detected. Orifice of opisthonotal gland (*gla*) not traceable due to strong ornamentation.

Lateral aspect (Fig. 2C). Pedotectum I and II absent. Discidium *dis* between acetabulum III and IV, developed as conspicuous rounded ridge.

Podosoma and venter (Figs 1B, 2B). Epimeral setation 3-1-2-2, all setae setiform and smooth, seta *1b* conspicuously longer (40–45 µm) than others (20–25 µm). Genital orifice large, rectangular with rounded corners, anteriorly broader. Six pairs of genital setae (25–30 µm) arranged in longitudinal rows along inner edge of plates, whereas fifth pair slightly laterally displaced. One pair of short, setiform aggenital setae *ag*. Strongly curved obvious transversal ridge between genital and anal opening. Anal valves subtriangu-

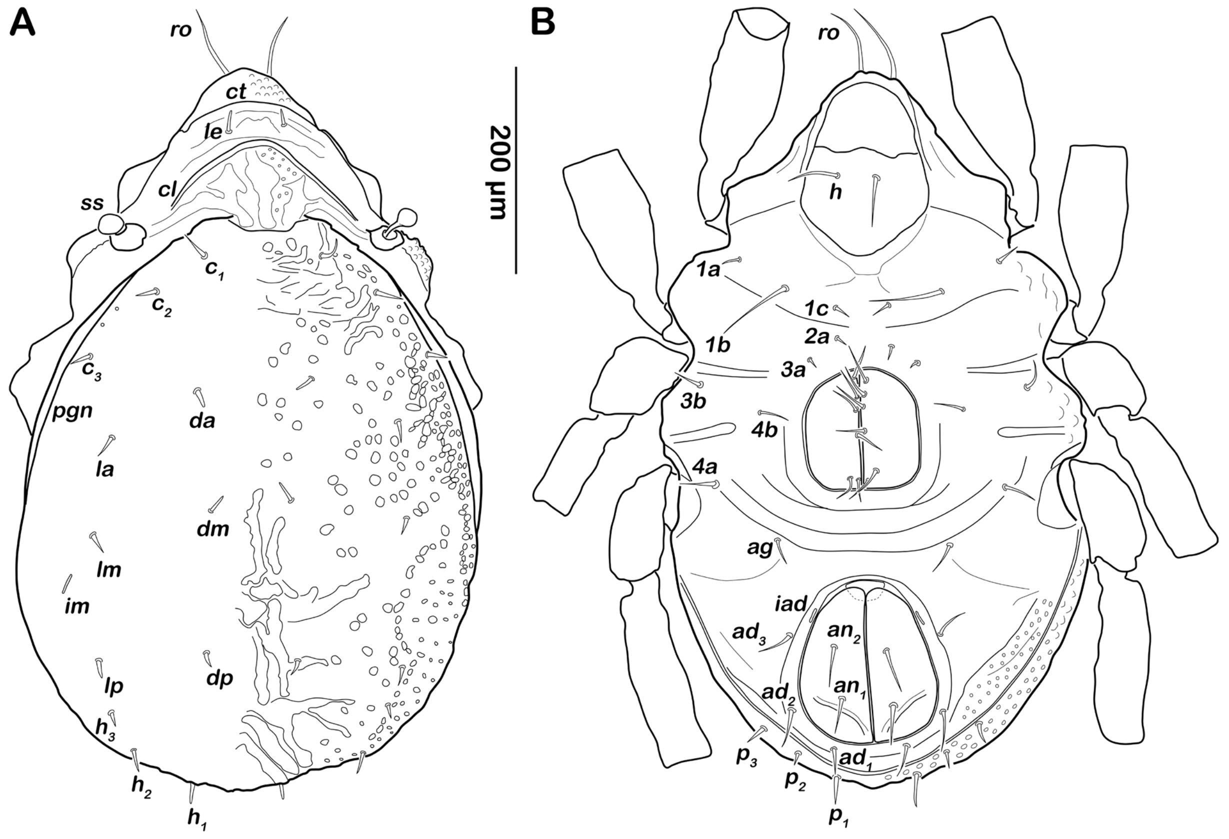

Fig. 1. *Ameronothrus twitter* Pfingstl and Shimano, sp. nov., adult female. A, Dorsal view, legs omitted; B, ventral view, mouthparts and legs distal segments omitted. Scale bar valid for both depictions.

lar, but strongly rounded. Two pairs of smooth anal setae, an_{1-2} (~30 µm); conspicuous oblique slightly curved ridge present posterior to seta an_1. Three pairs of spiniform adanal setae, ad_{1-3} (25–30 µm), first two pairs inserted laterally and third pair posterior of anal orifice. Lyrifissure *iad* flanking anterior third of anal plates.

Legs (Fig. 3). Ambulacrum tridactylous, median claw broad and strong, lateral claws weaker developed and dorsally slightly dentate. Extensive brachytracheae with slit-like stigmata on dorsal paraxial face of all femora and tracheal sacculi ventrally on all tibiae and dorsally on trochanter III and IV. Dorsal companion setae *d* associated with solenidia on genu I, II, III and all tibiae present. Primilateral setae of tarsus I present. Tectal (*tc*) and iteral (*it*) setae as well as most other terminal tarsal setae with spoon-shaped or nodular tips (these are sometimes difficult to observe). Famulus *ε* on tarsus I rod-like, blunt and next to solenidion ω_1, solenidion ω_2 shorter. Solenidia ω_1 and ω_2 on tarsus II adjacent. Formula of leg setation: I (0-4-3-5-18) (1-2-2); II (0-4-3-5-15) (1-1-2); III (2-3-2-4-15); IV (1-2-2-4-14).

Remarks. *Ameronothrus twitter* sp. nov. shows a unique cuticular structure, which allows to easily distinguish it from several other members of *Ameronothrus*. Two Russian species, *A. nidicola* and *A. oblongus* show strongly reticulate cuticular notogastral patterns (Sitnikova 1977), and though *A. yoichi* also shows a nodular notogastral cuticle, it lacks the conspicuous ridges in the anterior and posterior areas of notogaster as shown in *A. twitter* sp. nov. The European and North American species of *Ameronothrus* were classified into four groups based on morphological characters (Schubart 1975): (1) the *Ameronothrus marinus* (Banks, 1896) group, including *A. bilineatus* (Micheal, 1888), *A. schusteri* Schubart, 1970 and *A. schubarti* Weigmann and Schulte, 1975, (2) the *Ameronothrus maculatus* (Michael, 1882) group including *A. schneideri* (Oudemans, 1903), (3) the *Ameronothrus lineatus* (Thorell, 1871) group including *A. nigrofemoratus* (L. Koch, 1879) and (4) the *Ameronothrus lapponicus* Dalenius, 1963 group containing only this single species. *Ameronothrus twitter* sp. nov. can be easily distinguished from members of the *A. marinus* group by showing tarsal setae (*tc*) and (*it*) with nodules instead of hooks, and by adjacent solenidia ω_1 and ω_2 on tarsus II (these are clearly separated in the group). The primilateral setae (*pl*) on tarsus I are lacking in the *A. maculatus* group, but are present in *A. twitter* sp. nov. In the *A. lineatus* group the dorsal companion setae on all tibiae are lost whereas these are clearly present in *A. twitter* sp. nov., and finally *A. lapponicus* can be distinguished from the latter by its differently shaped pedipalp.

Considering the geographic proximity of *A. twitter* sp. nov. and *A. yoichi*, a close relationship of both Japanese species could be the case, but apart from cuticular similarities in the prodorsal and notogastral regions there are several striking differences, such as the reduction of dorsal companion setae, the loss of tarsal primilateral setae and the postanal position of all adanal setae in *A. yoichi*, contradicting

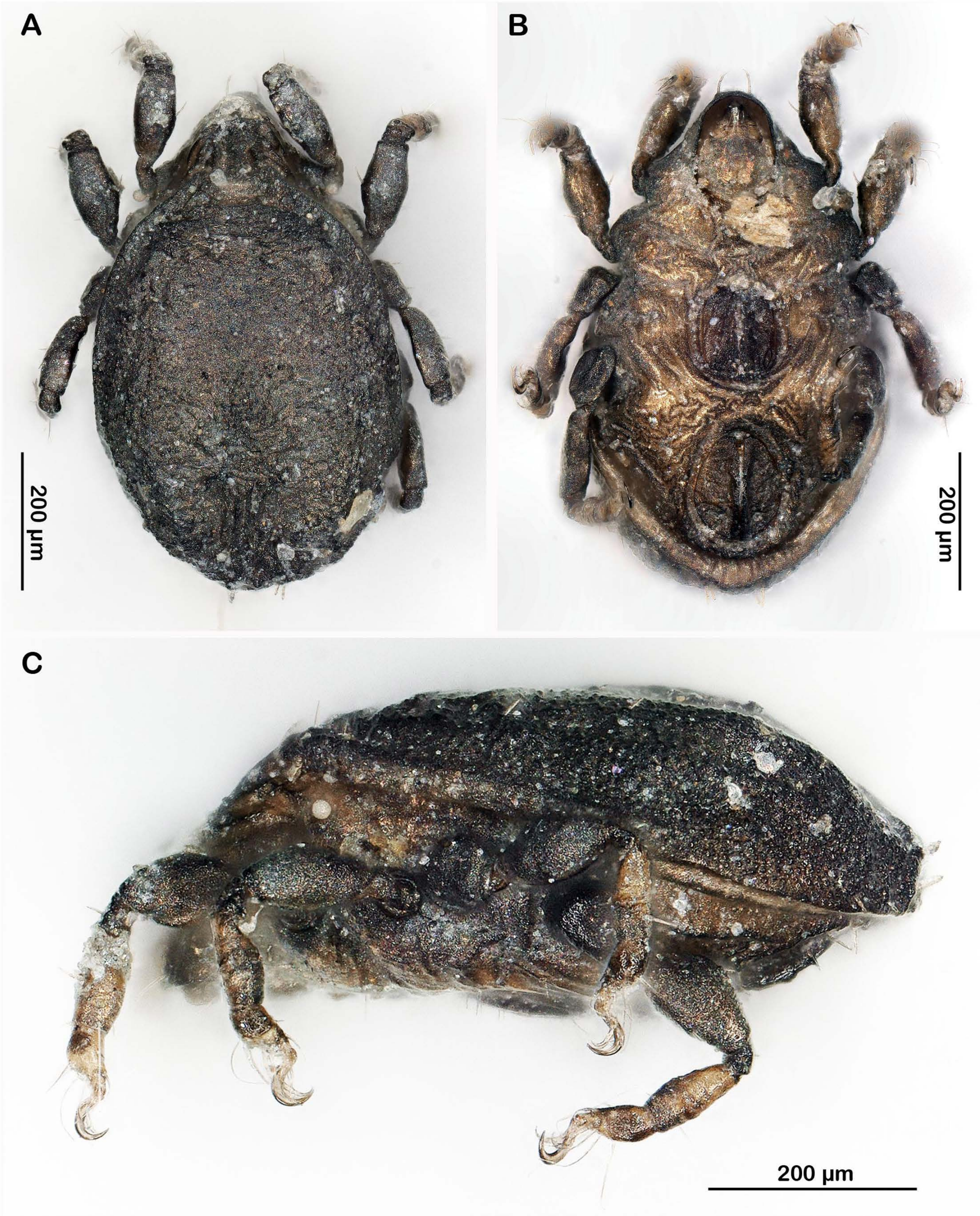

Fig. 2. *Ameronothrus twitter* Pfingstl and Shimano, sp. nov., stereomicroscopic photographs of adult female. A, Dorsal view; B, ventral view; C, lateral view.

such a relationship. However, Pfingstl et al. (2019) already stated that a clear assessment of phylogenetic relationships within *Ameronothrus* is not feasible yet due to incomplete descriptions of the Russian species and lacking molecular genetic data for nearly all taxa. A revision of the genus including morphological and molecular genetic data from all species could reveal natural relationships and provide important insights into the evolutionary history of this marine associated Holarctic group.

From an ecological point of view, we do not know much about this species, but aggregating individuals (a colony: Fig. 4C) of *A. twitter* sp. nov. were observed in a crack of a wharf on the 5 May, 2019 which was a quite cool day at the fishing port (Fig. 4A, B). On an earlier visit, on 2 May they were observed leaving the crack during warmer daytime (Fig. 4D, E). However, from the 6 May temperatures rose

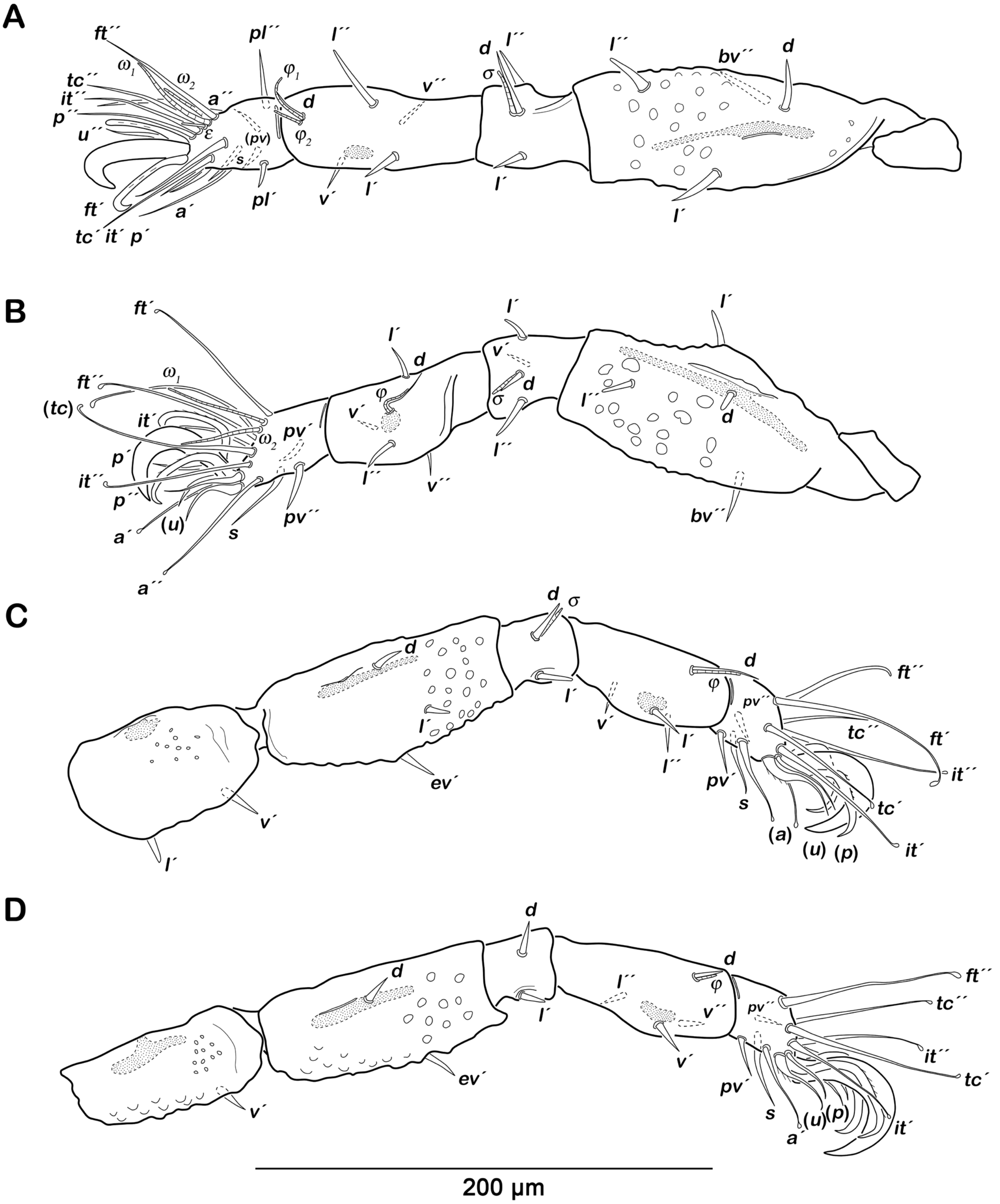

Fig. 3. *Ameronothrus twitter* Pfingstl and Shimano, sp. nov., adult legs. A, Right leg I dorsal view; B, left leg II dorso-lateral view of antiaxial aspect; C, left leg III antiaxial view; D, left leg IV antiaxial view. Scale bar valid for all legs.

considerably and no aggregating individuals were found on the following sampling day, on the 8 May. Aoki and Ohkubo (1974) reported colonies of *Phauloppia adjecta* Aoki and Ohkubo, 1974 found under bark in winter time and referred to this behavior as winter time aggregation. *Ameronothrus twitter* sp. nov. may also show aggregation behavior as protection against cold temperatures, but further observations are necessary. Presently, we only found this species on man-made concrete structures, but its original habitat may be coastal rocks. Several *Ameronothrus* species are known to live mainly in the sediment-free rock littoral (Schulte et al. 1975) and the same may apply to *A. twitter* sp. nov. Natural rocks and concrete structures are very similar substrates and lichen and algae are growing on both therefore, they are more or less equal habitats.

The accidental discovery of this species with the help of social media is quite unique and represents a rather unusual case. TN, who is not a scientist, came to the wharf

Fig. 4. *Ameronothrus twitter* Pfingstl and Shimano, sp. nov., collecting place and macro photography images (A and B taken by SS; C, D and E original photographs shared on Twitter by TN). A, Collecting place on the wharf of the fishing port (Choshi-Gaikou), Chiba, Japan, arrow pointing to exact location of mites; B, location of a colony in a crack between a car chock and the wharf, arrow pointing to the exact location of the colony; C, a colony of *A. twitter* Pfingstl and Shimano, sp. nov. in the colder day (11:23 am), 5 May 2019 (https://twitter.com/yatsume_project/status/1124999187626483717?s=20); D (https://twitter.com/yatsume_project/status/1123890470285918209?s=20) and E, moving individuals of *A. twitter* Pfingstl and Shimano, sp. nov. in the warmer day (11:57 am), 2 May 2019.

of the fishing port for fishing in his leisure time, but could not catch any fish at all. As one of his other hobbies is taking photographs of small arthropods, he randomly photographed some specimens that crossed his path this day and later uploaded it on twitter. SS checked the tweet with the photographs and video of oribatid mites and realized they probably belong to a new *Ameronothrus* species (Supplements 1 and 2).

Therefore, SS immediately went to Choshi-Gaikou and contacted TN via Twitter for guidance helping him to find the exact location where the photos were taken. SS found the colony and after examination in the lab it was clear this is a new species.

However, a handful of new species have already been discovered with the use social media (e.g., Wintertorn et al. 2012; Jaume-Schinkel et al. 2020), and one fungus species, namely *Troglomyces twitteri* Santam., Enghoff & Reboleira, was even the first to be found via twitter and named after it (Santamaria et al. 2020). All these cases show that social media platforms and citizen science can provide additional tools in biodiversity research. Moreover, in the future the increasing interplay between research and social media platforms will play an important role, but also a challenge for science and the dissemination of knowledge.

Acknowledgements

We would like to thank Dr. Ken-ichi Okumura (National Museum of Nature and Science, Tokyo) for the deposition of type specimens, and Drs. Hiroshi Yamasaki (Kyusyu University) and Hayato Tanaka (Tokyo Sea Life Park) for providing information about benthos floating method for isolation of mites.

This investigation was funded by the Austrian Science Fund (FWF): [I 3815] for TP and by bilateral Programs, Joint Research Projects (JSPS) and JSPS KAKENHI Grant Numbers 17K07271, 18K06392 for SS and SFH, research funds of the Asahi Glass Foundation and the Tokyo Metropolitan University Fund for TMU Strategic Research (Leader: Prof. Noriaki Murakami; FY2020–FY2022).

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Appendix

Supplement 1. Story of discovering the “undescribed species” on Twitter (by SS, one of authors) with screenshots of TN’s (one of authors) four tweets on PC browser. Available at https://doi.org/10.6084/m9.figshare.13728364.

Supplement 2. Tweeted video of mite’s walking by TN. Available at https://doi.org/10.6084/m9.figshare.13250393.