

First Report of Korean Cyst Nematode, *Heterodera koreana*, Parasitic on Bamboo, *Phyllostachys nigra*, from Iran

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Abstract: Bamboo is grown sporadically in the north of Iran and is confined to very limited areas. The history of growing bamboo was to some extent simultaneous with the entrance, commencement, and growth of the tea industry in the north about a century ago. The bamboo was used for making baskets to transfer the harvested tea foliage from farm to the factory and other linked functions. A main area allocated for bamboo growing is located in Lahidjan Agricultural Research Station (LARS) in the north of Iran, where several species of bamboo were cultivated in an area of 5 ha. The species include five species of *Phyllostachys* (viz., *P. aurea*, *P. bambusoides*, *P. decora*, *P. nigra*, *P. vivax*) and one species of *Arundinaria gigantea*, *Pleioblastus fortunei*, and *Semiarundinaria fastuosa*; however, only *P. aurea* and *P. nigra* have been precisely identified. A survey on plant parasitic nematodes associated with bamboo mainly on *P. nigra* in LARS revealed second-stage juveniles of cyst forming nematode in soil samples. Further analysis of root and soil samples led to recovery of a cyst nematode belonging to the genus *Heterodera* and the *Afenestrata* group. Cysts, vulval cone, and second-stage juveniles were studied for morphological and morphometric features. The classical identification was followed by amplification of the ribosomal RNA-ITS region and the D2-D3 expansion segments of 28S large-subunit rRNA gene; the amplified fragments were sequenced, edited, and compared with those of the corresponding published gene sequences. New D2-D3 and rRNA-ITS gene sequences were deposited in the GenBank database under the accession numbers KR818910 and KR818911, respectively. Based on the morphological and molecular data, the species of the cyst-forming nematode was identified as *H. koreana* (Vovlas et al., 1992; Mundo-Ocampo et al., 2008). The body contour of cysts was mainly subspherical, very often with irregular shape (Fig. 1A), yellowish to light brown, thin cuticle with fine zigzag pattern, without fenestration, lacking bulla, and underbridge. Vulval lips protruded, cuticular pattern of vulval cone with a tuberculate area (Fig. 2B), and vagina embedded into vulval lips. The second-stage juveniles cylindrical and slender, hemispherical cephalic framework, with three lines in lateral field, well-developed rounded stylet knobs, tail conoid tapering to fine rounded terminus, phasmids posterior to anus. The cyst measurements were ($n = 21$) length 502 ± 70 (420 to 640) μm ; width = 408 ± 60 (320 to 520) μm ; length/width = 1.23 ± 0.09 (1.07 to 1.5) μm . The morphometric characters of vulval cone were measured ($n = 7$): fenestral length = 62.4 ± 6.5 (51 to 71) μm ; fenestral width = 50.7 ± 3.2 (45 to 54) μm ; vulval slit = 51.9 ± 4.3 (46 to 59) μm ; distance from vulva to anus = 51.3 ± 4.4 (43 to 56) μm . Second-stage juveniles showed the following morphometric characters ($n = 14$): L = 455 ± 11.3 (437 to 472) μm ; $a = 29.9 \pm 0.9$ (28.3 to 31.5); $b = 2.7 \pm 0.4$ (2.2 to 3.5); $c = 7.4 \pm 0.9$ (6 to 8.9); $i = 6.1 \pm 0.4$ (5.1 to 6.7); lip region height = 3 μm ; lip region width = 7.5 ± 0.5 (7 to 8) μm ; stylet length = 18.1 ± 0.5 (17 to 19) μm ; anterior end to median bulb = 72.2 ± 1.7 (70 to 75) μm ; anterior end to secretory-excretory pore = 99.7 ± 2.5 (96 to 103) μm ; maximum body width = 15.2 ± 0.4 (15 to 16) μm ; body width at anus = 10.1 ± 1 (8 to 11) μm ; tail length = 62.0 ± 6.9 (51 to 74) μm ; hyaline part of tail = 44.0 ± 1.8 (40 to 47) μm . The egg measurements for 11 individuals were length = 102.5 ± 7.9 (93 to 119) μm ; width = 39.3 ± 4.2 (33 to 46) μm ; length/width = 2.6 ± 0.3 (2.0 to 3.1). The morphology, morphometric characters and molecular data of the population of *H. koreana* isolated from bamboo in Iran are in agreement with those previously reported for this species (Vovlas et al., 1992; Mundo-Ocampo et al., 2008). At present, five species of *Heterodera* belonging to the Cyperi and *Afenestrata* groups were reported from bamboo, *H. bamboosi* (Kaushal and Swarup, 1988; Wouts and Baldwin, 1998) on *Bambusa* sp. from India; *H. koreana* on *P. pubescence*, *P. aurea*, and *P. nigra* from South Korea and the United States; and *H. hainanensis* (Zhuo et al., 2013), *H. jengi* (Wang et al., 2013), and *H. guangdongensis* (Zhuo et al., 2014) on *P. pubescence* from China; thus showing host suitability of bamboo for at least five species of cyst-forming nematodes. A greenhouse test performed by planting rice seed cv. Hashemi in soil containing *H. koreana* showed successful multiplication of Korean cyst nematode on rice seedlings after 2 mon. The exact date of the establishment of bamboo plantation in LARS is not precisely clear, but it indicates that the Korean cyst nematode was most likely brought with the imported bamboo seedlings from unknown origin several decades ago. According to our best knowledge, this is the first report of occurrence of *H. koreana* from Iran. So far the Korean cyst nematode was reported from South Korea, Thailand, and the United States, Florida (from nurseries); this study includes the distribution of this cyst-forming nematode in Iran and expands the information of the occurrence of *H. koreana* for the world.

Key words: bamboo, detection, *Heterodera koreana*, Iran.

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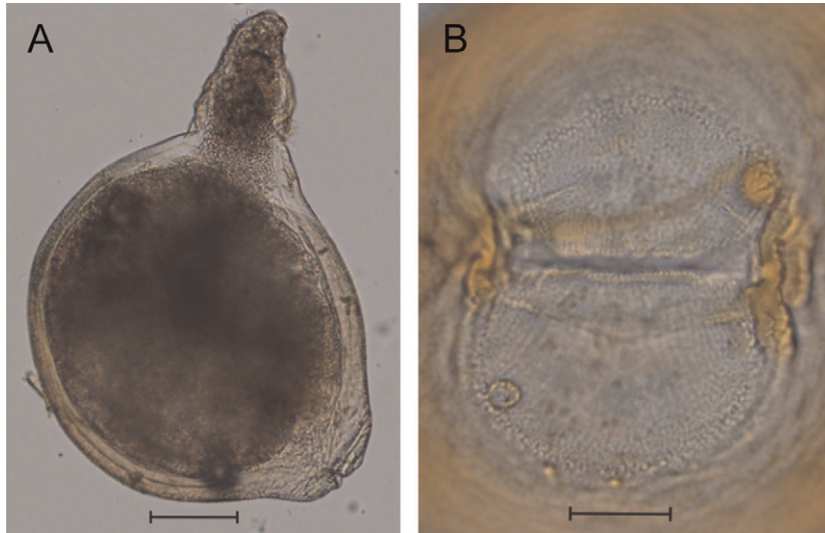


FIG. 1. Photomicrographs of *Heterodera koreana*. A. Young cyst. B. Vulval plate (scale bar: A = 20 μ m; B = 40 μ m).