First Record of *Protogamasellus mica* (Athias-Henriot) (Acari: Mesostigmata: Ascidae) from Japan, with a Description of the Male

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ABSTRACT

Females and males of *Protogamasellus mica* (Athias-Henriot, 1961) were collected from the soil of spinach-cultivated fields in greenhouses located in Hokkaido, northern Japan. This is not only the first record of the genus *Protogamasellus* Karg, 1962, in Japan but is also the first description of the *P. mica* male. The new Japanese name of “Kubiremayoidani” is proposed. Intraspecific variation was apparent in the lengths of the idiosoma and dorsal setae in females, and in the shape of the ventrianal shield in males.

Key words: Acari, Ascidae, *Protogamasellus mica*, spinach greenhouse, intraspecific variation, male

INTRODUCTION

The astigmatid mite species *Tyrophagus similis* Volgin, 1948, is known to be a harmful mite, affecting the growth of spinach. We have previously investigated native predatory insects and mites, with the aim of suppressing the population of such *Tyrophagus* mites in spinach fields in Hokkaido, northern Japan, and have collected several species of predatory mesostigmatic mites that could act as natural enemies (Saito and Takaku, 2010). One of these is an ascid species, identified as *Protogamasellus mica* (Athias-Henriot, 1961) (Acari: Mesostigmata: Ascidae), a small mite. This is not only the first record of the genus *Protogamasellus* in Japan but also the first description of the *P. mica* male.

*P. mica* was initially described by Athias-Henriot (1961) as *Rhodacarellus mica*. Karg (1962) proposed a new genus, *Protogamasellus*, of the family Aceosejidae (= Ascidae) on the basis of *Protogamasellus primitivus*. Later, Evans (1982) transferred *R. mica* to the genus

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Protogamasellus, and synonymized P. primitivus with P. mica, based on an examination of the type materials of R. mica and P. primitivus. Recently, Karg (2007) suggested that P. primitivus is discernible from P. mica by the number of teeth on the cheliceral movable digit and the length of the ventrianal setae, and concluded that P. primitivus is not synonymous with P. mica, and that they should be treated as separate species. However, it is not certain whether this conclusion was based on the observation of type specimens of P. mica or voucher specimens identified as P. mica. Furthermore, Lindquist (1965) examined the holotype of P. mica, and concluded that P. mica is conspecific with and a senior synonym of P. primitivus, as indicated by Evans (1982) (Mineiro et al., 2009). Therefore, in the present study we follow Evans (1982) and describe the present materials as P. mica. We describe the species based on both male and female specimens, with references to variations in the lengths of the idiosoma and dorsal setae, and the shape of the ventrianal shield. This is the first description of the male of this species.

MATERIALS AND METHODS

Native predatory mites (Acari: Gamasina) were collected from the soil of spinach-cultivated fields in greenhouses located in Hokkaido, northern Japan. Soil was collected to a depth of 5 cm from the surface, and transported to the laboratory in paper envelopes as soon as possible. Mites were extracted from the samples using a modified Tullgren apparatus (screen mesh, 1 mm; light bulb, 40 W). Using this apparatus, animals were collected in an acrylic jar containing 70% ethanol. Two-hundred milliliters of the soil was placed in the apparatus and retained there for 2 days. Mites were sorted by transferring the sample to a watch glass and examining the mites under a stereoscopic microscope. Some of the mites were mounted whole on glass slides in Hoyer’s medium (Krantz, 1978). Several mite specimens were dissected under a stereoscopic microscope after clearing in 60% lactic acid diluted with distilled water. Each body part was mounted in Hoyer’s medium or a polyvinyl alcohol-lactic acid (PVA) medium (Danielsson, 1984). Basic observations of 30 females and 5 males collected in 2010 were made using a light microscope and a differential interference contrast microscope, whereas a scanning electron microscope (Miniscope TM3040; HITACHI Ltd.) was used to observe the details of small structures of another 10 females collected in 2012. Before scanning, samples were freeze-dried, and coated with gold using standard pre-treatment equipment (Neo Coater M19010NCTR; JEOL Ltd.).

All measurements are given in micrometers (μm). Measurements in each description are based on all materials, and presented as the range, with the average and standard deviation in parentheses. Dorsal and ventral chaetotaxy follow the description by Lindquist and Evans (1965), whereas other terminology follows that of Evans and Till (1966). Voucher specimens have been deposited in the Zoological Collections of the Graduate School of Science, Hokkaido University, Sapporo, Japan.

DESCRIPTIONS

*Protogamasellus mica* (Athias-Henriot, 1961)

[Japanese name: Kubiremayoidani, new]
Rhodacarellus mica Athias-Henriot, 1961: 488, figs 295-298.
Protogamasellus primitivus Karg, 1962: 54, fig. 17; Genis et al., 1967: 339.
Protogamasellus mica: Lindquist and Evans, 1965: 43-44; Evans, 1982: 306-308, figs. 5-7; Halliday et al., 1998: 40; Mineiro et al., 2009: 26.

**Description.** Female: Dorsum (Fig. 1A): Idiosomal length 233.3–257.0 (245.0 ± 4.8).

![Fig. 1. Protogamasellus mica (Athias-Henriot, 1961), female. A, dorsum; B, venter; C, chelicera.](image-url)
Podonotal shield with 17 pairs of simple setae; length of shield 117.0–129.4 (122.7 ± 2.5), width 90.0–104.6 (97.1 ± 3.5) at the level of setae s3. Setae s5, 14.1–18.1 (15.3 ± 0.9) long, shorter than the distance between bases of setae s5–z6, 19.1–21.7 (20.4 ± 0.7). Pores present lateral to j4, and between s2 and s3. Distinct transverse suture running posterior to j4, and through insertions of z6. Reticulate area present posterior to j5, with a median and 2 lateral stripes heavily sclerotized, and a conspicuous transverse line through z6.

Opisthonotal shield with 15 pairs of simple setae; length of shield 116.3–127.6 (122.3 ± 2.7), width 82.8–95.2 (87.5 ± 3.1) at the level of setae S1. One pair of pore-like structures present between Z3 and Z4. Distinct transverse line running from both sides of the margin of the shield to the insertion of setae J1. J3 shorter than or approximately equal to the distance between J3 and J4; Z3 obviously surpassing insertions of Z4. Setae Z5 longer or approximately equal to J5.

Lengths of setae as follows: J2, 17.4–20.3 (18.7 ± 0.8); J3, 18.3–22.0 (20.4 ± 1.1); J4, 18.1–22.0 (19.8 ± 0.9); J5, 10.0–14.0 (11.8 ± 0.9, n = 29; one sample had broken setae); Z3, 18.2–21.8 (19.6 ± 0.9); Z5, 12.0–14.1 (13.0 ± 0.5). Distances between bases of setae as follows: J3–J4, 18.8–23.8 (21.8 ± 1.2); J4–J4, 16.8–23.9 (18.4 ± 1.4); Z3–Z4, 16.6–18.9 (18.1 ± 0.5). Intraspecific variation apparent.

Venter (Fig. 1B): Sternal shield with 3 pairs of simple setae. Genital shield wedge-shaped with slightly convex posterior; 1 pair of simple genital setae lying off the shield (Fig. 2). Ventrianal shield with 5 pairs of simple preanal setae, 1 pair of paranal setae, and a postanal seta; length 84.4–95.9 (90.0 ± 3.0). Anterior margin of the shield incised to the level of Jv2. Seta Jv3, length 9.0–13.0 (11.3 ± 1.1, n = 29; one sample had broken setae), shorter than the distance between

![Electron microscope picture of genital shield. Arrows indicate genital setae lying off the shield.](image)
bases of \(Jv3–Jv4\), 18.5–23.9 (20.6 ± 1.3). Peritreme extends to the level of \(r4\).

Gnathosoma: Hypostome with 3 pairs of hypostomatic setae and 1 pair of deutosternal setae. Deutosternal groove with 7 transverse rows of denticles. Apotele 2-tined. Gnathotectum essentially tripartite, saw-tooth appearance as in the male. Corniculi slender and sinuous. Movable digit of chelicera with 2 strong teeth and a row of 7 small teeth on the proximal half of the digit. Fixed digit with 5 teeth, 7 smaller closely-set teeth, and a bidentate tip. Pilus dentilis short (Fig. 1C).

Legs: Tarsi I–IV with claws and ambulacra. Setae \(pd\) and \(pl\) on femur IV relatively stubby and spine-like. Setae on tarsi II–IV relatively stout basally, tapering to long. Setae \(pl2\) and \(pl3\) on tarsus IV relatively stout and blade-like. Leg chaetotaxy typical for the genus. Chaetotaxy as follows (femur; genu; tibia):
- I: 2, 3/1, 2/2, 2; 2, 3/2, 3/1, 2; 2, 3/2, 3/1, 2
- II: 2, 3/1, 2/2, 1; 2, 3/1, 2/1, 2; 2, 2/1, 2/1, 2
- III: 1, 2/1, 1/0, 1; 2, 2/1, 2/0, 1; 2, 1/1, 2/1, 1
- IV: 1, 2/1, 1/0, 1; 2, 2/1, 3/0, 0; 2, 1/1, 3/1, 1

**Male:** Dorsum: Idiosomal length 187.7–208.8 (196.6 ± 7.8). Dorsal ornamentation similar to that of the female. Podonotal shield length 98.6–110.5 (104.0 ± 4.4), width 77.9–87.4 (83.2 ± 3.6) at the level of setae \(s3\). Setae \(J4\) 14.5–16.4 (15.3 ± 0.7) long, longer or approximately equal to the distance between the bases of \(J4\), 13.0–14.8 (14.0 ± 0.8). Length of other setae as follows: \(J2\), 14.4–16.0 (14.8 ± 0.7); \(Z3\), 13.9–16.3 (15.6 ± 1.0); \(Z5\), 10.6–11.4 (10.9 ± 0.3).

Venter (Fig. 3A): Ventral shield divided into 2 portions, i.e., sternogenital and ventrianal shields. Sternogenital shield with 4 pairs of simple setae in the sternal region and 2 pairs in the genital region. Ventrianal shield 65.3–78.4 (71.7 ± 5.6) long, with 6 pairs of simple preanal setae, 1 pair of paranal setae, and a postanal seta. Intraspecific variation in shape apparent (Fig. 3B). Peritreme the same as in the female.

Gnathosoma: Gnathotectum essentially tripartite, saw-tooth appearance as in the female (Fig. 3C). Movable digit of chelicera with a strong tooth, a row of 3 small teeth in the proximal half of the digit, and long spermatodactyl directed anteroventrally (Fig. 3D). Fixed digit with 5 teeth, 4 closely-set small teeth, and a bidentate tip.

Legs: Leg chaetotaxy as follows (femur; genu; tibia):
- I: 2, 3/1, 2/2, 2; 2, 3/2, 3/1, 2; 2, 3/2, 3/1, 2
- II: 2, 3/1, 2/2, 1; 2, 3/1, 2/1, 2; 2, 2/1, 2/1, 2
- III: 1, 2/1, 1/0, 1; 2, 2/1, 2/0, 1; 2, 1/1, 2/1, 1
- IV: 1, 2/1, 1/0, 1; 2, 2/1, 3/0, 0; 2, 1/1, 3/1, 1

**Material examined.** Soil of spinach-cultivated fields in greenhouses in Higashikagura, Hokkaido, Japan, M. Saito leg.: 4♀, 6-IV-2010; 4♀, 16-IV-2010; 3♀, 19-IV-2010; 8♀, 28-IV-2010; 5♀, 7-V-2010; 6♀, 17-V-2010; 2♂, 6-IX-2010; 1♂, 1-X-2010. Soil of spinach-cultivated fields in Pippu, Hokkaido, Japan, M. Saito leg.: 1♂, 15-VII-2010; 1♂, 8-IX-2010. Soil of spinach-cultivated fields in greenhouses in Naganuma, Hokkaido, Japan, M. Saito leg.: 10♀, 15-X-2012.

**Distribution.** This species has been recorded from North Africa (Athias-Henriot, 1961), Europe (Evans, 1982), Russia (Ghilarov and Bregetova, 1977), the U.S.A. (Walter and Kaplan, 1990), Australia (Halliday et al., 1998), Brazil (Mineiro et al., 2009), and Iran (Kazemi and Rajaei, 2013) as *P. mica*. Additionally, the species has been recorded from Europe, Asia, and South Africa under the name *P. primitivus* (Karg, 1962, 2007; Genis et al., 1967). This is the first record of the species from Japan.
Remarks. The present species is identified as a member of the genus *Protogamasellus* by the following diagnostic characters: (1) podonotal shield with transverse line at level of setae z6; (2) opisthonotal shield with similar transverse line at level of setae J1; (3) paranal setae inserted closer to anterior margin of anus than posterior margin; (4) genu IV with 8 setae; and (5) tibia IV with 9 setae (Halliday et al., 1998).

*Fig. 3*. *Protogamasellus mica* (Athias-Henriot, 1961), male. A, venter; B, intraspecific variation of ventrianal shield; C, gnathotectum; D, chelicera.
Karg (2007) treated the genus *Protogamasellus* as a member of the family Rhodacaridae, on the basis of phylogenetic research, and provided the following synapomorphic characters of *Protogamasellus* and *Rhodacarus* Oudemans, 1903 (family Rhodacaridae): (1) transverse lines on podonotum at the level of setae z6, and on opisthonotum at the level of setae J1; (2) spermatodactyl of male inserted inside movable digit in the form of a bulbodactylus; (3) tibia IV with 10 setae; (4) podonotum with 3 or 4 scleronoduli; (5) anterior part of podonotum with transverse line; and (6) peritreme shortened. However, some characters differ between the 2 genera. Transverse lines are present on the podonotum and opisthonotum in both, whereas the area enclosed by the transverse line and margin of the shield is granulated in *Rhodacarus*, but not in *Protogamasellus*. The spermatodactyl of movable digits are shaped differently in the 2 genera; the spermatodactyl is recurved and directed dorsally in *Rhodacarus*, whereas it is directed ventrally and is not recurved in *Protogamasellus*. Tibia IV bears 10 setae in *Rhodacarus*, whereas there are 9 setae in *Protogamasellus*. Additionally, the results of recent molecular phylogenetic analysis (Dowling and O'Connor, 2010) suggest that some of the abovementioned characters are not synapomorphic. Scleronoduli also appear in *Dendrolaelaps* of the family Digmasesellidae, which is not closely related to and is not a sister group of Rhodacaridae, and shortened peritremes also appear in many taxa of Mesosigmatidae, e.g., the families Zeronidae, Laelaponyssidae, and Laelapidae, among others. The following characteristics of the genus *Protogamasellus* are concordant with those of the family Ascidae, rather than Rhodacaridae: (1) sternal shield with 3 pairs of setae; (2) apotele 2-tined; (3) femur I with 12 setae; (4) tibia I with 13 setae; (5) genu IV with 8 setae; and (6) tibia IV with 9 setae. Therefore, *Protogamasellus* should be placed in the family Ascidae.

*P. mica* is considered a thelytokous species (Walter and Kaplan, 1990; Halliday et al., 1998). Although males of the species were collected in the field and described in the present study for the first time, they were few in number in comparison with the relative abundance of females. It was surmised that the occurrence of males may be influenced by food availability, or environmental change, or some other unknown factors.

The male spermatodactyl of *P. mica* is similar to that of *Protofurcatus bifurcalis* (Genis, Loots and Ryke, 1967), previously classified as belonging to the genus *Protogamasellus*. Both spermatodactyls bend ventrally at the middle of a movable digit, and attenuate distally. However, the spermatodactyl of *Protofurcatus bifurcalis* bears a tooth-like hooked projection, whereas in *P. mica* the surface is smooth and without such a projection. In male *P. mica*, the ventrianal shield is well developed anteriorly, and the anterior-most preanal setae, Jv1, is located on the ventrianal shield, as in *Protofurcatus bifurcalis*.

As for the intraspecific variation, Karg (2007) indicated that length of dorsal setae was constant on the basis of investigation of dorsal setae in *P. primitivus (=P. mica)*. However, we confirmed that there were variations in length of dorsal setae in our materials, as remarked by Evans (1982). Besides, we could confirm variability in the distance between setal insertions, length of idiosoma and dorsal shields, and shape of male ventrianal shield.
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REFERENCES

Athias-Henriot, C. (1961) Mesostigmates (Urop. excl.) édaphiques Méditerranéens (Acaromorpha, Anactinotrichida). *Acarologia*, 3: 281–509.

Danielsson, R. (1984) Polyviol as mounting medium for aphids (Homoptera: Aphidoidea) and other insects. *Entomologica Scandinavica*, 15: 383–385.

Dowling, A. P. G. and B. M. O'Connor (2010) Phylogenetic relationships with in the suborder Dermanyssina (Acari: Parasitiformes) and a test of dermanyssoid monophyly. *International Journal of Acarology*, 36: 299–312.

Evans, G. O. (1982) Observations of the genus Protogamasellus Karg (Acari: Mesostigmata) with a description of a new species. *Acarologia*, 23: 303–313.

Evans, G. O. and W. M. Till (1966) Studies on the British Dermanyssidae (Acari: Mesostigmata). Part II. Classification. *Bulletin of the British Museum (Natural History) Zoology*, 14: 107–370.

Genis, N. de L., G. C. Loots and P. A. J. Ryke (1967) The genus Protogamasellus Karg (Acari) with descriptions of new species and subspecies from the Ethiopian Region. *Journal of Natural History*, 1: 337–353.

Ghilarov, M.C. and N. G. Bregetova (1977) Handbook for the identification of soil inhabiting mites. Mesostigmata. Zoological Institute of the Academy of Sciences, Nauka, Leningrad. 718 pp. (In Russian)

Halliday, R. B., D. E. Walter and E. E. Lindquist (1998) Revision of the Australian Ascidae (Acarina: Mesostigmata). *Invertebrate Taxonomy*, 12: 1–54.

Karg, W. (1962) Zur Systematic und postembryonalen Entwicklung der Gamasiden (Acarina, Parasitiformes) Landwirtschaftlich Genutzter Boden. *Mitteilungen aus dem Zoologischen Museum in Berlin*, 38: 23–119.

Karg, W. (2007) New taxonomic knowledge of soil-inhabiting predatory mites (Acarina, Gamsina: Rhodacaroidea, Dermanyssoidae, Ascoidea). *Abhandlungen und Berichte des Naturkundemuseums Görlitz*, 78: 113–139.

Kazemi, S. and A. Rajaei (2013) As annotated checklist of Iranian Mestigmata (Acari), excluding the family Phytoseiidae. *Persian Journal of Acarology*, 2: 63–158.

Krantz, G. W. (1978) A Manual of Acarology, Second Edition. Oregon State University Book Store Inc., Corvallis. 509pp.

Lindquist, E. E. and G. O. Evans (1965) Taxonomic concepts in the Ascidae, with a modified setal nomenclature for the idiosoma of the Gamasina (Acarina: Mesostigmata). *Memoirs of the Entomological Society of Canada*, 47: 1–64.

Mineiro, J. L. de C., E. E. Lindquist and G. J. de Moraes (2009) Edaphic ascid mites (Acarina: Mesostigmata: Ascidae) from the state of São Paulo, Brazil, with description of five new species. *Zootaxa*, 2024: 1–32.

Saito, M. and G. Takaku (2010) Survey of indigenous predatory mites (Acarina: Mesostigmata) of *Tyrophagus similis* in spinach fields in Hokkaido. *Annual Report of the Society of Plant Protection of North Japan*, 61: 192–196. (In Japanese)

Walter, D. E. and D. T. Kaplan (1990) A guild of thelytokous mites (Acarina: Mesostigmata) associated with citrus roots in Florida. *Environmental Entomology*, 19: 1338–1343.
摘要

クビレマヨイダニ Protogamasellus mica (Athias-Henriot)（ダニ亜網：トゲダニ目：マヨイダ
ニ科）の日本からの初記録と本種雄の記載

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マヨイダニ科クビレマヨイダニ属（新称）のクビレマヨイダニ（新称）Protogamasellus
mica の雌雄が、北海道上川地方の施設栽培ホウレンソウ圃場の土壌中から発見された。本属の日本からの発見は初めてであり、本種の雌は初記録である。背板毛 J3, Z3 の長さおよび J3－J4, Z3－Z4 の基部間の距離は個体間で変異が大きかった。また、雌の胴体部の長さおよび雄の腹肛板の形態にも変異が見られた。