Zootaxa 4429 (2): 379–389
http://www.mapress.com/j/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4429.2.12
http://zoobank.org/urn:lsid:zoobank.org:pub:077BEC50-3983-414A-95CE-A5E5B4C44F6F

Mites of the family Parasitidae Oudemans, 1901 (Acari: Mesostigmata) from Japan: a new species of *Vulgarogamasus* Tichomirov, 1969, and a key to Japanese species

MOHAMED W. NEGM[1,2,3,4] & TETSUO GOTOH[1]

[1]*Laboratory of Applied Entomology & Zoology, Faculty of Agriculture, Ibaraki University, Ami, Ibaraki 300–0393, Japan. ORCID: T. Gotoh http://orcid.org/0000-0001-9108-7065*

[2]*Department of Plant Protection, Faculty of Agriculture, Assiut University, Assiut 71526, Egypt. waleednegm@yahoo.com, waleednegm@aun.edu.eg, ORCID: https://orcid.org/0000–0003–3479–0496*

[3]*Japan Society for the Promotion of Science, Chiyoda, Tokyo 102–0083, Japan.*

[4]*Corresponding author*

Abstract

Vulgarogamasus edurus **sp. nov.** (Acari: Parasitidae) is described based on females, deutonymphs and males extracted from leaf litter and soil in Ami, Ibaraki Prefecture, Japan. Morphological differences between the new species and its closely related species, *Vulgarogamasus fujisanus* (Ishikawa, 1972), are recorded based on the examination of type materials. Information about parasitid mites reported in Japanese literature is reviewed, and a key to species is provided.

Key words: Parasitiformes, morphology, Parasitoidea, Japan, new species, *Vulgarogamasus*, taxonomy

Introduction

Mites of the family Parasitidae Oudemans, 1901 (Acari, Mesostigmata) are important predators in soil, feeding on microarthropods, collembolans and nematodes (Lindquist *et al*., 2009). The family comprises 35 genera and about 426 described species (Beaulieu *et al*., 2011). The genus *Vulgarogamasus* Tichomirov, 1969 is worldwide in distribution, and includes cosmopolitan predators that inhabit forest habitats, litter, dung, nests of birds and wasps, and beehives (Micherdziński, 1969; Hyatt, 1980; El-Banhawy & Nasr, 1984; Karg, 1998; Stănescu & Gwiazdowicz, 2004). This genus comprises 39 species (OConnor & Klimov, 2016); of these 18 species were described as new from China, mostly from rodents and their nests (Gu *et al*., 1987; Ma, 1990; Bai *et al*., 1991, 1995; Gu & Huang, 1993; Ma & Wang, 1996; Gu & Guo, 1997; Ma *et al*., 2002).

Faunistic studies and taxonomic works of parasitid mites in Japan are still limited (Table 1). Two species, *Vulgarogamasus fujisanus* (= *Eugamasus fujisanus* Ishikawa, 1972) and *Parasitus gregarius* Ito, 1976, were previously described as new to Japan based on specimens extracted from a ground pit, and livestock & poultry manure (Ishikawa, 1972; Ito, 1976). In a survey of Gamasida mites associated with mine adits and caves in southwest Japan, Ishikawa (1982) recorded unidentified species of *Parasitus* Latreille and *Pergamasus* Berlese. Several species of parasitid mites are well known as phoronts upon insects. For example, Takaku *et al*. (1994) collected *Poecilochirus carabi* G. & R. Canestrini, 1882 as phoretic on some burying and ground beetles at Hokkaido, Northern Japan. Also, some biological and feeding traits of *Parasitus fimetorum* Berlese, 1903 and *Parasitus gregarius* were conducted using house fly and free-living nematodes as preys (Ito, 1971, 1973, 1977; Yasui, 1997).

The present study describes a new species of Parasitidae based on deutonymphal and adult stages, along with an identification key for parasitid mites so far reported from Japan. This work will facilitate the identification of parasitid mites, and enrich the taxonomic information of these potential soil predators.

Accepted by B. Halliday: 5 Apr. 2018; published: 6 Jun. 2018

TABLE 1. Checklist of parasitid mites cited in Japanese literature.

Taxa	Habitat/host/study	Reference
Unidentified genus	Livestock dung, associated with the house fly, *Musca domestica* L. (Diptera: Muscidae)	Ito (1970)
Cycetogamasus diviortus (Athias-Henriot, 1967)	Spinch-cultivated soil, Hokkaido	Saito & Takaku (2011)
Parasitus sp.	Feeding on free-living nematodes	Ito (1971)
	Effect of isolation on the moult of deutonymphs	Ito (1973)
	Outside Kawashimo-kô, Tobé, Shikoku	Ishikawa (1982)
	Mushroom *Phallus tenuis*, Kitaibaraki, Ibaraki	Okabe & Amano (1993)
	Review of house dust mites	Takaoka (2000)
Parasitus spp.	Mine adits and caves	Ishikawa (1982)
P. consanguineus Oudemans & Voigts, 1904	Associated with nematodes and in farm compost at Honshu and Shikoku	Ishikawa (1980)
P. fimetorum Berlese, 1903	Compost in experimental farm, Hokkaido	Yasui (1997)
	Laboratory culture	Tagami (2007)
P. gregarius Ito, 1976	Livestock and poultry manure	Ito (1976)
	Feeding on *M. domestica* and nematodes	Ito (1977)
Pergamasus sp.	Mine adits and caves	Ishikawa (1982)
Poecilochirus carabi G. & R. Canestrini, 1882	Burying and ground beetles	Takaku *et al.* (1994); Ishikawa & Takaku (1999, 2015)
Vulgarogamasus fujisanus (Ishikawa, 1972)	Kaminari-ana pit, Kansu-yama, Suyama, Shizuoka	Ishikawa (1972)

Materials and methods

Mites were collected from leaf litter mixed with soil, extracted using Tullgren funnels, and mounted on glass slides using Hoyer's medium under a stereomicroscope (SZ40, Olympus®, Japan). Prepared slides were placed on a hot plate at 45ºC to dry, then sealed with Semento® (FHK, Fujihira Industry, Japan) applied around the edge of the coverslip using a slide ringer. Permanent slides were examined for different taxonomic features with the aid of phase contrast (BX41, Olympus®) and differential interference contrast (BX53, Olympus®) research microscopes. Mite images were taken by a digital eyepiece camera (AM423X, Dino-Eye®, Taiwan) controlled by DinoCapture 2.0 software. Illustrations were done with Adobe Illustrator (Adobe Systems Incorporated, USA). Measurements are given in micrometres. Mite identification and idiosomal chaetotaxy follow that of Evans & Till (1979) and Hyatt (1980).

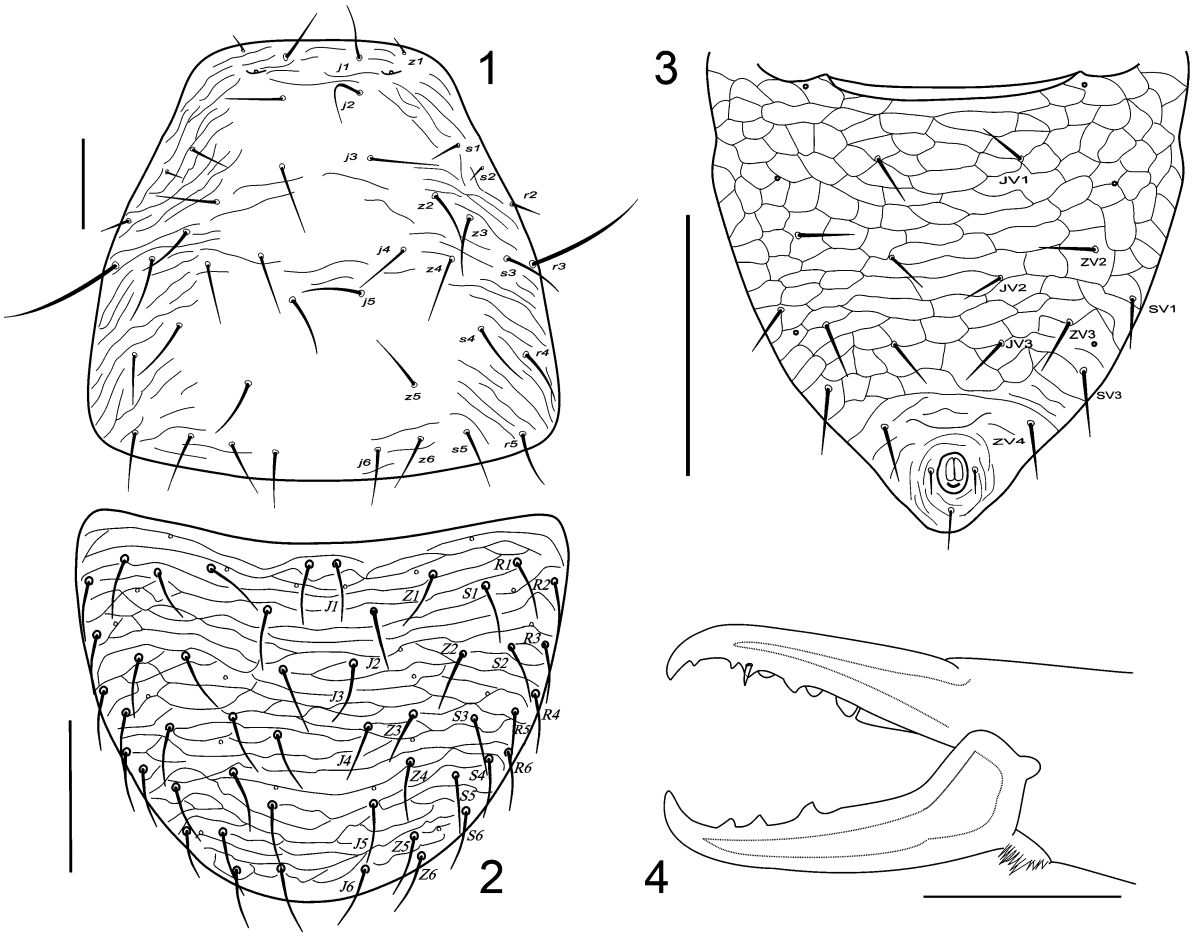
Vulgarogamasus edurus sp. nov.

[Japanese name: Ken-yadoridani]
(Figs. 1−22)

Female (holotype, average for three paratypes in parentheses)

Dorsal idiosoma. Dorsum divided into two shields, podonotal 393 (410) µm length along midline, 436 (420) µm width at level of setae *r3*, and opisthonotal 320 (300) µm length, 462 (452) µm width, the two shields are overlapping near the centre and gradually separating towards lateral corners. Podonotal shield (Fig. 1) with striations on lateral margins; with 21 pairs of simple setae, of these *j1* 58 (65), *z1* 20 (18), *j2* 66 (70), *j3* 70 (62), *r3* 130 (125) the longest, and a pair of distinct lyrifissures posteriad *z1*; setae *z1* distinctly shorter than distance between *z1* and *j1*. Opisthonotal shield (Fig. 2) completely reticulated; with 24 pairs of setae, of approximate length *J1* 60 (62), *J2* 63 (60), *J3* 63 (61), *J5* 65 (64), *Z1* 74 (76), *R1* 55 (54).

Ventral idiosoma. Tritosternum normal in shape, with long narrow base 25 (26) and pilose laciniae 35 (33); presternal region with 3–4 transverse lines and two subtriangular presternal shields (Fig. 5); sternal shield strongly reticulated, with three pairs of setae *st1* 23 (25), *st2* 20 (19), *st3* 19 (20), *st1–st3* 78 (80), *st2–st2* 57 (56) and two pairs of lyrifissures, the posterior pair of lyrifissures located equidistant between sternal setae *st2* and *st3* (Fig. 5). Metasternal shields with one pair of setae *st4* 16 (18), *st4–st4* 56 (58) and a pair of lyrifissures; genital shield triangular, with rounded endogynium. Peritremes extend to level between coxae I & II. Opisthogastric shield 156 (160) (length from genital shield base to post-anal seta), completely reticulated (Fig. 3); with eight pairs of setae excluding the para-anals and the post-anal seta.



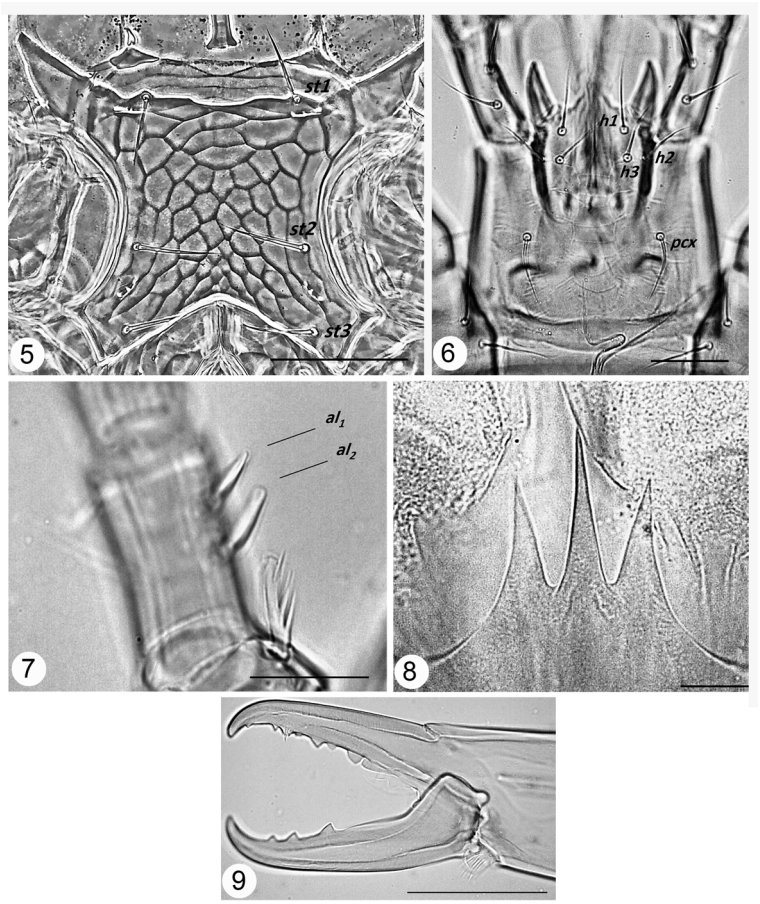
FIGURES 1–4. *Vulgarogamasus edurus* **sp. nov.**, female. 1. Podonotal shield. Scale bar = 100 μm. 2. Opisthonotal shield. Scale bar = 150 μm. 3. Opisthogastric shield. Scale bar = 100 μm. 4. Chelicera. Scale bar = 50 μm.

Gnathosoma. Corniculi short 42 (44); three pairs of hypostomal setae and a pair of palpcoxal setae present, *h1* 120 (122), *h2* 88 (85), *h3* 91 (98), *pcx* 86 (88) (Fig. 6); anterolateral seta of the palp-femur deeply branched while *al1* and *al2* of palp-genu entire (Fig. 7); epistome trispinate and stout, with central prong 35 (33) little longer than lateral ones 27 (29) (Fig. 8). Movable digit of chelicera 118 (122) with three teeth; the fixed digit with eight teeth (five large and three small) and a *pilus dentilis*, one minute tooth located distally and the two proximal teeth broad, with blunt tip (Figs. 4, 9).

Legs. Leg I 843 (860), leg II 633 (602), leg III 554 (542), leg IV 890 (915).

Deutonymph (average for 3 paratypes)

Dorsal idiosoma. Dorsum divided into two shields, podonotal 306 (320) length, 300 (285) width, and opisthonotal 188 (200) length, 290 (282) width, at widest point. The two shields are well separated with soft integument. Podonotal shield (Fig. 10) with striations along its lateral margins; with 20 pairs of simple setae, of these *j1* 44 (46), *z1* 16 (14), *j2* 42 (45), *j3* 47 (44), *j4* 49 (45), *j5* 45 (46), *j6* 38 (34), *r3* 110 (122) the longest; a pair of distinct lyrifissures located posteriad *z1*; setae *z1* shorter than distance between *z1* and *j1*. Opisthonotal shield (Fig. 11) completely reticulated; with 13 pairs of setae, of these *J1* 35 (34), *J2* 38 (37), *J3* 38 (38), *J4* 40 (37), *J5* 45 (44).



FIGURES 5–9. *Vulgarogamasus edurus* **sp. nov.**, female. 5. Sternal shield. Scale bar = 50 µm. 6. Hypostome. Scale bar = 100 µm. 7. Anterolateral setae on palp-femur and palp-genu. Scale bar = 50 µm. 8. Epistome. Scale bar = 20 µm. 9. Chelicera. Scale bar = 50 µm.

Ventral idiosoma. Tritosternum normal, with rectangular base 83 (80) length and pilose laciniae 163 (166). Sternal shield (Fig. 15) 224 (230) length along midline, entirely reticulated, with longitudinal lines along lateral edges, slightly concave anteriorly, with three pairs of setae *st1* 50 (51), *st2* 35 (37), *st3* 28 (26), distances between sternal setae *st1–st2* 82 (80), *st2–st3* 51 (53), *st2–st2* 94 (96), setae *st4* and *st5* off shield, on soft cuticle. Opisthogaster represented by soft cuticle, one pair of small irregular-shaped medapodal shields present, one pair of minute setae directly located posteriad coxae IV, opisthogaster with seven pairs of pre-anal setae in central area posterior to anal shield, setae *ZV3* missing but bases distinctly visible (Fig. 16). Anal shield 93 (100) length, 97 (93) width, reticulated and with one pair of simple setae 42 (45) located laterally on shield, in addition to a pair of para-anal setae 18 (20) and a post-anal seta 22 (24).

Gnathosoma. Corniculi short 27 (30). Hypostomal and palpcoxal setae (Fig. 17) present, *h1* 45 (46), *h2* 36 (37), *h3* 40 (42), *pcx* 40 (45); epistome trispinate, with median prong 27 (28) longer than lateral ones 16 (18) (Fig. 18); anterolateral setae of the palp-femur branched while *al1* and *al2* entire on palp-genu, as in female. Movable digit of chelicera 88 (90) with three teeth, the fixed digit with 11 teeth (seven large and four minute teeth distally) and a *pilus dentilis* (Fig. 12).

Legs. Leg I 700 (734), leg II 487 (476), leg III 422 (431), leg IV 654 (662).

Male (average for three paratypes)

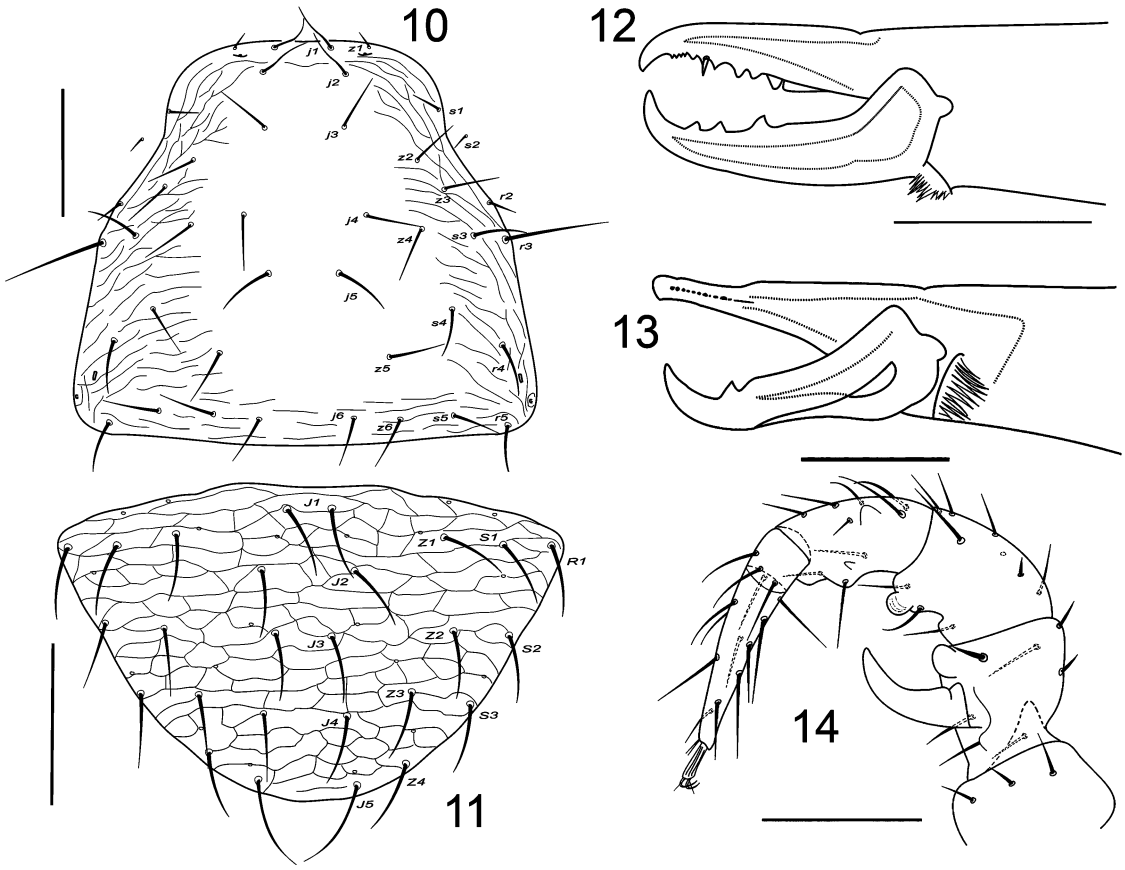
Dorsal idiosoma. Dorsum strongly sclerotised and separated into two shields by a transverse suture. Podonotal shield 397 (412) µm length, 430 (422) µm width, with lateral striations, with 21 pairs of normal setae, *r3* the longest 116 (122). Opisthonotal shield 345 (333) µm length, 426 (412) µm width, completely reticulated; with 25–26 pairs of simple setae.

Ventral idiosoma. Tritosternum with a reduced base 10 (12) and pilose laciniae 66 (70); two subtriangular presternal shields present; holoventral shield with five pairs of setae and three pairs of lyrifissures in the area

between coxae of legs I-IV, distances between setae *st1–st2* 94 (97), *st2–st3* 60 (58), *st3–st4* 55 (57), *st4–st5* 71 (77), *st2–st2* 97 (102), entirely reticulated except the area lateral to the first pair of lyrifissures. The genital orifice opens at the anterior margin of holoventral shield; peritremes extend to level between coxa I & II; opisthogastric shield completely reticulated, with para-anals slightly shorter than the post-anal seta.

Gnathosoma. Corniculi short 27 (30); three pairs of hypostomal setae and a pair of palpcoxal setae present, *h1* 52 (50), *h2* 32 (35), *h3* 48 (51), *pcx* 44 (47) (Fig. 19); epistome trispinate, with prongs shorter than in female and deutonymph (Fig. 20), central prong 10 (9), lateral prongs 6 (7); anterolateral setae on the palp-femur and palp-genu as in female; movable digits of chelicerae 84 (88) unidentate and with spermatotremes (Figs 13, 21).

Legs. Leg II with apophyses on femur, genu and tibia (Figs 14, 22). Leg I 880 (892), leg II 642 (655), leg III 570 (583), leg IV 820 (803).



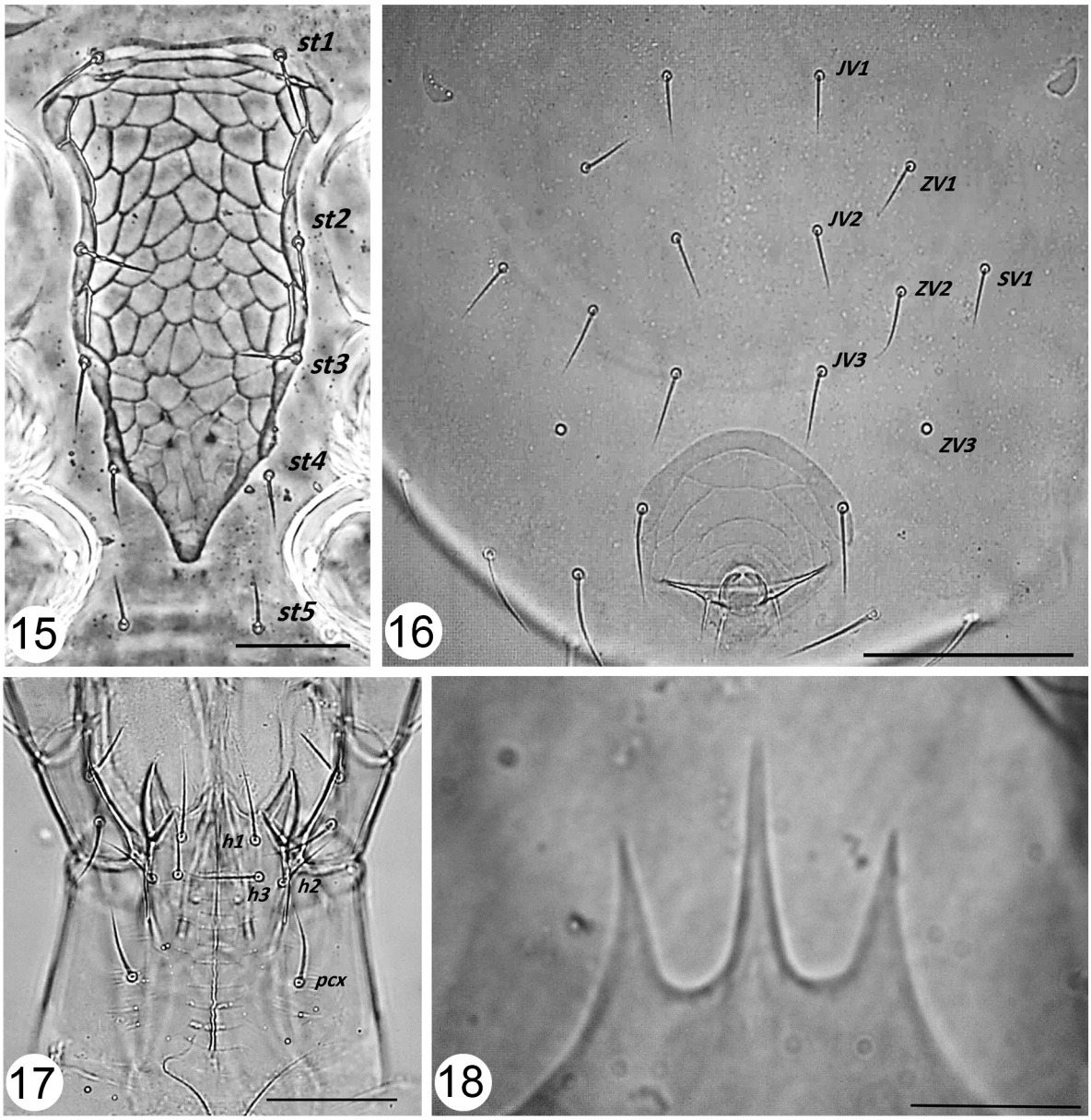
FIGURES 10–14. *Vulgarogamasus edurus* **sp. nov.** 10. Deutonymph, podonotal shield. Scale bar = 100 µm. 11. Deutonymph, opisthonotal shield. Scale bar = 100 µm. 12. Deutonymph, chelicera. Scale bar = 50 µm. 13. Male, chelicera. Scale bar = 50 µm. 14. Male, leg II. Scale bar = 100 µm

Etymology. The name of the new species is derived from Latin word *edurus* meaning hard and refers to its rigid or tough sclerotised body.

Type material. Holotype female and 9 females, 6 males and 7 deutonymph paratypes were collected from a mixture of leaf litter and soil at Ibaraki University, Ami, Ibaraki Prefecture, 36° 02' 09" N, 140° 12' 54" E, 10 November 2017, coll. M. W. Negm. Type specimens will be deposited in the National Museum of Nature and Science (NMNS), Tsukuba, Ibaraki Prefecture, Japan.

Remarks. The new species is closely related to *Vulgarogamasus fujisanus* (Ishikawa, 1972), originally described as *Eugamasus fujisanus* Ishikawa, 1972, from female specimens found in a pit "Kaminari-ana" at Kansuyama, Shizuoka Prefecture. However, the new species was extracted from leaf litter and soil, mostly in association with collembolan insects. Also, the new species is relatively close to *V. oligochaetus* Gu & Huang (Gu & Huang, 1993) and *V. zhenningensis* Gu & Wang (Gu *et al*., 1987) collected from a bird nest and *Rattus norvegicus* Berkenhout (Mammalia: Rodentia), respectively. However, the former differs from *V. edurus* in having only two pairs of sternal setae located on the sternal shield, and in the shape of epistome, while the latter differs in having

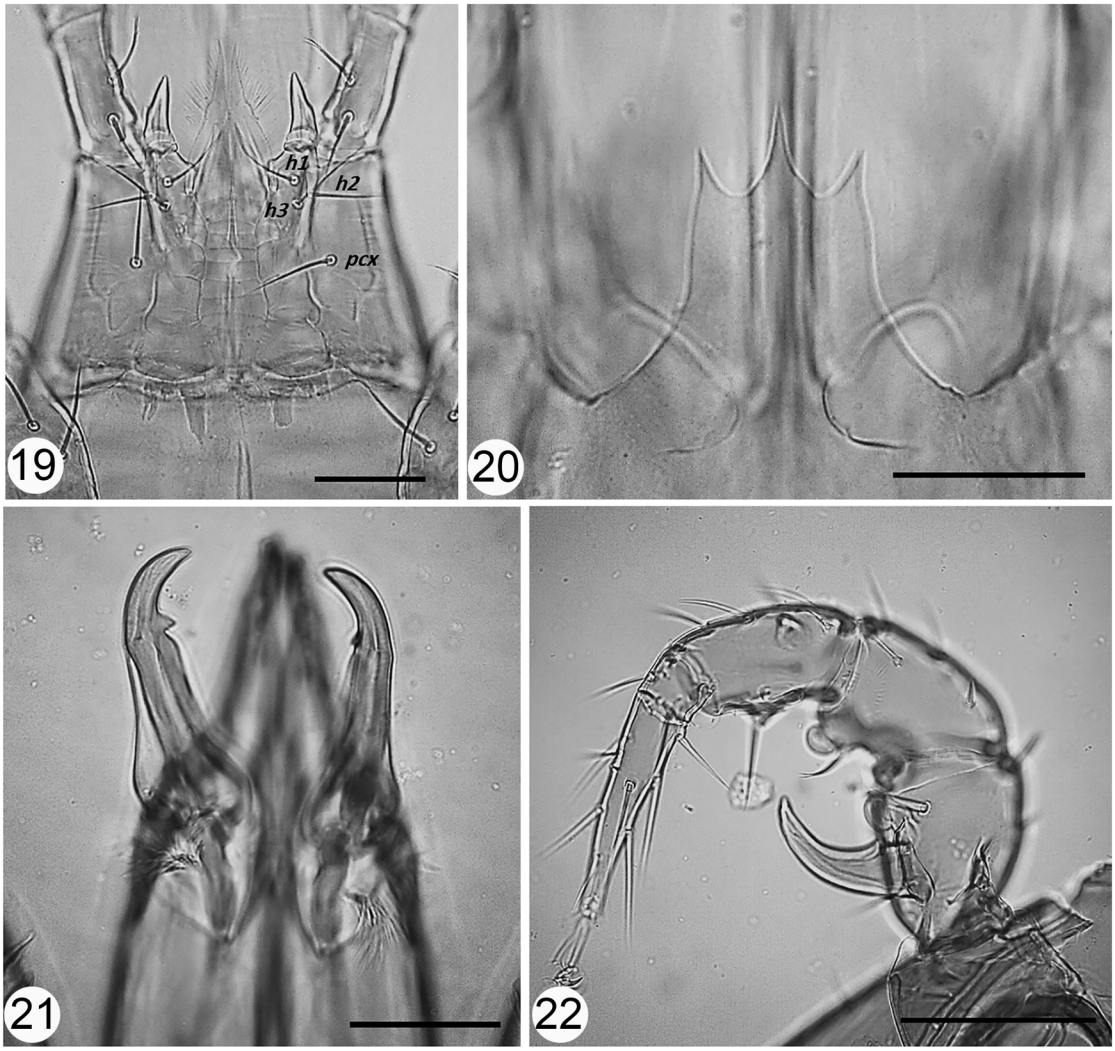
both setae *r3* and cheliceral digits distinctly longer. Table 3 lists the interspecific variations between females of *V. edurus* and its closely related species described from China.



FIGURES 15–18. *Vulgarogamasus edurus* **sp. nov.**, deutonymph. 15. Sternal shield. Scale bar = 50 µm. 16. Central region of opisthogaster. Scale bar = 100 µm. 17. Hypostome. Scale bar = 50 µm. 18. Epistome. Scale bar = 20 µm.

Since the new species is most similar to *V. fujisanus*, females of the two species were investigated in detail. By the examination of the holotype female of *V. fujisanus* (National Museum of Nature and Science, Tsukuba, Japan) and based on the original designation of species, *V. fujisanus* and *V. edurus* are similar in having strongly reticulated dorsum and venter, trispinate epistome, and a relatively similar hypostome. However, the following taxonomic features separate their females (*V. fujisanus* vs. *V. edurus*): the former has distinctly longer idiosomal setae than the latter (Table 2 shows the differences in some setal measurements between the two comparable species), setae *r3* 261 µm vs. 130 (125) µm; setae *z1* 64 µm longer than distance between bases of *z1* and *j1* vs. *z1* 20 (18) shorter than distance between *z1* and *j1*; 10 pairs of opisthogastric setae (excluding para-anals and post-anal seta) vs. eight pairs (one pair each of *JV* and *ZV* series absent); epistome with central prong much longer and thicker than lateral ones vs. central prong 35 (33) little longer than lateral ones 27 (29), but the same thickness; fixed digit of chelicera with two large and five small teeth vs. five large and three small teeth; anterolateral setae

(*al1*, *al2*) on palp-genu in same shape and length vs. *al1* shorter than *al2* and with pointed tip but *al2* with blunt tip. *Vulgarogamasus fujisanus* was described as new and compared with *Eugamasus maschkeae* (Willmann, 1936) based on numerical differences of setal pairs on podonotal and opisthonotal shields, and the opisthogaster. Also, the length of the central prong of the trispinate epistome was variable. However, Micherdziński (1969) depicted the epistome of *E. maschkeae* with two prongs only (Fig. Abb. 378C, D; p. 540), highlighting that according to Willmann (1936) and Holzmann (1955) a short blunt central prong should be present. In the present new species, all female type specimens have a uniform shape of the epistome. Moreover, the fixed digit of the chelicera of *E. maschkeae* females has more teeth, including a remarkable row of seven adjacent equal teeth (Micherdziński, 1969; Fig. Abb. 378B; p. 540).



FIGURES 19–22. *Vulgarogamasus edurus* **sp. nov.**, male. 19. Hypostome. Scale bar = 50 µm. 20. Epistome. Scale bar = 20 µm. 21. Chelicera. Scale bar = 50 µm. 22. Leg II. Scale bar = 100 µm.

Key to genera and species of parasitid mites from Japan (deutonymphs and adults)

1. Females, dorsum with a holodorsal shield. Males, tritosternum bifurcate, with a reduced base covered by genital orifice lamina . . . . . subfamily Pergamasinae Juvara-Bals . . . . . *Cycetogamasus diviortus* (Athias-Henriot) [=*Pergamasus diviortus*]
- Females, dorsum divided into podonotal and opisthonotal shields. Males, tritosternum absent, normal or modified . . . . . .subfamily Parasitinae Oudemans ... 2
2. Females, epistome finely tapered anteriorly with angular serrated margins. Deutonymphs, sternal shield with transverse granular band between *st1* and *st2*. Seta *al* of palp-femur setiform or spatulate; idiosomal length less than 2000 µm. Males, setae on palp trochanter set on strong tubercles . . . . . *Poecilochirus carabi* G. & R. Canestrini
- Females, epistome different in shape. Deutonymphs, sternal shield without such transverse granular band. Seta *al* of palp-

femur bifid, with one or more distinct slender processes; idiosomal length more than 2000 µm. Males, setae on palp trochanter not arising from strong tubercles. 3

3. Females and deutonymphs, setae *z5* of dorsal hexagon markedly different in shape and length from setae *j5* and *j6*. Males, tritosternum absent, reduced or greatly modified . . . . . *Parasitus* Latreille … 4

- Females and deutonymphs: setae *z5* of dorsal hexagon alike setae *j5* and *j6* in shape and length. Males, tritosternum normally developed . . . . . *Vulgarogamasus* Tichomirov… 6

4. Females, sternal setae *st1* distinctly forked and arising from small platelets; epistome trispinate with sharply-tipped prongs. Deutonymphs, lateral prongs of the trispinate epistome deeply forked; opisthonotal shield with setae relatively similar in shape and length. Males, opisthonotal setae *J1–J4* distinctly shorter than other setae . . . . . *P. consanguineus* Oudemans & Voigts [= *Rhabdocarpais consanguineus* (Oudemans & Voigts)]

- Females, sternal setae *st1* normal in shape and arising from sternal shield; epistome not as above. Deutonymphs, lateral prongs of epistome not forked; opisthonotal shield with setae not similar in shape or length. Males, opisthonotal setae *J1–J4* of same length or slightly shorter than other setae 5

5. Females, podonotal shield with 23 pairs of setae; setae *r3* 127µm (incorrectly depicted as *r5* in original description) slightly longer than *j1* 82µm, *j3* 97µm and *z5* 106µm (*z2* in original description); epistome with median prong blunt-tipped and broader than the lateral ones; opisthonotal setae short. Deutonymphs, opisthonotal setae *J5* simple and short; *Z3* very long (255–258µm). Males, opisthonotal setae similar in shape and length . . . . . *P. gregarius* Ito

- Females, podonotal shield with 21 pairs of setae; setae *r3* distinctly longer than *j1*, *j4* and *z5*; epistome with median prong either long and pointed or forked; opisthonotal setae markedly longer. Deutonymphs, opisthonotal setae *J5* stout and longer; *Z3* shorter (<100 µm). Males, opisthonotal setae different in shape and length . . . . . *P. fimetorum* (Berlese) [= *Phorytocarpais fimetorum* (Berlese)]

6. Females, with ten pairs of opisthogastric setae (excluding para-anals and post-anal seta); humeral setae *r3* longer (261 µm, original description); anterolateral setae al_1 and al_2 of palp-genu similar in shape and length; podonotal setae longer . . . . . *V. fujisanus* (Ishikawa)

- Females, with eight pairs of opisthogastric setae; setae *r3* shorter (< 200 µm); setae al_1 shorter than al_2 and with a pointed tip while al_2 blunt; podonotal setae shorter . . . . . *V. edurus* **sp. nov.**

TABLE 2. Comparison of some setal lengths (µm) between females of *Vulgarogamasus fujisanus* (Ishikawa, 1972) and *V. edurus* **sp. nov.**

Idiosomal seta	*Vulgarogamasus fujisanus*	*V. edurus* **sp. nov.** holotype (average for 3 paratypes)
j1	118	58 (65)
j2	156	66 (70)
j3	141	70 (62)
z1	64	20 (18)
r3	261	130 (125)
J1	118	60 (62)
J2	118	63 (60)
J3	118	63 (61)
J5	123	65 (64)
Z1	131	74 (76)
R1	103	55 (54)

Discussion

A new species of the cosmopolitan worldwide genus *Vulgarogamasus* is described, increasing the parasitid mite fauna of Japan to seven species. Reporting such a low number of species in a rich family with more than 420 species described globally, may indicate that this area is expected to contain many more species awaiting discovery. Thus, further and extensive studies are recommended in searching for more diversity. Also, further identification of the published unidentified genera and species will enrich the fauna.

Describing new species of parasitid mites is quite challenging. Since females, deutonymphs and males are relied upon in identification keys, it is important to assure these stages belong to a single species. Some descriptions have been published depending on only one stage without describing other stages, leaving a taxonomic gap in species discrimination. Teodorowicz *et al*. (2012) provided complementary taxonomic information for *Vulgarogamasus kraepelini* (Berlese, 1904) through describing the larvae and protonymphs. The adoption of

TABLE 3. Interspecific variations between females of *Vulgarogamasus edurus* **sp. nov.** and its closely related species.

Morphological feature	*V. oligochaetus* (Gu & Huang, 1993)	*V. zhenningensis* (Gu & Wang; Gu *et al*., 1987)	*V. multisetus* (Gu & Huang, 1993)	*V. qinghaiensis* (Gu & Yang; Gu *et al*., 1987)	*V. fujisanus* (Ishikawa, 1972)	*V. edurus* **n. sp.** (present study)
Setae *r3*	115 μm	128 μm	86 μm	185 μm	261 μm	130 μm
Podonotal setae	20 pairs	22 pairs	34 pairs	21 pairs	18 pairs	21 pairs
Opisthonotal setae	23 pairs	26 pairs	54 pairs	25 pairs	25 pairs	24 pairs
Sternal setae	2 pairs of setae on sternal shield	*st3* longer than *st1* and *st2*	2 pairs of setae of same length (90 μm)	*st1* (103 μm) *st2* (86 μm) *st3* (82 μm)	3 pairs (no measurements)	*st1* (23 μm) *st2* (20 μm) *st3* (19 μm)
Hypostomal & palpcoxal setae	setae of same length (62 μm)	*h1* (49 μm) *h2* (17 μm) *h3* (58 μm) *pcx* (115 μm)	*h1* (97 μm) *h2* (82 μm) *h3* (95 μm) *pcx* (105 μm)	*h1* (86 μm) *h2* (74 μm) *h3* (95 μm) *pcx* (86 μm)	*h1* (115 μm) *h2* (90 μm) *h3* (131 μm) *pcx* (92 μm)	*h1* (120 μm) *h2* (88 μm) *h3* (91 μm) *pcx* (86 μm)
Epistome (tectum)	3 prongs, median prong shorter and triangular, lateral prongs longer, asymmetric and curved outwards	3 prongs of same size and length (25 μm)	3 prongs, well separated by 2-5 fine irregular teeth, median prong long, 2 shorter prongs on both sides, sharp tipped	median prong with wider base, greatly longer (99 μm) than very narrow lateral prongs	median prong greatly longer, and distinctively thicker than lateral prongs	median prong slightly longer (35 μm) than lateral ones, but similar in thickness
Cheliceral lengths & dentition	digits of same length (111 μm), movable digit with 3 teeth, fixed digit with 5 teeth	movable digit (111 μm), 3 teeth; fixed digit (115 μm), 5 teeth	digits of same length (173 μm), movable digit with 3 teeth, fixed digit with 3 teeth	movable digit (255 μm), 3 teeth; fixed digit (230 μm), 4 teeth	movable digit (141 μm), 3 teeth; fixed digit with 7 teeth	movable digit (118 μm), 3 teeth; fixed digit with 8 teeth
Anterolateral setae on palp-genu (al_1, al_2)	spoon-like	entire with blunt tip	finger-like, branched	spoon-like	spatulate	al_1 entire, shorter and pointed, al_2 longer and blunt
Anterolateral seta on palp-femur (*al*)	hair-like	comb-like with 5 branches	finely pilose	entire with blunt tip	spatulate and finely pilose	deeply branched
Opisthogastric setae	8 pairs	6 pairs	12-14 pairs	10 pairs	10 pairs	8 pairs
Legs	I (790 μm) II (568 μm) III (560 μm) IV (815 μm)	I (815 μm) II (543 μm) III (518 μm) IV (831 μm)	I (1341 μm) II (1004 μm) III (930 μm) IV (1407 μm)	I (1053 μm) II (809 μm) III (761 μm) IV (1160 μm)	I (1430 μm) II (1050 μm) III (965 μm) IV (1425 μm)	I (843 μm) II (633 μm) III (554 μm) IV (890 μm)

molecular methods could provide a better level of understanding. Dabert *et al*. (2011) studied the andropolymorphism between the parasitid species *Aclerogamasus similis* (Willmann) and *A*. *holzmannae* (Micherdziński), and found that although the females are indistinguishable, males are different, confirming the synonymy between the two species after DNA barcoding. However, not all developmental stages of this species are completely known and described.

Reporting the new species with females, males and deutonymphs altogether in association with collembolans may suggest it is a soil predator. Information about the predatory aspects of several parasitid mites was summarised by Gerson *et al*. (2003), and Lindquist *et al*. (2009). However, predation on pest mites using parasitids has been scarcely studied. Some studies investigated the predatory performance of certain soil mesostigmatid mites, including *Parasitus* spp., against free living nematodes and house fly larvae and eggs (Ito, 1970, 1971, 1973, 1976, 1977). Such behaviour may encourage more ecological studies to examine the predator-prey interaction between the Japanese parasitid mites and their associated soil microarthropods and pestiferous nematodes.

Acknowledgement

The senior author would like to thank the Japan Society for the Promotion of Science for funding his postdoctoral fellowship. This work was supported in part by JSPS KAKENHI Grant Number JP17F17397. Special thanks to Dr. Hirotsugu Ono (Department of Zoology, National Museum of Nature and Science, Tsukuba, Ibaraki Prefecture) for his kind permission to examine the holotype of *V. fujisanus*.

References

Bai, X., Fang, L. & Yin, S. (1995) A new species of the genus *Vulgarogamasus* from China (Acari: Parasitidae). *Acta Zootaxonomica Sinica*, 20, 182–184.

Bai, X., Gu, Y. & Chen, B. (1991) A new species of *Vulgarogamasus* (Acari: Parasitidae). *Acta Zootaxonomica Sinica*, 16, 74–78.

Beaulieu, F., Dowling, A.P.G., Klompen, H., Moraes, G.J. de & Walter, D.E. (2011) Superorder Parasitiformes Reuter, 1909. *Zootaxa*, 3148, 123–128.

Dabert, M., Bigos, A. & Witalinski, W. (2011) DNA barcoding reveals andropolymorphism in *Aclerogamasus* species (Acari: Parasitidae). *Zootaxa*, 3015, 13–20.

El-Banhawy, E.M. & Nasr, A.K. (1984) Incidence of mites in bee hives in the State of New York with descriptions of two new species. *Bulletin of the Zoological Society of Egypt*, 34, 76–82.

Evans, G.O. & Till, W.M. (1979) Mesostigmatic mites of Britain and Ireland (Chelicerata: Acari-Parasitiformes). An introduction to their external morphology and classification. *Transactions of the Zoological Society of London*, 35, 139–270.
https://doi.org/10.1111/j.1096-3642.1979.tb00059.x

Gerson, U., Smiley, R.L. & Ochoa, R. (2003) *Mites* (*Acari*) *for Pest Control*. Blackwell Science, Oxford, 539 pp.
https://doi.org/10.1002/9780470750995

Gu, Y. & Guo, X. (1997) A new species of the genus *Vulgarogamasus* (Acari: Parasitidae). *Acta Zootaxonomica Sinica*, 22, 134–136.

Gu, Y. & Huang, C. (1993) Mites of the subfamily Parasitinae from Shaanxi Province with descriptions of three new species (Acari: Parasitidae). *Acta Zootaxonomica Sinica*, 18, 177–183.

Gu, Y., Wang, C., Yang, X. & Li, F. (1987) Mites of the subfamily Parasitidae in China with descriptions of three new species (Acarina: Parasitidae). *Acta Zootaxonomica Sinica*, 12, 40–49.

Holzmann, C. (1955) *Die Familie Parasitidae Oudemans 1901. Eine monographische Bearbeitung*. Dissertation, Universität Erlangen, Manuskript Staatsbibliothek München, 281 pp.

Hyatt, K.H. (1980) Mites of the subfamily Parasitinae (Mesostigmata: Parasitidae) in the British Isles. *Bulletin of the British Museum* (*Natural History*) *Zoology*, 38, 237–378.

Ishikawa, K. (1972) The fauna of the lava caves around Mt. Fuji-san. XI Mesostigmata (Acarina). *Bulletin of the Natural Science Museum*, *Tokyo*, 15, 445–451.

Ishikawa, K. (1980) *Parasitidae*. *In*: Ehara, S. (Ed.), *Illustrations of the Mites and Ticks of Japan*. Zenkoku Nôson Nyôiku Nyôkai, Tokyo, pp. 26–27. [in Japanese]

Ishikawa, K. (1982) Gamasid mites (Acarina) found in the subterranean domain of Southwest Japan. *Journal of the Speleological Society of Japan*, 7, 88–100.

Ishikawa, K. & Takaku, G. (1999) Gamasida. *In*: Aoki, J. (Ed.), *Pictorial Keys to Soil Animals of Japan*. Tokai University Press,

Tokyo, pp. 173–210. [in Japanese]
Ishikawa, K. & Takaku, G. (2015) Gamasida. *In*: Aoki, J. (Ed.), *Pictorial Keys to Soil Animals of Japan. 2nd Edition*. Tokai University Press, Tokyo, pp. 153–200. [in Japanese]
Ito, Y. (1970) Preliminary surveys on macrochelid and some other mesostigmatid mites occurring in the experimentally deposited livestock dungs as predators of muscid flies. *Japanese Journal of Sanitary Zoology*, 21, 205–208. https://doi.org/10.7601/mez.21.205
Ito, Y. (1971) Predation by manure-inhabiting mesostigmatids (Acarina: Mesostigmata) on some free-living nematodes. *Applied Entomology and Zoology*, 6, 51–56. https://doi.org/10.1303/aez.6.51
Ito, Y. (1973) Effect of isolation on the moult of *Parasitus* sp. deutonymphs (Acarina: Mesostigmata). *Applied Entomology and Zoology*, 8, 1–7. https://doi.org/10.1303/aez.8.1
Ito, Y. (1976) A new species of parasitid mites in manure (Acarina: Parasitidae). *Japan Journal of Sanitary Zoology*, 27, 343–346. https://doi.org/10.7601/mez.27.343
Ito, Y. (1977) Predatory activity of mesostigmatid mites (Acarina: Mesostigmata) for house fly eggs and larvae under feeding of nematodes. *Japan Journal of Sanitary Zoology*, 28, 167–173. https://doi.org/10.7601/mez.28.167
Karg, W. (1998) To the knowledge of the Eugamasides Karg with new species from the rain-forests of Ecuador (Acarina, Parasitiformes). *Mitteilungen aus dem Museum für Naturkunde in Berlin*, *Zoologische Reihe*, 74, 185–214. https://doi.org/10.1002/mmnz.19980740204
Lindquist, E.E., Krantz, G.W. & Walter, D.E. (2009) Order Mesostigmata. *In*: Krantz, G.W. & Walter, D.E. (Eds.), *A Manual of Acarology. 3rd Edition*. Texas Tech University Press, Lubbock, pp. 124–232.
Ma, L. (1990) Three new species of the subfamily Parasitinae (Acarina: Parasitidae) from Jilin Province, China. *Entomotaxonomia*, 12, 61–68.
Ma, L., Liu, J. & Cui, S. (2002) A new species of the genus *Vulgarogamasus* and a new species of the genus *Hypoaspis* (Acari: Gamasina: Parasitidae, Laelapidae). *Acta Zootaxonomica Sinica*, 27, 735–773.
Ma, L. & Wang, S. (1996) Four new species of the family Parasitidae and discovery of the genus *Trachygamasus* in China (Acari: Mesostigmata). *Acta Arachnologica Sinica*, 5, 81–88.
Micherdziński, W. (1969) *Die Familie Parasitidae Oudemans*, *1901* (*Acarina*, *Mesostigmata*). Panstwowe Wydawnictwo Naukowe, Krakow, 690 pp.
OConnor, B. & Klimov, P. (2016) North American bee-associated mites: Potential threats to native and introduced pollinators. Available from: http://insects.ummz.lsa.umich.edu/beemites/Species_Accounts/Vulgarogamasus.htm (accessed 15 December 2017)
Okabe, K. & Amano, H. (1993) Mites species collected from field mushrooms (II): Mesostigmata, Prostigmata and Astigmata. *Journal of the Acarological Society of Japan*, 2, 19–28. https://doi.org/10.2300/acari.2.19
Saito, M. & Takaku, G. (2011) Composition of indigenous predatory mites (Acari: Gamasina) in spinach fields in Hokkaido. *Japanese Journal of Applied Entomology and Zoology*, 55, 171–173. https://doi.org/10.1303/jjaez.2011.171
Stănescu, M. & Gwiazdowicz, D.J. (2004) Preliminary research on Mesostigmata mites (Acari) from a spruce forest in the Bucegi massif in Romania. *Acta Scientiarum Polonorum*, *Silvarum Colendarum Ratio et Industria Lignaria*, 3, 79–84.
Tagami, K. (2007) Description of adults and redescription of deutonymphs of *Histiostoma darwishii* Eraky, 1994 (Astigmata: Histiostomatidae), an associate of *Parasitus fimetorum* Berlese (Mesostigmata: Parasitidae). *International Journal of Acarology*, 33, 79–85. https://doi.org/10.1080/01647950708684504
Takaku, G., Katakura, H. & Yosida, N. (1994) Mesostigmatic mites (Acari) associated with ground, burying, roving carrion and dung beetles (Coleoptera) in Sapporo and Tomakomai, Hokkaido, Northern Japan. *Zoological Science*, 11, 305–311.
Takaoka, M. (2000) Review on mite fauna of house dust in Japan. *Journal of the Acarological Society of Japan*, 9, 93–103. https://doi.org/10.2300/acari.9.93
Teodorowicz, E., Gwiazdowicz, D.J. & Kamczyz, J. (2012) Description of larva and protonymph of *Vulgarogamasus kraepelini* (Acari: Parasitidae). *Biologia*, 67, 540–545. https://doi.org/10.2478/s11756-012-0033-x
Tichomirov, S.I. (1969) Morphological and ecological structure of the genus *Parasitus* sensu Micherdziński, 1966 (Gamasoidea, Parasitidae). I. Subgenera *Eugamasus* Berl., *Parasitus* Latr., *Vulgarogamasus* subgen. n.]. *Zoologicheskii Zhurnal*, 48, 1325–1336.
Willmann, C. (1936) Milben aus den Bergwerken von Mährisch-Altstadt. *Beiträge zur Biologie des Glatzer Schneeberges*, *Breslau*, 2, 192–199.
Yasui, Y. (1997) Sperm competition and the significance of female multiple mating in the predatory mite *Parasitus fimetorum*. *Experimental and Applied Acarology*, 21, 651–664. https://doi.org/10.1023/A:1018456618435