First Record of *Riccardoella (Proriccardoella) triodopsis* (Acariformes: Trombidiformes: Ereynetidae) from Japan, with Additional Morphological Information

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The parasitic mite *Riccardoella (Proriccardoella) triodopsis* Fain and Klompen, 1990 was sampled from two localities in Chiba prefecture, Japan. The sampled mites were identified based on palps and leg chaetotaxy and structure of famulus on tibia I. This study is represented by the second record of *R. triodopsis* inhabiting the pulmonate snail and the first discovery in Japan.

Key Words: Parasite, new record, Chiba Prefecture, mite.

Introduction

At present, eight species are known in the genus *Riccardoella* Berlese, 1923. Six out of the eight species were reported from the lung and body surface of terrestrial gastropods, and the remaining two species were found only from soils (Berlese 1923; Fain and van Goethem 1986; Fain and Klompen 1990; Fain and Barker 2003, 2004; André et al. 2004; Waki et al. 2018a). The members of genus *Riccardoella* are divided into two subgenera, *Riccardoella* Berlese, 1923 and *Proriccardoella* Fain and van Goethem, 1986, based on the morphology of setae and leg chaetotaxy. The subgenus *Riccardoella* contains only one species, *R. limacum* Schrank, 1776, which is the type species of the genus. The remaining seven species belong to the subgenus *Proriccardoella*.

In Japan, two species of the present genus were reported from terrestrial gastropods. *Riccardoella (Proriccardoella) tokyovensis* Waki and Shimano, 2018 was described from the lung of the clausiliid land snail, *Tauphaedusa tau* Boettger, 1877, in a forest city park in Tokyo, Japan (Waki et al. 2018a). *Riccardoella (Proriccardoella) reaumuri* Fain and van Goethem, 1986, which was described from the helicid land snail, *Arianta arbustorum* Linnaeus, 1758, in France, was reported from three species of land snails on Okinawajima-island (Waki et al. 2018b). In addition, Nakamura et al. (2006) reported *Riccardoella* sp., which was identified to the genus level, from soils in Shikoku, Japan. Here we report the occurrence of *R. triodopsis* Fain and Klompen, 1990 for the first time in Japan, since first taxonomically described from Alabama, USA. Additional morphological information is provided based on specimens newly collected.

Materials and Methods

Host land snails, *Acusta despecta sieboldtiana* Sowerby, 1839 (Pulmonata: Camaenidae), were sampled from two localities; Hegurishimo (35°05′20″N, 139°54′05″E) and Ohi (35°05′20″N, 139°58′16″E), Minami-Bousou City, Chiba Prefecture, Japan in 21 April and 7 September 2014, respectively. The land snails were transferred to the laboratory, and mites were collected as follows. We held each of the sampled snails by hands and observed its respiration holes and surface of the soft body once or twice a week for a month. When we found mites coming out from the respiration hole or walking around the mantle surface of the host, we collected specimens with a soft brush and then dropped into 99% EtOH for fixation and preservation. For morphological observation under a compound microscope, fixed mites were mounted, permeated, and sealed with Hoyer’s Medium on the slide. All measurements in the description are in micrometers (µm). The mites were identified based on Waki et al. (2018a). Line drawings were prepared with a camera lucida attached to the compound microscope (Eclipse Ni-U, Nikon). Morphological terminology followed André et al. (2004), Walter et al. (2009), and Waki et al. (2018a).

Mites sampled were identified by morphological observation under a compound microscope as follows with some additional information.
Family Ereynetidae Oudemans, 1931
[Japanese name: Yawasuji-dani-ka]
Genus Riccardoella Berlese, 1923
[Japanese name: Katatsumuri-dani-zoku]
Subgenus Proriccardoella Fain and van Goethem, 1986
[Japanese name: Fusage-katatsumuri-dani-azoku]
Riccardoella (Proriccardoella) triodopsis
Fain and Klompen, 1990
[New Japanese name: Nyumura-katatsumuri-dani]
(Figs 1–5)

Material examined. Twenty mites were sampled in this study. The following description is based on five adult females and three adult males sampled from Acusta despecta siebolditiana Sowerby, 1839 (Pulmonata: Camaenidae). These specimens examined are deposited in Meguro Parasitological Museum, Tokyo, Japan with accession numbers 21441 A–F (five females and one male) and 21442 A, B (two males).

Description of adult female. Body (Figs 1, 4). Length 356–413. Color pale orange. Surface of idiosoma, gnathosoma, and legs with striated cuticle.

Idiosoma (Figs 1, 4). Idiosoma oval. Idiosoma length 344–391 and width 237–288. Two pairs of lyrifissures (ia and im) present (Figs 1A, 4A, B). Lyrifissures ip indistinct. Lengths of setae on idiosoma: Dorsum: vi 24–30; ve 7–11; sci 49–77; sce 22–30; ci 20; c2 23–28; d1 18–21; e1 20–22; f1 20–21; f 53–64; h1 18–21; h2 23–31. Venter: Length of setae 1a, 3a, and 4a: 6–9. All setae weakly barbed. Setae sci and fI long and narrow (Fig. 4D). Other setae sub cylindrical (Fig. 4D). Variation of setae: single specimen (21441D) with additional vi seta (Fig. 4D).

Gnathosoma (Figs 1B, 2, 5A, B). Length 57–63 and width 57–67. No eyespot. All setae not prolonged by filaments.

Fig. 1. Idiosoma of Riccardoella (Proriccardoella) triodopsis (female, 21441A). A: Dorsal view, B: ventral view and coxae. Scale bar: 100 µm.

Fig. 2. Gnathosoma of Riccardoella (Proriccardoella) triodopsis (female, 21441B). Scale bar: 10 µm.
Palptarsus with 4 barbed setae (3–5) with fine tip and solenidion ω (3–4) (Fig. 5A, B), apically.

Legs (Figs 1B, 3, 5D–F). All legs cylindrical. Femur IV divided into 2 segments. All setae on legs not prolonged by filaments. Setation on legs (I–II–III–IV, without solenidion, eupathidion, and famulus included): tarsi I–IV 12-9-8-8; tibiae I–IV 5-3-3-3; genua I–IV 4-4-3-3; femora I–IV 6-4-3-3; trochanters I–IV 1-1-1-0; coxae I–IV 2-1-2-1. Leg chaetotaxy eupathidiotaxy and solenidiotaxy given in Table 1. Tibia I with oval erenynetal organ φ (Fig. 3A). Erenynetal organ consisting from: famulus (k″) 11–12 long and guard seta (l″) 13–17 long: famulus 65–82% of length of guard seta (Figs 3A, 5E, F). Famulus not forked apically. Solenidia on tarsi I–II 0–0 (Figs 3A, B, 5C), no solenidia on tibiae, genua, femora, trochanters, or coxae. Solenidion ω in tarsi I and II subcylindrical, placed on dorsal position between setae f″ζ and f‴ζ (Figs 3A, 5C). Length of solenidion ω in tarsi I 6–8 and II 4–5. Eupathidion ζ on tarsi 7–1-0-0. Eupathidion with long spine on tip (Fig. 5C, D). Pretarsus with two claws and empodium. Claws, ca. 10 times longer than width, containing inconspicuous dents.

**Description of male.** Male smaller than female but shape as in females. Body length (including gnathosoma) 313–357.


**Habitat.** This species inhabits the lung and body surface of the terrestrial gastropod, *A. despecta sieboldtiana* Sowerby, 1839, living in litter layers and on short plants near...
Remarks. The mite sampled in the present study belongs to the genus *Riccardoella* by having the following morphological characteristics of the genus (Fain and van Goethem 1986; Fain and Barker 2003; André et al. 2004; Waki et al. 2018a): palp with 3 segments; tibia I with 5 setae; trochanter I with single seta; femur IV with 3 setae; idiosoma with lyrifissure *im*. The sampled mites belong to the subgenus *Proriccardoella* by having following morphological features: trochanter III with a seta; coxa I with 2 setae; tarsus I with famulus consisting more than 60% the length of its guard seta (*l′″*); palptarsi and legs with setae not prolonged by a filament (see Fain and van Goethem 1986).

The mites sampled were identified as *R. triodopsis* based on a combination of the following morphologies: tarsi II–IV with 9, 8, and 8 setae, respectively; tibia I with 5 setae; femur I with 6 setae; trochanters I and III with a seta; coxae I and III with 2 setae; palptarsus with 4 setae; famulus (*k″*) on tibia I not forked apically.

*Riccardoella triodopsis* is similar to *R. oudemansi* Thor, 1932 in possession of morphological features: tarsi III and IV with 8 setae; tibia I with 5 setae; femora I and II with 6 and 4 setae, respectively. However, *R. triodopsis* is distinguished from *R. oudemansi* in the presence of 2 setae in coxa III and 4 setae on palptarsus whereas 3 setae present on both parts in *R. oudemansi*. Moreover, famulus is not forked

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**Table 1.** Leg chaetotaxy, eupathidiotaxy, and solenidiotaxy of *Riccardoella* (*Proriccardoella*) *triodopsis*. Single and double prime marks: anterior and posterior sides of the leg segment, respectively. Parentheses: a pair of setae.

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<tr>
<th>Leg</th>
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<th>Trochanter</th>
<th>Femur</th>
<th>Genus</th>
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<td>d, (l), (v), k′, ω</td>
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in its apical part in *R. triodopsis* but forked in *R. oudemansi*. *Riccardoella triodopsis* is also similar to *R. reaumuri* Fain and van Goethem, 1986 in the following morphological characters: tarsi III and IV with 8 setae; tibia I with 5 setae; femora I and II with 6 and 4 setae, respectively; coxa III with 2 setae. However, these two species are clearly distinguished by the number of setae on palptarusus: 4 setae in *R. triodopsis* while 3 setae in *R. reaumuri*. Moreover, the apical part of famulus is not forked in *R. triodopsis* but forked in *R. reaumuri*.

According to figures in the original description of *R. triodopsis* by Fain and Klompen (1990), the famulus *k* is 83% length of its guard f seta, although the authors described that the famulus length is “almost as long as” its guard seta. In this study, the famulus of the Japanese specimens is shorter than in that original description. This difference in length between the American and Japanese specimens may represent geographic variation in this species.

So far, *R. triodopsis* has not been reported from anywhere else since its original description in 1990 from USA. Thus, this is the second record of *R. triodopsis* and the first report from Japan. Chiba Prefecture is approximately 10,000 km far from the type locality in Alabama, USA, suggesting that *R. triodopsis* may have a worldwide distribution. In this study, *R. triodopsis* was collected from the land snail *A. despecta sieboldiana* the member of Camaenidae Pilsbry, 1895, whereas the type host *Triodopsis obstricta* Say, 1821 belongs to Polygyridae Pilsbry, 1895. This suggests that *R. triodopsis* probably show a wide host range. Similarly, *Riccardoella limacum* Schrank, 1776, *R. oudemansi*, and *R. reaumuri* have been found each from three to four families of terrestrial mollusks and thus have worldwide distributions (Turk and Phillips 1946; Baker 1970; Barker and Ramsay 1978; Fain and van Goethem 1986; Ueckermann and Tiedt 2003; Schüpbach and Baur 2008a; b; Zabludovskaya and Badanin 2010; Stojnić et al. 2016; Waki et al. 2018a). Thus, it may be a common feature for the mites of *Riccardoella* to have a wide range of hosts and distribution.

The Japanese name newly established for the species refers to Mr. Nobuhiro Nyumura, who sampled the specimens examined in this study.

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