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Description of *Verutus mesoangustus* n. sp. (Tylenchida: Heteroderidae) from Japan

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Verutus mesoangustus n. sp. was described from root of *Miscanthus sinensis* in Ibaraki and Kumamoto Prefecture, Japan. The new species differs from the type and only known species of the genus, *V. volvingentis*, in the distinctively constricted midbody in female, and shorter body in female, male and second-stage juvenile.

The genus *Verutus* ESSER, 1981 is a peculiar shaped nematode in Heteroderidae, which is considered to be a unique genus of subfamily Verutinae at the present time (ESSER, 1981). The mature female of this genus is characterized by saccate to reniform body annulated thoroughly, large vulva located on subequatorial portion of body, and absence of cyst stage. According to the comparative studies of cuticle structure of female, *Verutus* is considered to be a primitive form in the family (CLIFF and BALDWIN, 1985). A close ally was found from *Miscanthus sinensis* ANDERSS. in Kumamoto and Ibaraki Prefecture, Japan, and described as a new species herein.

Verutus mesoangustus n. sp.

Measurements and descriptions

Female (Fig. 1). Population from Yatabe, Ibaraki (holotype and paratypes): $n=4$, L (including neck) $=270$–342 μm (307 μm, mean), maximum width (W) $=188$–290 μm (230), $L/W=0.95$–1.8 (1.4), neck length $=41.2$–73.3 μm (61.2), length of anterior body (from anterior end to most slender point of midbody) $=137$–280 μm (204), width of anterior body (width of do.) $=116$–178 μm (140), length of posterior body (from posterior end to most slender point of midbody) $=177$–205 μm (194), width of posterior body (width of do.) $=120$–137 μm (131), stylet $=14.0$–16.0 μm (15.1, $n=3$), prorhabdion $=8.0$–9.3 μm (8.7, $n=3$), stylet knob height $=2.0$ μm ($n=3$), do. width $=3.3$ μm ($n=3$). Population from Mt. Aso, Kumamoto (paratypes): $n=12$, $L=305$–445 μm (358 μm, mean), masimum width (W) $=158$–360 μm (236), $L/W=1.1$–2.8 (1.9), neck length $=49.5$–103.8 μm (76.2), length of anterior body $=152$–280 μm (201), width of anterior body $=133$–214 μm (163), length of posterior body $=139$–267 μm (194), width of posterior body $=105$–248 μm (170), stylet $=14.7$–19.0 μm (17.7, $n=8$), prorhabdion $=6.7$–8.7 μm (7.9, $n=9$), stylet knob height $=2.0$–2.7 μm (2.2, $n=8$), do. width $=3.7$–4.7

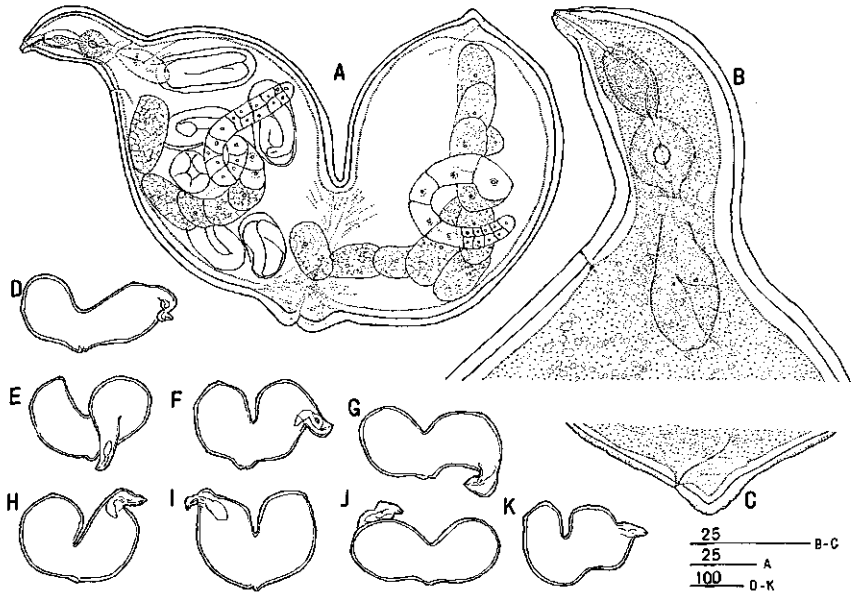

Fig. 1. *Verutus mesoangustus* n. sp. Female adult.
A: general shape, B: anterior body, C: posterior end of body (tail terminus and anus), E–K: variations of body shapes. Numerical figures at scale bars are presented in micrometers.

μm (4.2, n=8). Body asymmetrical, constricted at midbody, so that the entire body looks as if two ovoid parts were connected by a narrow bridge. Neck distinctly projected from the body, variable in shape and direction. Anterior end truncate. Stylet slender, flexible; knobs round. Dorsal esophageal gland orifice approximately 3.0–8.0 μm posterior to stylet base. Procorpus short, massive; metacorpus spherical; isthmus short; basal glandular portion elongated globate, extending over the intestine, and terminus reaching 70.0–123.7 μm (mean: 96.3 μm, n=10) from anterior end of body. Hemizonid at the level of isthmus. Excretory pore at 54.0–77.5 μm from lip. Vulva subequatorial, vulval slit 36.3–52.8 μm (40.8) wide, and vulval lips markedly protuberant. Reproductive system didelphic, amphidelphic, reflexed, and well developed. Body with subcrystalline layer; cuticle distinctly annulated throughout, annules 1 μm apart; thickness of cuticle ca. 3 μm at midbody, 4.0–8.0 μm around vulva; lateral field not observed. Lip region separated from body. First head annule distinct, truncate in front, and other annules obscure. Cephalic framework weakly developed.

Male (Fig. 2). Population from Yatabe, Ibaraki (paratypes): n=25, L=370–556 μm (448$\pm$40: mean$\pm$standard deviation), a=19.1–30.9 (24.2$\pm$2.6), b=4.9–7.2 (6.2$\pm$0.6), b'=3.2–4.7 (3.9$\pm$0.4), c=66.7–134.2 (92.8$\pm$17.7), c'=0.3–0.6 (0.4$\pm$0.09), stylet=14.7–16.7 μm (15.8$\pm$0.6), prorhabdion=7.3–8.0 μm (7.9$\pm$0.4), stylet knob height=1.3–2.0 μm (1.6$\pm$0.2), do. width=2.3–3.0 μm (2.9$\pm$0.3), spicule=21.3–26.7 μm (23.2$\pm$1.5), gubernaculum=7.3–10.7 μm (9.2$\pm$0.7), T=29.8–73.7 (50.5$\pm$7.9), excretory pore from anterior end/L=13.8–20.4% (17.2$\pm$1.4). Population from Mt. Aso, Kumamoto (paratypes): n=4, L=450–570 μm (506: mean), a=23.3–30.0 (26.5), b=5.6–6.8 (6.3), b'=3.4–4.3 (4.0), c=85.1–135.0 (99.5), c'=0.3–0.5 (0.4), stylet

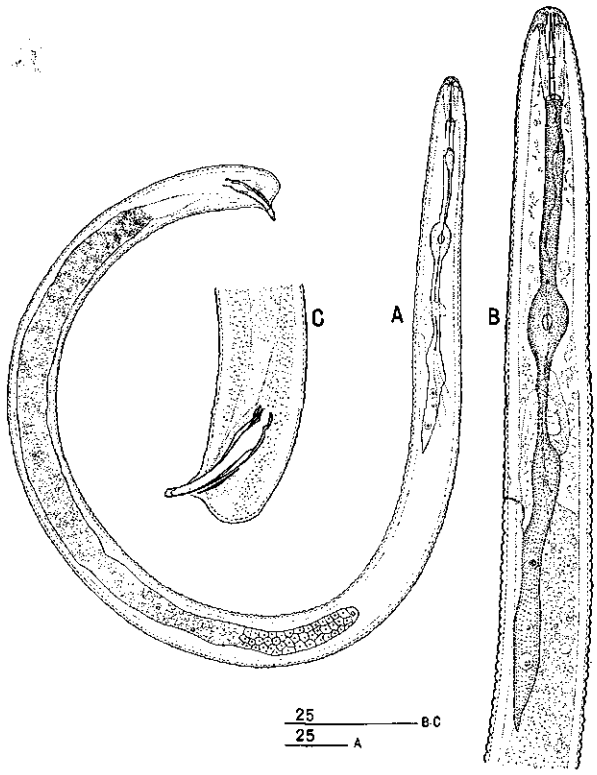

Fig. 2. *Verutus mesoangustus* n. sp. Male adult.
A: general shape, B: anterior body, C: posterior end of body (spicules, gubernaculum and tail). Numerical figures at scale bars are presented in micrometers.

=17.0–18.0 μm (17.4), prorhabdion=7.3–8.7 μm (8.0), stylet knob height=1.3–2.0 μm (1.8), do. width=2.3–3.3 μm (2.9), spicule=23.3–26.3 μm (24.7), gubernaculum=8.0–10.7 μm (9.3), T=47.6–58.4 (54.9), excretory pore from anterior end/L=14.9–18.4% (17.0). Body circular or C-shaped after treatment by gentle heat, never twisted even in tail region. Lip region subspherical with 3 to 5 annules. Labial disk ovoid, submedian lobes fused, amphid apertures subspherical and large. Stylet a little longer than that of second-stage juvenile; prorhabdion acute, about half stylet length; knobs sloping posteriorly and triangular in profile. Dorsal esophageal gland orifice at 2.0–3.3 μm behind stylet base. Procorpus cylindrical. Metacorpus ovate, not strongly musculated. Esophago-intestinal junction about the level of hemizonid. Extending esophageal gland lobes occupy usually less than half body width. Hemizonid one annule long, immediately in front of excretory pore. Testis single, well developed. Spicules arcuate, gubernaculum thin and elongated spindle-shaped. Tail present, very short. Lateral field with four incisures; space between inner incisures as wide as outer ones. Body annule not coarse, 1.3–2.2 μm (1.6±0.2) apart at midbody.

Second-stage juvenile (Fig. 3). Population from Yatabe, Ibaraki (paratypes): n=25, L=320–380 μm (346±16), a=22.1–27.1 (24.0±1.2), b=3.5–4.3 (3.9±0.4), b'=

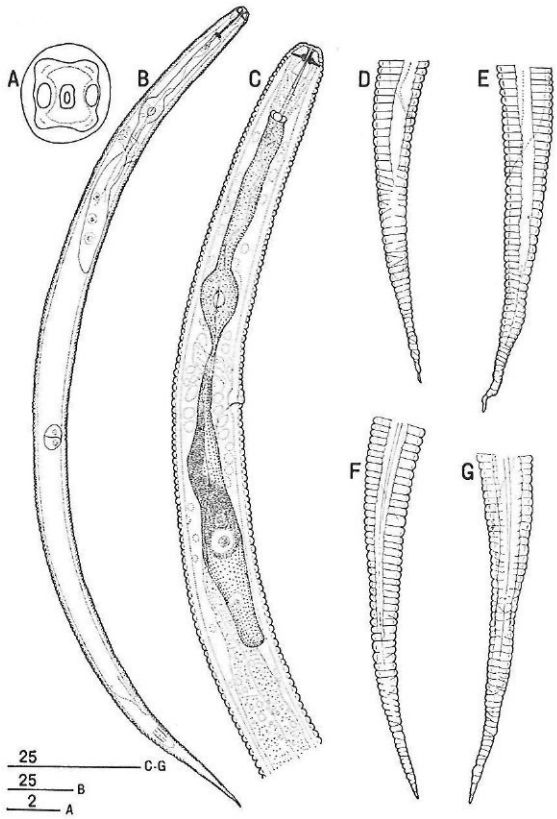

Fig. 3. *Verutus mesoangustus* n. sp. Second-stage juvenile.
A: face view, B: general shape, C: anterior body, D–G: variations of tails. Numerical figures at scale bars are presented in micrometers.

2.4–2.8 (2.6±0.1), c=6.8–7.8 (7.2±0.3), c'=5.0–6.6 (5.7±0.4), stylet=13.7–16.7 μm (14.7±0.6), prorhabdion=6.3–8.0 μm (7.2±0.4), stylet knob height=1.3–2.0 μm (1.6±0.3), do. width=2.7–3.7 μm (2.9±0.2), dorsal esophagus orifice from stylet base =2.0–3.3 μm (3.1±0.3), excretory pore from anterior end of body=66.7–83.3 μm (73.4±3.7), do./L=19.8–23.2% (21.2±0.8). Population from Mt. Aso, Kumamoto (paratypes): n=25, L=302–371 μm (345±21), a=21.3–26.7 (24.3±1.4), b=3.6–4.3 (4.0±0.2), b'=2.4–3.1 (2.7±0.1), c=6.2–8.6 (7.1±0.6), c'=4.7–8.0 (6.0±0.8), stylet =12.7–16.0 μm (14.4±0.8), prorhabdion=6.4–8.8 μm (7.2±0.7), stylet knob height= 1.6–2.0 μm (1.6±0.1), do. width=2.4–3.2 μm (2.8±0.3), dorsal esophageal gland orifice from stylet base=2.4–4.4 μm (3.6±0.5), excretory pore from anterior end of body=65.2–81.8 μm (73.4±4.2), do./L=19.5–23.2% (21.3±0.8). Body vermiform, and ventrally arcuate after treatment by gentle heat. Anterior end truncate, head with usually 4 or 5, rarely 3 annules, continuous with body contour, 2.4–4.0 μm (3.3 μm: mean) high, and 6.3–8.0 μm (6.9) wide at base. Labial framework moderately sclerotized. In face view, labial disk ovoid to rectangular with narrower dorsal- and ventral extensions; submedian lips (lip sectors in OTHMAN and BALDWIN's sense) fused; lateral

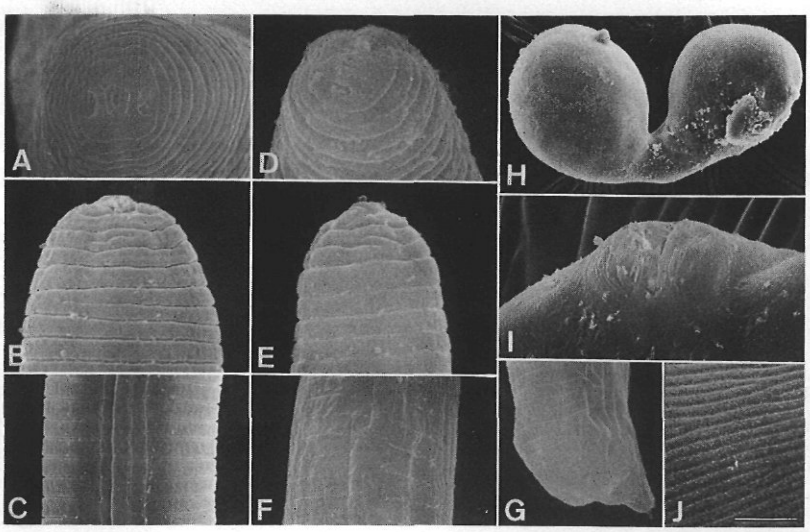

Fig. 4. *Verutus mesoangustus* n. sp. Scanning electron microscopy.
Second-stage juvenile: A, face view; B, head (lateral view); C, midbody. Male adult: D, face view; E, head (lateral view); F, midbody; G, tail end. Female adult: H, general view; I, vulva; J, annulation. Scale bar indicates 2 μm for A, B, D, E; 4 μm for C, F, G; 8 μm for J; 20 μm for I; and 80 μm for H.

lips semicircular; and amphid apertures large, oval. Stylet thin, prorhabdion sharply pointed, about half stylet length; knobs round, slightly directed anteriorly. Dorsal esophageal gland orifice at about twice stylet-knob height (2.0–4.4 μm, mean 3.4 μm) from stylet base. Procorpus cylindrical, metacorpus oval shaped; isthmus not clearly defined; esophago-intestinal junction 6.0–23.3 μm (15.9) posterior to excretory pore. Glandular lobes overlaps intestine laterally and ventrally, variable in length. Excretory pore at immediately behind the hemizonid. Hemizonid one or two annules long. Genital primordium located around middle of the body, oval shaped, with two cells, 5.0–8.8 μm (7.0) wide and 9.5–16.0 μm (11.7) long. Anus at 35.8–55.8 μm from terminus. Tail thin, the tip pointed. Hyaline area of tail 16.0–22.7 μm (19.7) long. Phasmids minute, located at 27.0–43.8 μm (34.9) from the tail end. Lateral field 2.8–5.6 μm (4.0) wide with four incisures. Body annules small, but distinct, 1.1–1.6 μm (1.4) apart around midbody.

Type specimens. Holotype female is deposited in the Herbarium and Insect Museum of the National Institute of Agro-Environmental Sciences (NIAES), Yatabe, Ibaraki Prefecture, Japan. Some paratypes will be distributed to the following institutes: USDA Nematode Collection, Beltsvill, Maryland, USA; University of California, Nematode Survey Collection, Davis, California, USA; Nematology Department, Rothamsted Experimental Station, Herts., England; Commonwealth Institute of Parasitology, Harpenden, Herts., England; Department of Nematology, Agricultural University, Wageningen, The Netherlands; Instituut voor Dierkunde, Rijksuniversiteit Gent, Gent, Belgium; and Laboratoire des Vers, Muséum National d'Histoire Naturelle, Paris, France. Remaining paratypes are retained in the collection of NIAES.

Type host. Eulalia, *Miscanthus sinensis* ANDERSS.