Some of the plant-parasitic nematodes related to okra in Khuzestan province, southwest Iran

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Abstract

Okra is considered as one of the most important fruit vegetables of tropical regions, one of the main cultivation areas of which in Iran is Khuzestan province. Due to the lack of a comprehensive research on identifying the plant-parasitic nematodes related to okra in Iran, the present study tried to identify the nematode species in Khuzestan province. In this regard, several root and soil samples were collected from okra fields in the different areas of the province. In addition, centrifugal-floatation and tray methods were applied to extract the nematodes from soil samples. Further, the adult females of *Meloidogyne javanica* were separated from root galls by using a sterilized needle and scalpel, fixed, and transferred to pure glycerin through using modified De Grisse method. After preparing permanent microscopic slides, the species were identified on a light microscope equipped with a drawing tube based on the morphological and morphometric characteristics, and valid keys. Based on the results, *M. javanica* was isolated from the roots and rhizosphere of okra. Furthermore, the other recovered species included *Geocenamus brevidens*, *G. microdorus*, *G. rugosus*, *Pratylenchus thornei*, *Psilenchus hilarulus*, *P. vinciguerrae* and *Tylenchorhynchus elegans*. In the study, the morphometric data and photomicrographs of the species under study were provided and their differences with other populations were discussed. To the best of our knowledge, the study is the first report of all the latter seven species associated with okra. The morphological and morphometric data related to the Iranian populations of *P. vinciguerrae* and *T. elegans* were presented for the first time.

Keywords: Abelmoschus esculentus, morphology, morphometric data, plant-parasitic nematodes, taxonomy

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Introduction

Okra (*Abelmoschus esculentus* L. Moench) from Malvaceae Juss. family is a commercial vegetable crop, which is broadly cultivated in the tropical, subtropical, and warm temperate regions of the world (Hussain et al., 2011, 2012; Singh et al., 2014). The fruit of okra is considered as a good source of protein, carbohydrates, vitamins, and minerals. Due to the benefits, it has a special place in human diet. Additionally, it is used in the medicine, for example as a blood volume expander or in plasma replacement (Singh et al., 2014). In Iran, okra is mainly cultivated in the west and south, among which Khuzestan province is the major production region (Pakravan, 2008). Some plant-parasitic nematodes are associated with okra. For instance, root-knot nematodes are major pests of okra, which can lead to root galling, wilting, leaf chlorosis, stunted growth, decrease in photosynthesis, and poor fruit quality (Prajapati et al., 2018). Some species such as *Helicotylenchus* Steiner, 1945, *Tylenchorhynchus* Cobb, 1913, *Hoplolaimus indicus* Sher, 1963, *Rotylenchulus reniformis* Linford & Oliveira, 1940, and *Meloidogyne incognita* Kofoid & White, 1919 have been found in the okra farms of India (Bhosle, 2004). Four root-knot nematode species of *M. arenaria* (Neal, 1889) Chitwood, 1949, *M. incognita*, *M. javanica* (Treub, 1885) Cobb, 1890, and *M. hapla* Chitwood, 1949 are the most damaging species, and infecting 85.28% of okra farms in Pakistan (Hussain et al., 2012). The species of the genera *Criconema* Hofmanner & Menzel, 1914, *Helicotylenchus* sp., *Hoplolaimus* Daday, 1905, *Longidorus* Micoletzky, 1922, *Pratylenchus* Filipjev, 1936, and *Xiphinema* Cobb 1913, have been observed in association with okra in Pakistan (Hussain et al., 2015). Based on the available data, no extensive study has been focused on the plant-parasitic nematodes associated with okra in Iran. Considering the results of the previous study, *M. javanica* has been reported from okra in Fars province, Iran, leading a 10% yield loss (Ahmadi and Moosavi, 2017). Thus, the present study aimed to recognize the plant-parasitic nematodes related to okra in Khuzestan province, southwest Iran.

Materials and methods

Root and soil samples were collected from different okra fields in Khuzestan province, southwest Iran. The soil samples were taken from 5-40 cm depth, put in the polyethylene bags with relevant information, transferred to laboratory, and kept in the refrigerator at 4˚C until processing for nematode extraction.

In addition, Jenkins (1964) or tray (Whitehead and Hemming, 1965) method was employed to extract the nematodes from soil samples. The female root-knot nematodes were extracted from root galls by using a needle and scalpel under a stereoscopic microscope. Further, the collected specimens were killed by adding boiling formaldehyde solution (4%) and transferred to anhydrous glycerin based on the De Grisse (1969) method. An Olympus light microscope equipped with a drawing tube was applied for observations and measurements. Furthermore, some specimens were photographed by using an Olympus DP72 digital camera attached to an Olympus BX51 light microscope equipped with differential interference contrast (DIC). Finally, nematode species were identified based on the morphological and morphometric characters using valid keys e.g. Siddiqi (2000), Geraert (2008, 2011 and 2013) at genus or species level.

Results and discussion

In the present study, eight plant-parasitic nematode species were recognized including *Geocenamus brevidens* (Allen, 1955) Brzeski, 1991, *G. microdorus* (Geraert, 1966) Brzeski, 1991, *G. rugosus* (Siddiqi, 1963) Brzeski, 1991, *Meloidogyne javanica*, *Pratylenchus thornei* Sher & Allen, 1953, *Psilenchus hilarulus* de Man, 1921, *P. vinciguerrae* Brzeski, 1991, and *Tylenchorhynchus elegans* Siddiqi, 1961.

Iranian population of *Geocenamus brevidens*

(Figure 1, A-F)

MEASUREMENTS

See Table 1.

The general morphology of the recovered population of the species closely resembled that of the other populations (Geraert, 2011), while its stylet length was slightly shorter (11.7-14.3 *vs* 13.0-16.5 μm). Of course, this type of variation has already been reported (Hasanzadeh et al., 2005).

G. brevidens is associated with various plants in the different areas of Iran such as faba bean in Khuzestan province (Azimi, 2017). In the study, this species was recovered from the rhizosphere soil of the okra fields close to the city of Shushtar, Khuzestan province, southwest Iran (GPS coordinates: 31°57′12.77″N, 48°51′27.29″E).

Iranian population of *Geocenamus microdorus*

(Figure 1, G-L)

MEASUREMENTS

See Table 1.

The general morphology of the recovered populations of the species was closely consistent with that of the other populations (Geraert, 2011), and those reported from diverse plants in the various regions of Iran (Ghaderi et al., 2018). The species has been found from faba bean in Khuzestan province based on the morphological and molecular data (Azimi et al., 2016). *G. microdorus* was obtained from the rhizosphere soil of the okra fields near the cities of Ramhormoz (GPS coordinates: 31°17′7.22″N, 49°36′13.51″E) and Ramin (GPS coordinates: 31°28′56.17″N, 48°54′2.97″E), Khuzestan province, southwest Iran. Additionally, no difference was attained between the two populations in terms of their morphometric data.

Iranian population of *Geocenamus rugosus*

(Figure 1, M-R)

MEASUREMENTS

See Table 1.

The populations of *G. rugosus* were in agreement with the original description of the species morphologically and morphometrically (Geraert, 2011). However, their stylet length was slightly less (19-21 *vs* 20-24 μm). *G. rugosus* has been observed in association with various plants in the different regions of Iran such as faba bean in Khuzestan province (Azimi et al., 2016). In the study, it was recovered from the rhizosphere soil of the okra fields close to Ramhormoz (GPS coordinates: 31°17′7.22″N, 49°36′13.51″E) and Ramin (GPS coordinates: 31°28′29.5″N, 48°51′24.59″E), Khuzestan province, southwest Iran. The two populations were not different morphometrically.

Iranian population of *Meloidogyne javanica*

(Figure 2, A-C)

MEASUREMENTS

See Table 2.

The results represented a closely consistency between the general morphology of the *M. javanica* populations and that of the

other populations from different plants in the various regions of Iran such as the intended province (Mahdikhani-Moghadam, 2018; Eisvand et al., 2020). However, they had a slightly longer body length in the second-stage juveniles (J2s) compared to that reported by Askarian et al., 2009 (455-483 *vs* 395-420 µm). Further, the female vulva-anus was greater (25.4-28.6 *vs* 15-19 µm) and the b ratio in the J2s was slightly lower (3.8-4.2 *vs* 5.2-8.0) than those of Hesar et al. (2011).

The species has been previously found from okra in Khuzestan province (Ahmadi and Tanha Maafi, 2012). Regarding the present study, it was obtained from the okra root in the fields of Hamidie (GPS coordinates: 31°27′16.53″N, 48°26′22.62″E), Soosangerd (GPS coordinates: 31°28′37″N, 48°24′53.48″E), Shush (GPS coordinates: 32°12′17.7″N, 48°13′59.77″E), and Shushtar (GPS coordinates: 31°58′35.54″N, 48°53′11.84″E) cities, Khuzestan province, southwest Iran. Furthermore, no difference was achieved among the populations in terms of morphometric data.

Table 1. Morphometrics of Iranian populations of *Geocenamus brevidens, G. microdorus* and *G. rugosus* from Khuzestan province, Iran. All measurements are in µm and in the form: mean±SD (range)

	Geocenamus brevidens	*Geocenamus microdorus*	*Geocenamus rugosus*
Character	Females	Females	Females
n	5	10	10
L	559.7±28.5 (539.5-579.8)	539.4±54.9 (511-651)	775.3±95.9 (689-913)
a	29.8±1.3 (28.8-30.7)	30.7±1.9 (26.4-33.0)	34±2 (30.9-36.9)
b	4.7±0.3 (4.5-4.9)	4.5±0.2 (4.3-4.8)	4.8±0.3 (4.5-5.3)
c	14.1±3.1 (11.9-16.3)	13.7±0.8 (12.6-14.9)	15.4±1.1 (13.8-16.7)
c'	3.6±0.3 (3.4-3.8)	3.3±0.3 (2.8-3.8)	3.1±0.3 (2.6-3.4)
V	54.2±0.6 (53.7-54.6)	56.0±1.2 (54.1-58.0)	56.0±0.8 (54.5-57.0)
Stylet length	13.0±1.8 (11.7-14.3)	13.4±0.8 (12.0-14.5)	19.8±1.0 (19-21)
m	73.7±5.2 (70.0-77.3)	59.7±3.4 (55.6-64.3)	55.9±3.4 (51.7-60.0)
DGO	2.3±0.4 (2.0-2.6)	1.8±0.2 (1.3-2.0)	2.6±0.4 (2.0-3.3)
Pharynx	116.3±4.7 (113-120)	132.6±9.7 (118-143)	157.3±10.9 (143-171)
MB	43.9±0.3 (43.7-44.1)	42.9±1.5 (40.9-45.5)	45.0±1.3 (42.6-46.2)
Excretory pore from anterior end	91.4±8.7 (85.2-97.5)	94.4±10.2 (82-107)	125.3±10.9 (108-135)
Body width	18.9±1.8 (17.6-20.2)	19.3±1.9 (16.9-21.5)	22.4±1.4 (20.2-24.1)
Lip region-vulva	303.3±18.9 (289-317)	336.6±28.3 (301-366)	414.3±39.2 (380-471)
Vulval body width	17.6±0.1 (17.5-17.6)	19.2±1.9 (15.6-21.5)	22.2±1.5 (20.2-24.1)
Vulva-anus	215.3±3.2 (213-217.5)	217.9±22.2 (185-241)	294.3±39.5 (252-346)
Anal body width	11.4±2.3 (9.8-13.0)	13.2±0.9 (11.7-14.3)	16.4±1.7 (14.3-18.9)
Tail length	41±11 (33.2-48.8)	43.4±4.7 (35.8-50.7)	50.6±5.4 (42.3-56.6)
Tail annuli	44.8±3.4 (40-49)	43.6±7.2 (36-58)	25.5±3.3 (20-30)

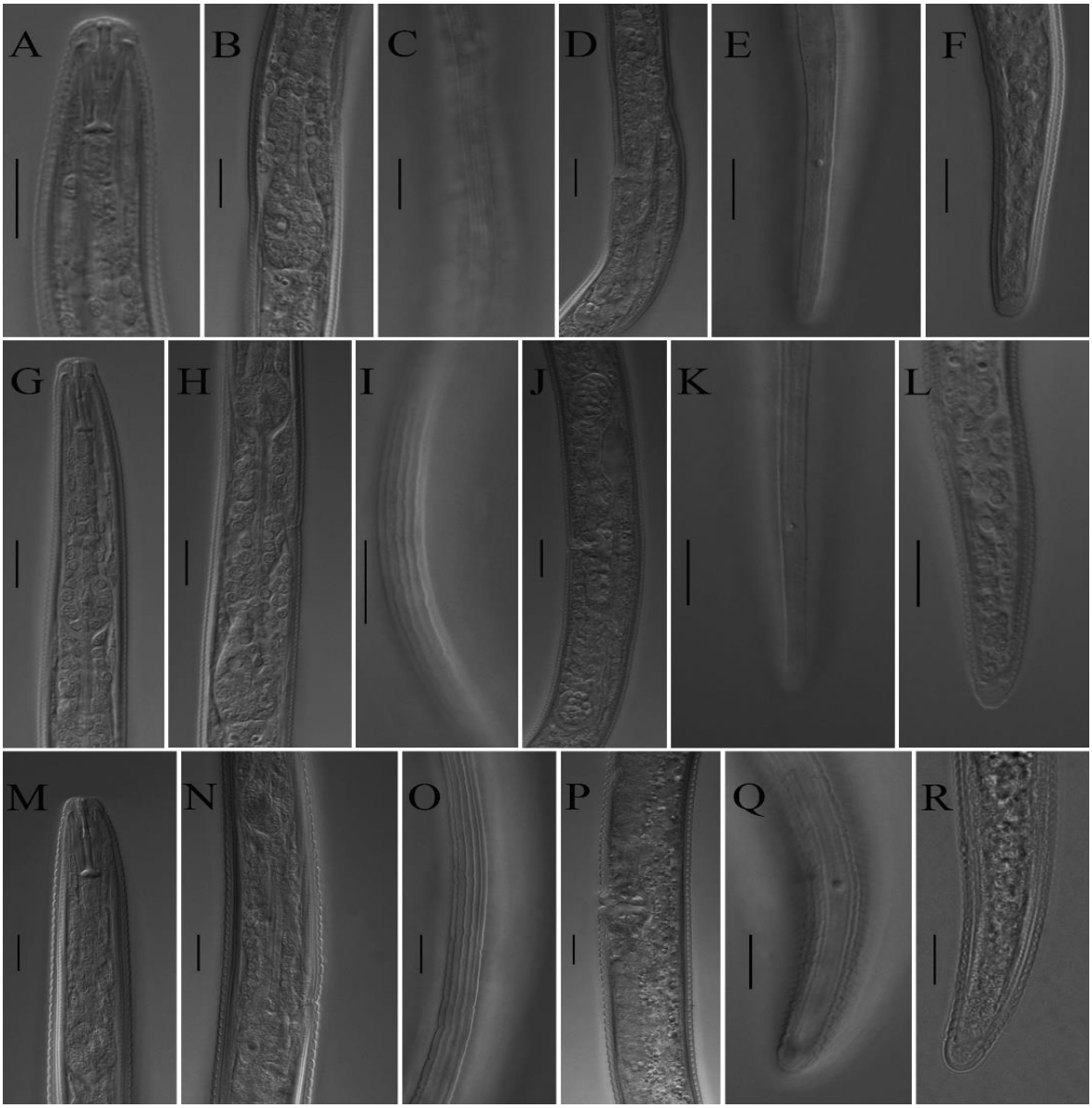

Figure 1. Iranian populations of *Geocenamus brevidens* (Allen, 1955) Brzeski, 1991, *G. microdorus* (Geraert, 1966) Brzeski, 1991 and *G. rugosus* (Siddiqi, 1963) Brzeski, 1991 from Khuzestan province, Iran (female). A-F: *G. brevidens*, G-L: *G. microdorus* and M-R: *G. rugosus*. A, G & M: Anterior body region; B, H & N: Part of pharynx; C, I & O: Lateral field at mid-body; D, J & P: Vulval region; E, K & Q: Tail showing phasmid; F, L & R: Tail. (Scale bars: 10 µm)

Table 2. Morphometrics of *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949 from Khuzestan province, Iran. All measurements are in µm and in the form: mean±SD (range)

	Meloidogyne javanica	
Character	Females	Second-stage juveniles (J2)
n	10	5
L	729.8±115.7 (612.8-922.4)	464.8±16.3 (455.0-483.6)
a	1.4±0.2 (1.2-1.7)	31.5±2.0 (30.3-33.8)
b	-	4.0±0.2 (3.8-4.2)
b'	-	2.7±0.2 (2.5-2.9)
c	-	8.1±0.2 (8.0-8.3)
c'	-	5.5±0.6 (4.8-6.0)
Stylet length	15.3±1.9 (12.6-18.8)	12.5±0.5 (12.1-13.0)
DGO	4.9±0.6 (4.7-6.3)	2.5±0.5 (2-3)
Neck length	213.8±58.7 (164.9-329.7)	-
Lip region height	-	2.5±0.2 (2.2-2.6)
Lip region width	-	5.1±0.5 (4.6-5.5)
Metacorpus length	-	11.7±1.3 (10.4-13.0)
Metacorpus width	-	12.1±0.5 (11.7-12.4)
Anterior end to end of gland lobe	-	175.1±16.6 (159.3-192.4)
Excretory pore from anterior end	36.9±14.2 (25.1-62.8)	87.1±2.4 (84.5-89.1)
Greatest body width	466.8±94.2 (317.1-567.6)	14.8±0.4 (14.3-15.0)
Vulva slit length	23.4±2.3 (21.5-26.0)	-
Vulva slit-anus	27.0±2.3 (25.4-28.6)	-
Anal body width	-	10.4±1.7 (9.1-12.4)
Distance between two phasmids	24.0±2.8 (22-26)	-
Tail hyaline	-	15.2±1.3 (13.7-16.3)
Tail length	-	57.0±3.1 (54.6-60.5)

Iranian population of *Pratylenchus thornei*

(Figure 2, D-H)

MEASUREMENTS

See Table 3.

The populations of *P. thornei* were in agreement with the original description morphologically and morphometrically (Geraert, 2013), while their stylet length was slightly shorter (14.0-16.3 *vs* 15-19 µm). This species is associated with various plants in the different areass of Iran (Ghaderi et al., 2018). However, it was recovered from the rhizosphere soil of the okra fields close to Shushtar (GPS coordinates: 31°55′49.22″N, 48°49′35.16″E) and Karoon (GPS coordinates: 31°13′1.16″N, 48°34′37.77″E) cities in the study, Khuzestan province, southwest Iran. The populations of the species were not different with respect to morphometric data.

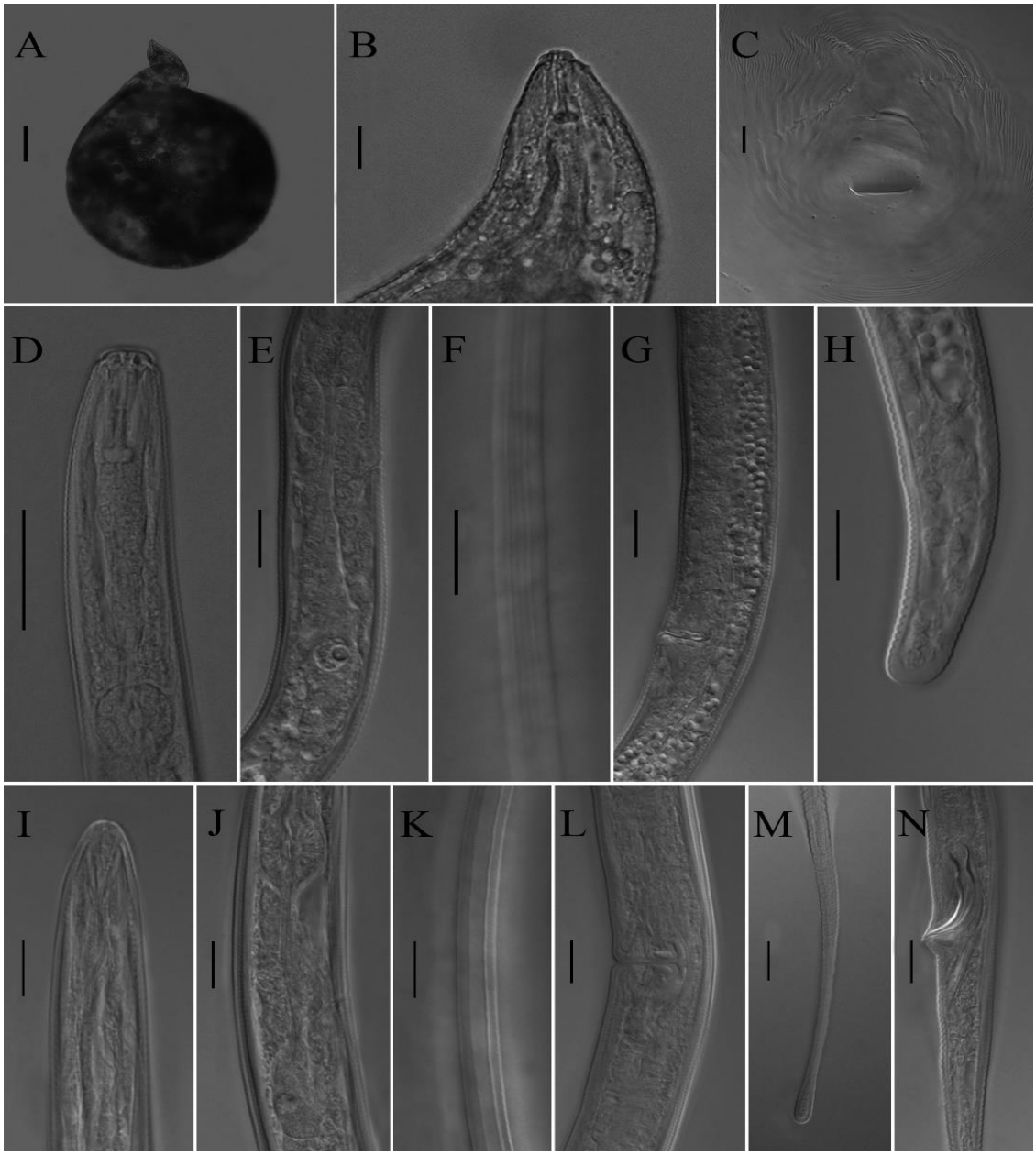

Figure 2. Iranian populations of A-C: *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949, D-H: *Pratylenchus thornei* Sher & Allen, 1953 and I-N: *Psilenchus hilarulus* de Man, 1921 from Khuzestan province, Iran. A: Female entire body; B: Anterior body region; C: Perineal pattern. D: Anterior body region; E: Part of pharynx; F: Lateral field at mid-body; G: Vulval region; H: Tail. I: Anterior body region; J: Part of pharynx; K: Lateral field at mid-body; L: Vulval region; M: Female tail; N: Male tail. (Scale bars: A = 100 µm; B-N = 10 µm)

Table 3. Morphometrics of *Pratylenchus thornei* Sher & Allen, 1953 and *Tylenchorhynchus elegans* Siddiqi, 1961 from Khuzestan province, Iran. All measurements are in µm and in the form: mean±SD (range)

	Pratylenchus thornei	*Tylenchorhynchus elegans*
Character	Females	Females
n	12	5
L	611±65.6 (517-732)	678.4±32.3 (643-706)
a	34.6±2.8 (30.6-39.1)	30.6±2.6 (28.3-32.9)
b	7.9±1.0 (6.2-10.0)	4.8±0.1 (4.6-4.8)
b'	4.5±0.4 (3.6-5.0)	-
c	22.7±5.4 (18.1-37.6)	13.4±0.5 (12.8-14.0)
c'	2.6±0.6 (1.6-3.2)	3.6±0.7 (3.0-4.6)
V	77.0±1.3 (75.6-79.1)	55.1±0.6 (54.7-55.8)
Stylet length	15.1±0.8 (14.0-16.3)	16.2±0.9 (15.0-17.2)
m	56.3±7.6 (45.0-71.4)	57.1±3.1 (53.8-60.0)
DGO	2.7±0.5 (2.0-3.3)	2.4±0.3 (1.8-2.6)
Median bulb	56.6±4.2 (50.7-66.3)	62.0±3.7 (57-66)
Pharynx	77.5±7.1 (67-91)	142.4±4.3 (138.5-146.9)
Pharyngeal overlap	136.1±12.5 (117-155)	-
Excretory pore from anterior end	87.2±8.4 (70.2-100.8)	105.3±8.5 (97.5-114.4)
MB	42.4±4.5 (37.5-54.0)	45.2±0.6 (44.6-45.9)
Body width	17.9±1.9 (15.0-21.5)	21.3±1.3 (19.0-22.8)
Lip region-vulva	470.4±52.1 (391-569)	364±16.5 (352-376)
Vulval body width	17.5±1.4 (15.0-19.5)	22.8±1.6 (20.2-24.5)
Vulva-anus	110.2±15.9 (87-133)	253.9±11.7 (240.5-261.3)
Anal body width	10.7±1.6 (8.5-13.0)	13.4±2.1 (11-15)
PUS	19.4±3.8 (15.6-25.4)	-
Tail length	27.7±4.2 (16.3-31.2)	51.5±2.0 (50.0-54.5)
Tail annuli number	26.8±3.6 (20-30)	25.7±3.8 (23-30)
Phasmid from tail terminus	15.5±1.3 (13.7-16.9)	15.6±0.8 (14.5-16.5)

Iranian population of *Psilenchus hilarulus*

(Figure 2, I-N)

MEASUREMENTS

See Table 4.

The general morphology of the species population closely resembles that of the other population (Geraert, 2008). This species has been observed in the rhizosphere soil of sugarcane (Kheiri, 1995) and citrus (Eisvand et al., 2019) in Khuzestan province, Iran. In the study, it was obtained from the rhizosphere soil of the okra fields near Shushtar (GPS coordinates: 32°2′34.6″N, 48°49′46.26″E), Khuzestan province, southwest Iran.

Table 4. Morphometrics of *Psilenchus hilarulus* de Man, 1921 and *Psilenchus vinciguerrae* Brzeski, 1991 from Khuzestan province, Iran. All measurements are in µm and in the form: mean±s.d. (range)

	Psilenchus hilarulus		*P. vinciguerrae*
Character	Females	Males	Females
n	7	3	10
L	936.2±160.6 (770-1207)	800.9±6.4 (796-805)	841.7±26.7 (816-877)
a	43.5±3.8 (40.6-47.6)	43.3±2.8 (41.3-45.2)	41.7±1.2 (40.6-43.4)
b	6.8±0.9 (5.7-8.4)	6.6±0.8 (5.8-7.5)	6.2±0.3 (5.8-6.6)
c	6.5±0.8 (5.6-7.7)	6.2±0.2 (6.0-6.3)	7.9±0.4 (7.6-8.4)
c'	11.3±0.6 (10.5-12.2)	8.3±0.3 (8.0-8.6)	7.9±1.1 (6.9-9.4)
V	47.4±2.0 (43.0-48.8)	-	50.6±2.4 (48.4-52.7)
V'	56.0±2.2 (52.3-58.9)	-	57.5±1.7 (55.5-59.7)
Stylet length	13.2±1.0 (12.4-14.8)	13.4±0.5 (13.0-13.7)	12.4±0.5 (11.8-13.0)
m	38.3±6.0 (31.0-47.3)	40.1±4.5 (35.0-43.7)	44.7±2.5 (42-47)
DGO	4.7±0.6 (3.9-5.8)	5.6±0.5 (5.2-5.9)	6.5±0.7 (5.2-7.5)
Pharynx	138.4±8.9 (128.7-151.5)	136.2±4.1 (133-140)	143.5±7.1 (132-149)
MB	57.6±2.0 (55.1-61.5)	57.1±1.4 (56.1-58.1)	54.1±1.5 (52.7-56.0)
Excretory pore from anterior end	111.1±12.7 (96.9-128.7)	99.5±1.8 (98-101)	99.5±5.2 (93-104)
Body width	20.1±1.3 (18.5-22.1)	18.6±1.3 (17.6-19.5)	18.9±1.7 (16-21)
Lip region-vulva	462.9±71.3 (387.4-578)	-	426.3±26.5 (401-462)
Vulval body width	20.5±1.3 (18.9-22.8)	-	19.7±1.1 (18-21)
Vulva-anus	341±51 (301-399)	-	316.1±5.9 (310-322)
Anal body width	12.5±0.9 (11.5-13.6)	15.7±0.9 (15.0-16.3)	12.8±1.4 (11.1-14.2)
Tail length	142.3±10.1 (130-157)	127.5±0.9 (127-133)	107.2±5.4 (100-114)
T/Vulva anus	0.4±0.1 (0.3-0.5)	-	0.4±0.1 (0.3-0.4)
Spicule length	-	22.3±3.2 (20.0-24.5)	-
Gubernaculum length	-	5.9±1.1 (4.7-6.9)	-
Bursa	-	51.9±4.4 (48.8-55.0)	-

Iranian population of *Psilenchus vinciguerrae*
(Figures 3, 4)

MEASUREMENTS

See Table 4.

DESCRIPTION

Female

Body ventrally arcuate following heat fixation. Cuticle annuli 0.8-1.1 µm wide at mid-body. Lateral field mostly with four incisures, 5.5-7.2 µm wide or about one-third of body diameter, the outer bands of which are more distinct. Lip region smooth and trapezoid, continuous with body contour, 3.5- 4.5 µm high and 6.0-7.2 µm wide. Stylet straight with distinct lumen, conus short, shaft without basal knobs. Median bulb oval, 11-14 µm long and 9-11 µm wide, basal bulb pyriform, 9.5-11.0 µm wide and 17.0-19.5 µm long, offset from intestine. Excretory pore at the level of isthmus. Nerve ring surrounding the middle part of the isthmus. Reproductive system didelphic-amphidelphic, ovary with the oocytes arranged in a single row, spermatheca non-offset, elongated, filled with rounded to slightly oval sperm, 17-22 µm long and 9.5-13.0 µm wide, vulva a transverse slit lacking flaps or epiptygma, vagina 9-11 µm long. Tail elongate conical, its terminus rounded or rarely filamentous. Phasmids 20.0-32.5 µm posterior to anus.

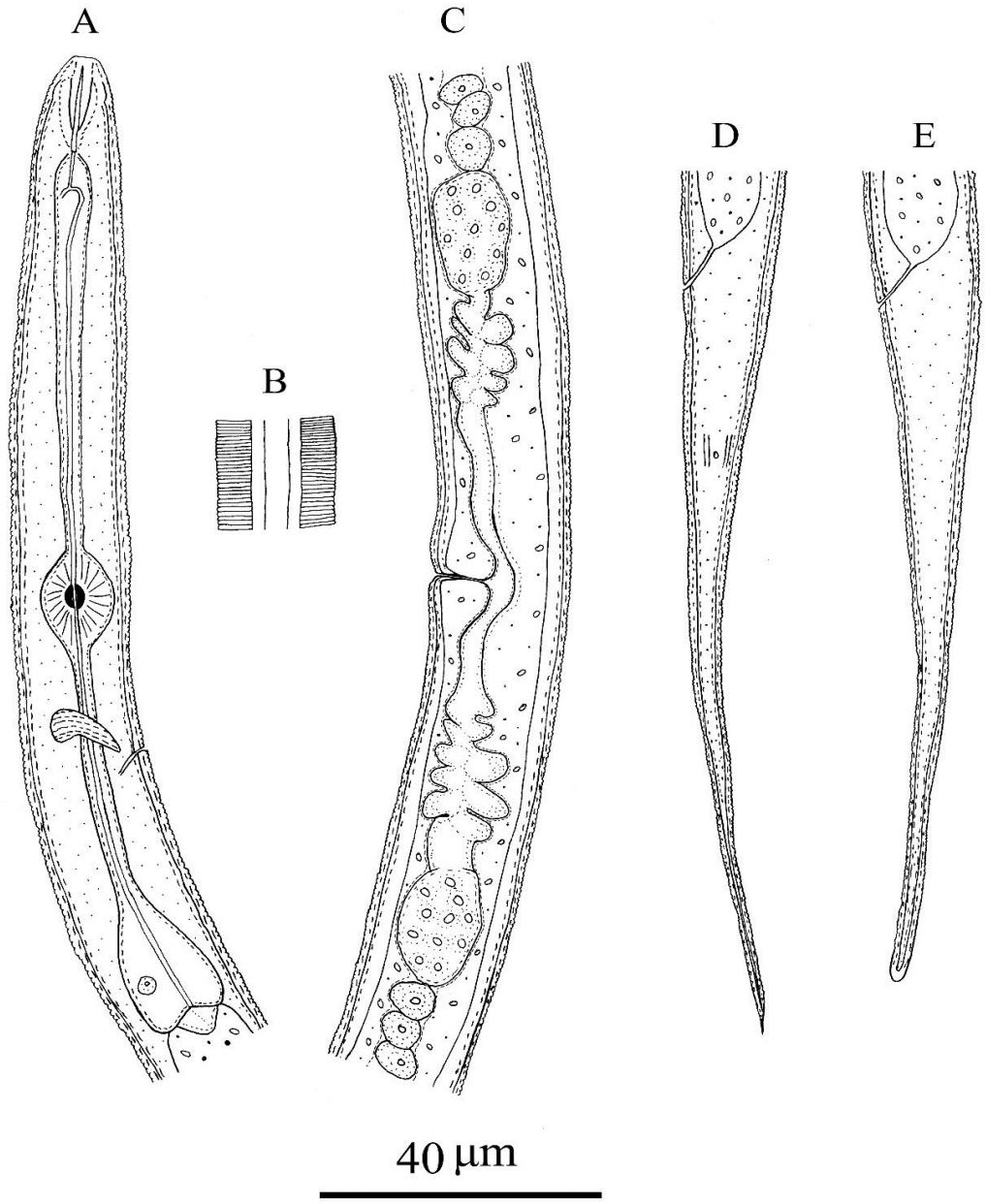

Figure 3. Iranian population of *Psilenchus vinciguerrae* Brzeski, 1991 from Khuzestan province, Iran. A: Anterior body region; B: Lateral field at mid-body; C: Part of reproductive system; D, E: Tail

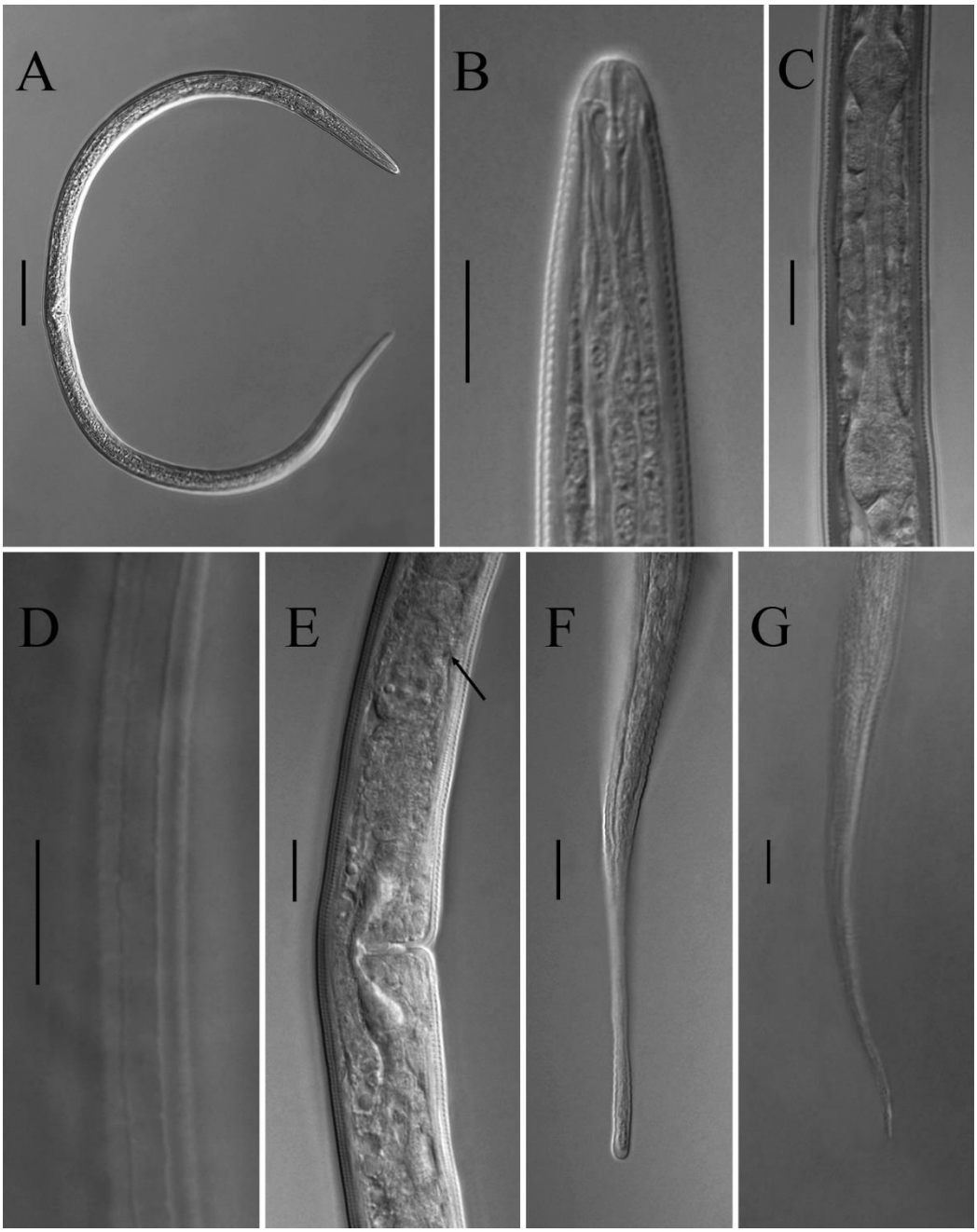

Figure 4. Iranian population of female of *Psilenchus vinciguerrae* Brzeski, 1991 from Khuzestan province, Iran. A: Entire body; B: Anterior body region; C: Part of pharynx; D: Lateral field at mid-body; E: Part of reproductive system (the arrow indicates the spermatheca); F, G: Tail. (Scale bars: A = 50 µm; B-G = 10 µm)

Male

Not found.

The results related to *P. vinciguerrae* indicated a closely agreement between the general morphology of its population and that of the type population described by Brzeski (1991), while its tail length was slightly less (100-114 *vs.* 90-204 µm). The species has already been reported from tuberose (*Polianthes tuberosa* L.) in Iran (Husseinvand et al., 2016), although no morphometric or morphological data have been provided for the population. Regarding the study, *P. vinciguerrae* was recovered from the rhizosphere soil of the okra fields close to Shushtar (GPS coordinates: 31°53′48.17″N, 48°51′36.61″E), Khuzestan province, southwest Iran.

Iranian population of *Tylenchorhynchus elegans*

(Figures 5, 6)

MEASUREMENTS

See Table 3.

DESCRIPTION

Female

Body slightly arcuate ventrally after heat fixation. Cuticle annuli 1.9-2.2 µm wide at mid-body. Lateral field 5.5-7.1 µm wide (about one-third of body diameter) with four incisures, the outer bands distinctly crenate. Cephalic region hemispherical, bearing 3 annuli, continuous with body contour, 2.6-3.8 µm high and 6.5-8 µm wide, the cephalic framework lightly sclerotized. Stylet knobs rounded, slightly posteriorly directed, 4-5 µm across. Dorsal gland orifice at 2.0-2.6 µm behind stylet knobs. Median bulb oval, 14.0-15.5 µm long and 11-13 µm wide, basal pharyngeal bulb pyriform, 30-34 µm long and 11.5-14.0 µm wide, very slightly covering the anterior end of intestine. Excretory pore at the level of the beginning of the basal bulb, 1-2 annuli behind hemizonid. Nerve ring surrounding the middle part of the isthmus. Reproductive system didelphic-amphidelphic, ovary with the oocytes arranged in a single row, spermatheca rounded to slightly oval, axial, 16.4-18.8 µm long and 14-16 µm wide, filled with rounded sperm, vulva a transverse slit with epiptygma, vagina 11.0-12.5 µm long. Tail sub-cylindrical, with a broadly rounded smooth terminus, bearing 23-30 annuli on ventral side. Phasmids distinct, located at 14.5-16.5 µm behind anus.

Male

Not found.

Remark

The general morphology of *T. elegans* population was closely consistent with that of the type population (Siddiqi, 1961), although c ratio was lower (12.8-14.0 *vs* 14.5-16.0). The species has been found from Kohgiluyeh and Boyer-Ahmad province in Iran (Ghaemi and Pourjam, 2012), but no morphometric or morphological data have been presented for the population. However, it was obtained from the rhizosphere soil of the okra fields near Ramhormoz (GPS coordinates: 31°15′35.35″N, 49°36′37.12″E) city in the present study, Khuzestan province, southwest Iran.

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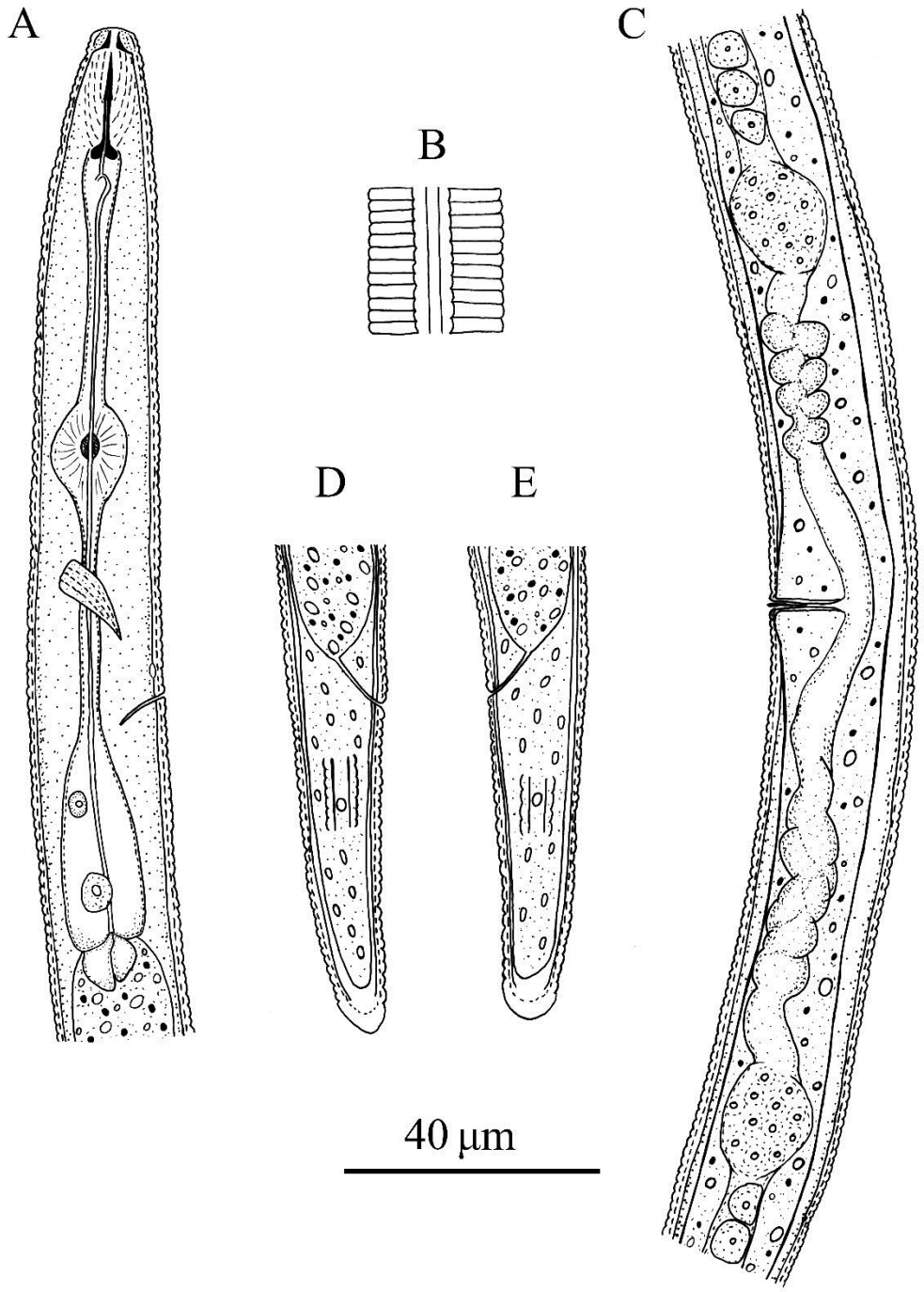

Figure 5. Iranian population of female of *Tylenchorhynchus elegans* Siddiqi, 1961 from Khuzestan province, Iran. A: Anterior body region; B: Lateral field at mid-body; C: Part of reproductive system; D, E: Tail

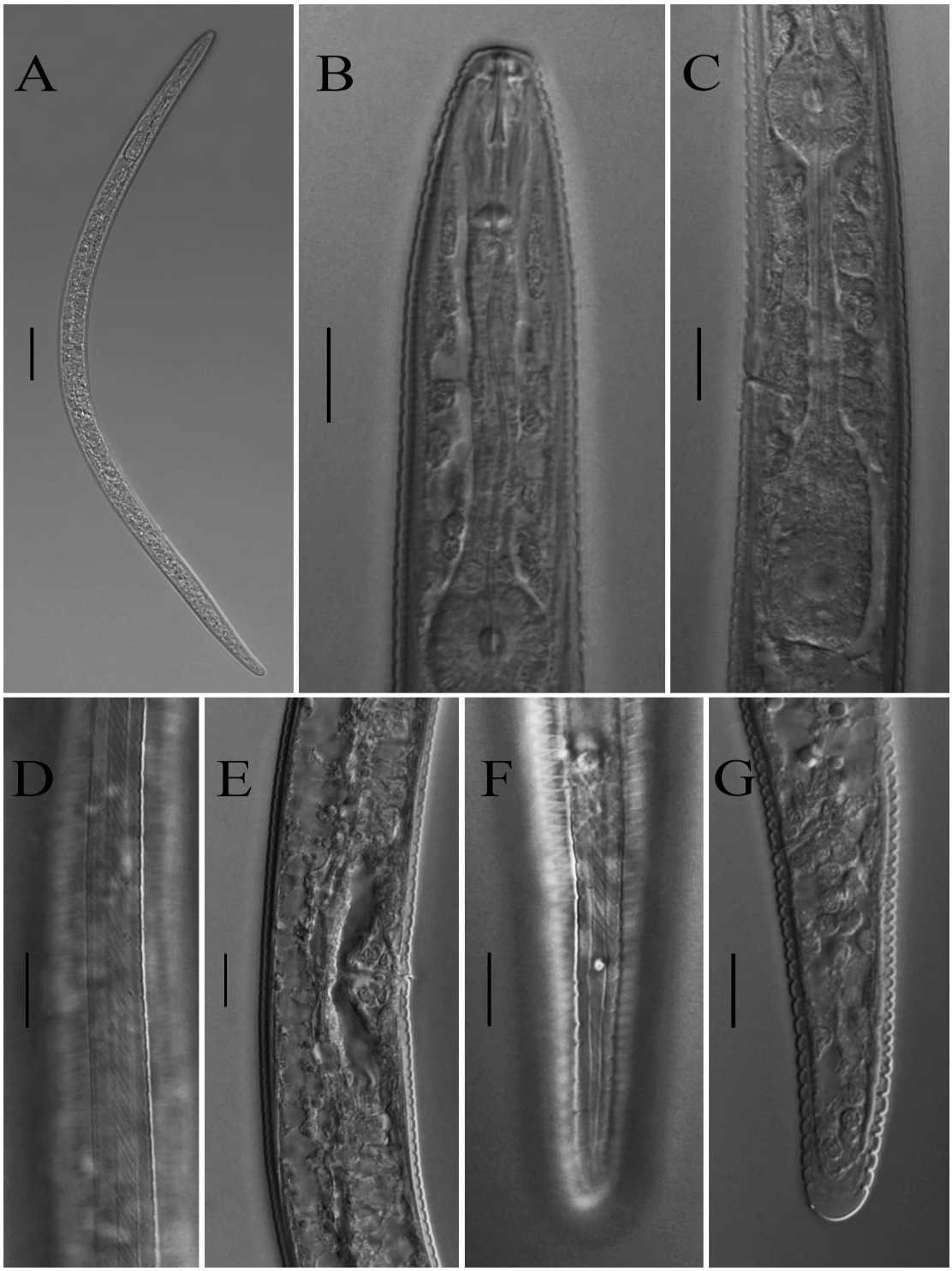

Figure 6. Iranian population of *Tylenchorhynchus elegans* Siddiqi, 1961 from Khuzestan province, Iran. A: Entire body; B: Anterior body region; C: Part of pharynx; D: Lateral field at mid-body; E: Vulval region; F: Tail showing phasmid; G: Tail. (Scale bars: A = 50 µm; B-G = 10 µm)

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برخی از نماتدهای انگل گیاهی مرتبط با بامیه در استان خوزستان، جنوب غرب ایران

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چکیده

گیاه بامیه با نام علمی *Abelmoschus esculentus* L. Moench متعلق به خانواده‌ی پنیرک (Malvaceae) و محل پیدایش آن آفریقای مرکزی می‌باشد. برخی از محققین آن را بومی غرب آفریقا و آسیا می‌دانند. بامیه گیاهی یک ساله بوده و یکی از مهم‌ترین سبزیجات میوه‌ای مناطق گرمسیری محسوب می‌گردد. استان خوزستان یکی از مناطق اصلی کشت این محصول در ایران می‌باشد و سطح زیر کشت آن در خوزستان به بیش از ۲۶۰۰ هکتار می‌رسد. نظر به این‌که تاکنون پژوهش کاملی در خصوص شناسایی فون نماتدهای انگل گیاهی مرتبط با این گیاه در کشور انجام نگرفته بود و گزارش‌های موجود صرفاً محدود به ذکر آلودگی و حساسیت گیاه بامیه به نماتد ریشه‌گرهی (*Meloidogyne javanica*) بود، مطالعه حاضر با هدف شناسایی گونه‌های نماتد انگل گیاهی مزارع بامیه در استان خوزستان انجام پذیرفت. تعداد ۹۵ نمونه خاک و ریشه از مزارع بامیه در مناطق مختلف استان خوزستان جمع‌آوری گردید. برای استخراج نماتدهای کرمی شکل از خاک از دو روش الک-سانتریفیوژ و سینی استفاده شد و در صورت وجود آلودگی به نماتد ریشه گرهی، با استفاده از سوزن و اسکالپل، از محل گال‌های ریشه جداسازی گردید. پس از استخراج نماتدها، تثبیت و انتقال آن‌ها به گلیسیرین با روش تکمیل شده‌ی دگریسه انجام پذیرفت. سپس از نماتدهای جداشده، پرپاراسیون‌های میکروسکوپی دائمی تهیه گردید. شناسایی گونه‌ها با استفاده از میکروسکوپ نوری مجهز به لوله‌ی ترسیم و بر اساس ویژگی‌های ریخت‌شناسی و ریخت‌سنجی و با استفاده از کلیدهای معتبر انجام گرفت. در تحقیق حاضر، هشت گونه از پنج جنس متعلق به نماتدهای انگل گیاهی فوق بالاخانواده Tylenchomorpha شناسایی گردید که عبارتند از: *Geocenamus brevidens*، *G. microdorus*، *G. rugosus*، *Meloidogyne javanica*، *Pratylenchus thornei*، *Psilenchus hilarulus*، *P. vinciguerrae* و *Tylenchorhynchus elegans*. اطلاعات ریخت‌سنجی و عکس‌های میکروسکوپ نوری برای گونه‌های مورد مطالعه تهیه شد و تفاوت آن‌ها با شرح اصلی و یا بعضی از جمعیت‌های گزارش شده قبلی مورد بحث قرار گرفت. بر اساس منابع موجود، این اولین گزارش از همه گونه‌های فوق به استثناء *M. javanica* در مزارع بامیه دنیا می‌باشد. همچنین اطلاعات ریخت‌شناسی و ریخت‌سنجی جمعیت‌های ایرانی *P. vinciguerrae* و *T. elegans* برای اولین‌بار تهیه گردید.

کلیدواژه‌ها: Abelmoschus esculentus، نماتدهای انگل گیاهی، داده‌های ریخت‌سنجی، ریخت‌شناسی، طبقه‌بندی