

Research Article

## New record of three species of *Ditylenchus* Filipjev, 1936 (Nematoda: Anguinidae), with a key to the species reported from Iran

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**Abstract:** Fifteen species of the genus *Ditylenchus* were recovered and identified from Kermanshah province, western Iran. Morphological and morphometric characters of three known species namely *D. filimus*, *D. hexaglyphus* and *D. nanus*, being new records for Iran's nematode fauna, are given and discussed. *Ditylenchus filimus* is characterized by having a short stylet (7-8  $\mu\text{m}$ ), four lines in lateral fields, well-developed and valvate median bulb, and the typical female tail ending to a filamentous process. *D. hexaglyphus*, is characterized by having a short stylet (6.5-8.0  $\mu\text{m}$ ), six lines in lateral fields, not developed and non-valvate median bulb, and conoid tail with rounded tip. *D. nanus*, is characterised by having a short stylet (6-7  $\mu\text{m}$ ), six lines in lateral fields, median bulb well-developed and valvate, and tail conoid with finely rounded tip. A dichotomous key for identification of the species occurring in Iran is also provided.

**Keywords:** *Ditylenchus filimus*, *D. hexaglyphus*, *D. nanus*, identification, morphology, taxonomy

### Introduction

The genus *Ditylenchus* Filipjev, 1936 was erected for *D. dipsaci* (Kühn, 1857) Filipjev, 1936 as type species of the genus. Species of the genus are mostly common in temperate zones, including the Mediterranean Basin (Vovlas *et al.*, 2011). Among more than 60 species presently recognized under the genus *Ditylenchus* (Siddiqi, 2000; Vovlas *et al.*, 2011; Vovlas *et al.*, 2015), only a few are parasites of higher plants, while the majority of species are mycophagous (Sturhan & Brzeski, 1991). The two genera *Ditylenchus* and *Nothotylechus* Thorne, 1941 are morphologically closely related (Siddiqi, 2000), but have separated from each other based on the

nature of metacarpus (Brzeski, 1981; Fortuner & Maggenti, 1987; Siddiqi, 2000; Andrassy, 2007). The former (*Ditylenchus*) has a well-developed, muscular and valvate median bulb, whereas *Nothotylechus* has a valveless and non-developed median bulb (Siddiqi, 2000; Andrassy, 2007). Fortuner and Maggenti (1987) considered *Nothotylechus* as a junior synonym of *Ditylenchus*. Later, Brzeski (1991) followed Fortuner and Maggenti's (*op. cit.*) scheme and placed all species under *Ditylenchus*. Here, we follow Fortuner and Maggenti's classification scheme, since there is not enough available molecular data for supporting this synonymy. The number of valid species is uncertain pending a thorough review of the genus, additional material being necessary for molecular analyses.

To date, 26 species of *Ditylenchus* have been reported in different localities in Iran (Ghaderi *et al.*, 2012; Tanha Maafi *et al.*, 2013; Pachenari Torghabei *et al.*, 2014; Miraeiz *et al.*, 2014;

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Mirshekari and Abdollahi, 2014; Esmaili *et al.*, 2015). In order to find more species of plant parasitic nematodes associated with orchard plants, a survey was conducted in Kermanshah province, western Iran. As a result, several nematode species were identified, three of which belonging to the genus *Ditylenchus* and representing new records for Iran's nematode fauna are illustrated and their characters and tentative differences with the data given in their original descriptions or with the data in other reports are discussed in present study.

## Materials and Methods

### Sampling, extracting, mounting and drawing

Soil and root samples were randomly collected from the rhizosphere of orchard plants in Kermanshah province, western Iran during November 2013 to January 2014. The nematodes were recovered from the soil samples by using the rapid centrifugal-flotation method (Jenkins, 1964) and tray method (Whitehead and Hemming, 1965). Specimens to be observed under light microscopy (LM) were heat-killed by adding hot 4% formaldehyde solution and processed to pure

glycerin using De Grisse's (1969) method. Permanent slides were prepared and studied using a light Olympus BH-2 microscope. Measurements and drawings were made using a drawing tube attached to the microscope. Species were identified using available identification key (Brzeski, 1991) and original descriptions. The used morphometric indexes and abbreviations in morphometric tables (Tables 2-4) are according to Siddiqi (2000).

## Results and Discussion

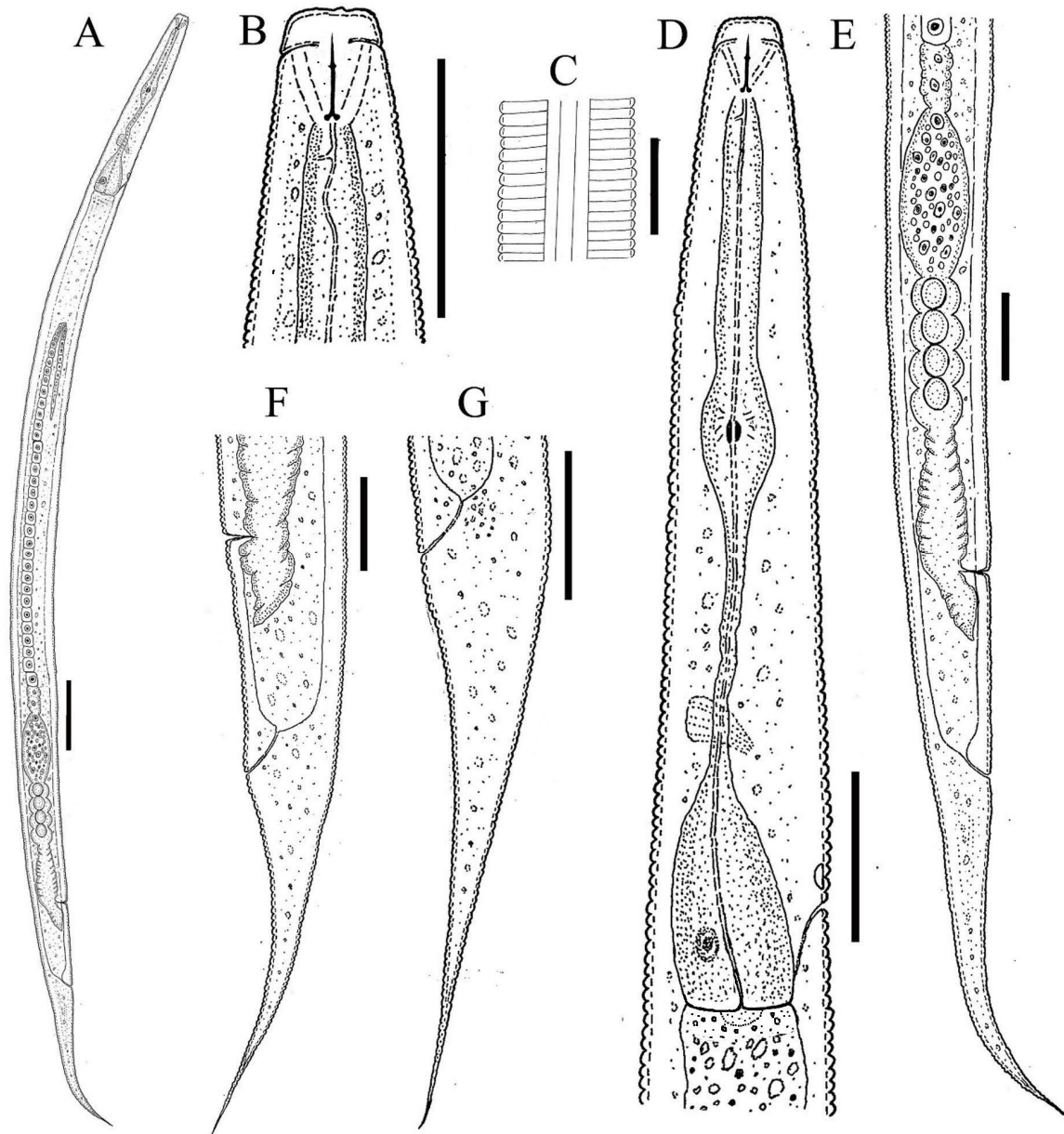
In total, fifteen species belonging to the genus *Ditylenchus* (see table 1), were collected and identified in present study. Among them, three species namely *D. filimus* Anderson, 1983, *D. hexaglyphus* (Khan and Siddiqi, 1968) Fortuner and Maggenti, 1987 and *D. nanus* Siddiqi, 1963 were new records for Iran's nematode fauna. The morphological and morphometric characters of these three species as well as their comparisons with other reports worldwide are discussed below.

### Iranian population of *Ditylenchus filimus* Anderson, 1983 (Figs 1 and 2; Table 2)

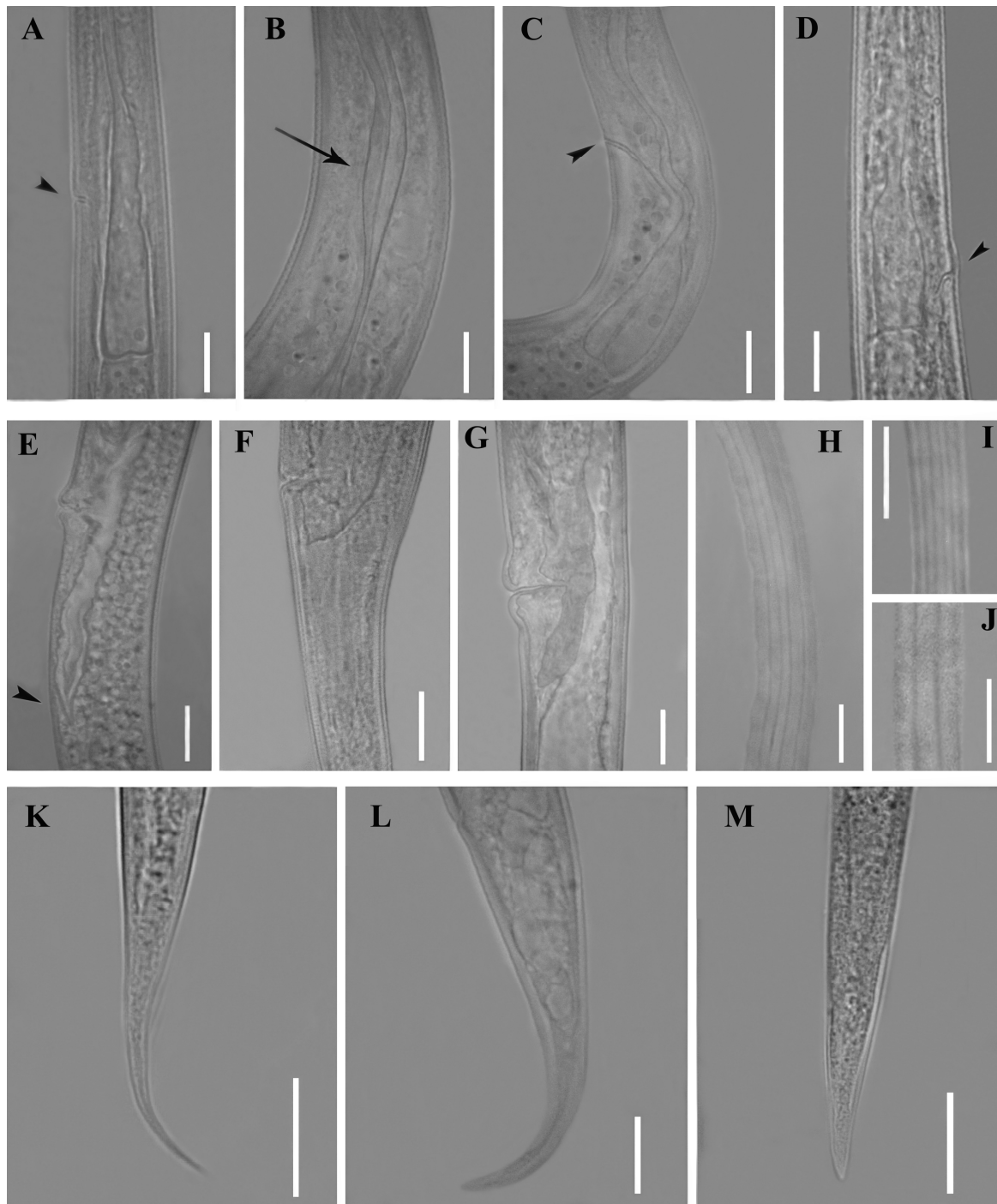
**Table 1** *Ditylenchus* species recovered from soil and root samples in Kermanshah province in the present study.

<i>Ditylenchus</i> species	Locality (Iranian Western Cities)	Associated plants
<i>D. acutatus</i> Brzeski, 1991	Ghasr-e Shirin	Grapevine
<i>D. anchiliosomus</i> (Tarjan, 1958) Fortuner, 1982	Ghasr-e Shirin	Prunus
<i>D. dipsaci</i> (Kiihn, 1857) Filipjev, 1936	Gilan-e Gharb	Grapevine
<i>D. exilis</i> Brzeski, 1984	Vizh-e Nan	Olive
<i>D. filimus</i> * Anderson, 1983	Gilan-e Gharb	Apple
<i>D. hexaglyphus</i> * (Khan and Siddiqi, 1968) Fortuner and Maggenti, 1987	Ghasr-e Shirin	Palm
<i>D. kheirii</i> Fortuner and Maggenti, 1987	Sarpol-e Zehab	Ficus
<i>D. longicauda</i> Geraert: and Choi, 1988	Sarpol-e Zehab	Prunus
<i>D. medians</i> (Thorne and Malek, 1968) Fortuner and Maggenti, 1987	Gilan-e Gharb	Olive
<i>D. medicaginis</i> Wasilewska, 1965	Eslam Abad-e Gharb	Grapevine
<i>D. myceliophagus</i> Goodey, 1958	Vizh-e Nan	Apple
<i>D. nanus</i> * Siddiqi, 1963	Gilan-e Gharb	Juglans
<i>D. persicus</i> Esmaili, Heydari, Castillo and Palomares-Rius	Gilan-e Gharb	Grapevine
<i>D. triformis</i> Hirschmann and Sasser, 1955	Eslam Abad-e Gharb	Grapevine
<i>D. valveus</i> Thorne and Malek, 1968	Gilan-e Gharb	Punicae

\* New record for Iran's nematode fauna.



**Figure 1** *Ditylenchus filimus* from Kermanshah province, western Iran. A: Female entire body; B: Female anterior end; C: Lateral lines; D: Pharyngeal region; E: Reproductive system; F: Vulva to body end; G: Female posterior body (tail). (All scale-bars 20  $\mu$ m, except A which is 40  $\mu$ m).



**Figure 2** Light micrographs of three *Ditylenchus* species reported from Kermanshah province, western Iran. *D. nanus*, A: Basal pharyngeal region and showing excretory pore; E: Vulval region; H: Lateral field; L: Female posterior body end). *D. hexaglyphus*, B: Median bulb of pharynx; C: Basal pharyngeal region and showing excretory pore; F: Vulva region; I: Lateral field; M: Female posterior body end. *D. filimus*, D: Basal pharyngeal region and showing excretory pore; G: Vulva region; J: Lateral field; K: Female posterior body end. (All scale-bars 10 µm, except F & K: 20 µm).

**Table 2** Morphometric data of Iranian population of *Ditylenchus filimus* from Kermanshah province, western Iran and its comparison with other populations.

Characters\Origin	Present study	Anderson, 1983		Brzeski, 1991
	Female	Female	Male	Female
n	8	17	1	3
L	592 ± 39.8 (410-806)	718 ± 46 (619-788)	684	660 (585-774)
a	25.8 ± 4.3 (22.4-35.2)	29 ± 2.7 (24-31)	31	38 (34-42)
b	5.6 ± 1.0 (4.4-7.3)	7.3 ± 0.5 (6.3-8.3)	6.1	6.0 (5.6-6.5)
c	10.6 ± 1.9 (7.5-12.4)	10 ± 0.5 (9.4-11.2)	10.1	9.5 (8.7-10.2)
c'	4.5 ± 0.9 (3.1-5.7)	5.2 ± 0.7 (4.3-6.4)	3.8	6.2 (5.8-6.5)
V or T	81.2 ± 1.7 (79.2-84.0)	84 ± 1.0 (83-85)	-	81
Stylet	7.3 ± 0.5 (7.0-8.0)	8.0 (7-9)	8	7.5-8.0
Excretory Pore	88.6 ± 9.8 (77.0-105)	98 ± 4.6 (89-106)	91	91 (84-96)
Pharynx	110 ± 11.2 (93-130)	99 ± 4.6 (88-105)	107	108 (103-118)
VBW	19.6 ± 3.7 (16.0-25.0)	-	-	-
PUS	17.5 ± 3.4 (13-23)	16 ± 2 (13-28)	-	-
PUS/VBW	0.9 ± 0.2 (0.6-1.2)	0.7 (0.5-0.9)	-	0.8-1.1
Tail	56.4 ± 10.6 (40.0-74.0)	72 ± 4.6 (62-78)	??	67-71
Tail/anal body width	4.1 ± 0.8 (3.5-5.0)	-	-	-
Spicules	-	-	29	-
Gubernaculum	-	-	7	-

Measurements are in  $\mu\text{m}$ .

**Female.** Body cylindrical, robust, almost straight, sometimes slightly ventrally curved when heat-killed. Lip region low, continuous with body contour, 3.0-3.5  $\mu\text{m}$  high and 5-6  $\mu\text{m}$  wide at the base. Labial framework slightly sclerotized. Cuticle finely annulated (annuli about 1-2  $\mu\text{m}$  wide at mid-body). Lateral field 4.5-6  $\mu\text{m}$  wide, one sixth of body diameter, with four equidistant lines. Stylet distinct, basal knobs well-developed and rounded, conus occupying 37.5-42.9% of stylet total length. Dorsal gland orifice (DGO) opening at 1.5-2.5  $\mu\text{m}$  from base of stylet knobs. Deirids 9-11  $\mu\text{m}$  posterior to excretory pore. Pharynx with cylindrical procorpus, posteriorly joining a fusiform, slightly muscular median bulb with small, prominent sclerotised valve, 53-58  $\mu\text{m}$  from anterior end. Posterior glandular region bulbular, pyriform and not overlapping intestine. Nerve ring encircling isthmus at 63-80  $\mu\text{m}$  from anterior end. Excretory pore prominent with duct

opposite to base of pharyngeal basal bulb. Hemizonid distinct, about 2-3 body annuli wide, just anterior to excretory pore. Reproductive tract monodelphic-prodelphic, occupying 45.9-73.5% of the body length. Ovary sometimes reaching to basal pharyngeal bulb and reflexed at tip. Oocytes mostly arranged in a single row. Spermatheca cylindrical, filled with numerous spherical sperm cells. Crustaformeria consisting of four rows of four cells. Vulva a transverse slit. Post-vulval uterine sac (PUS) short, about 30-35% of vulva to anus distance (VAD) long. Tail almost, straight, elongate-conoid, ending to a filamentous process.

**Male.** Not found.

*Ditylenchus filimus* was first described by Anderson (1983). It was recovered from beet pulp amended mushroom compost, Assiniboine Mushroom Inc., Manitoba, Canada. All morphological and morphometric characters of our population conform closely to those given

by Anderson (1983), except body length has a wider range (410-806 vs 619-788  $\mu\text{m}$ ), probably due to geographical intraspecific variations. The Iranian population of *Ditylenchus filimus* comes close to *D. brevicauda* (Micoletzky, 1925) Filipjev, 1936, *D. equalis* Heyns, 1964 and *D. nortoni* (Elmiligy, 1971) Bello and Geraert, 1972. It can be distinguished from *D. brevicauda* by having tail ending in a filamentous process vs tapering gradually to a sharp tip and male absence vs presence. It differs from *D. equalis* by having a tail often ending in a filamentous process vs pointed to dull and male absence vs presence. It differs from *D. nortoni* by position of the excretory pore and hemizonid (located at opposite to basal bulb vs mid-isthmus), deirids near to base of pharynx vs mid-isthmus and tail ending in a filamentous process vs pointed. Presently studied population of the species was collected from the rhizosphere of apple trees in an orchard in city of Gilan-e Gharb, Kermanshah province and is reported for the first time from Iran.

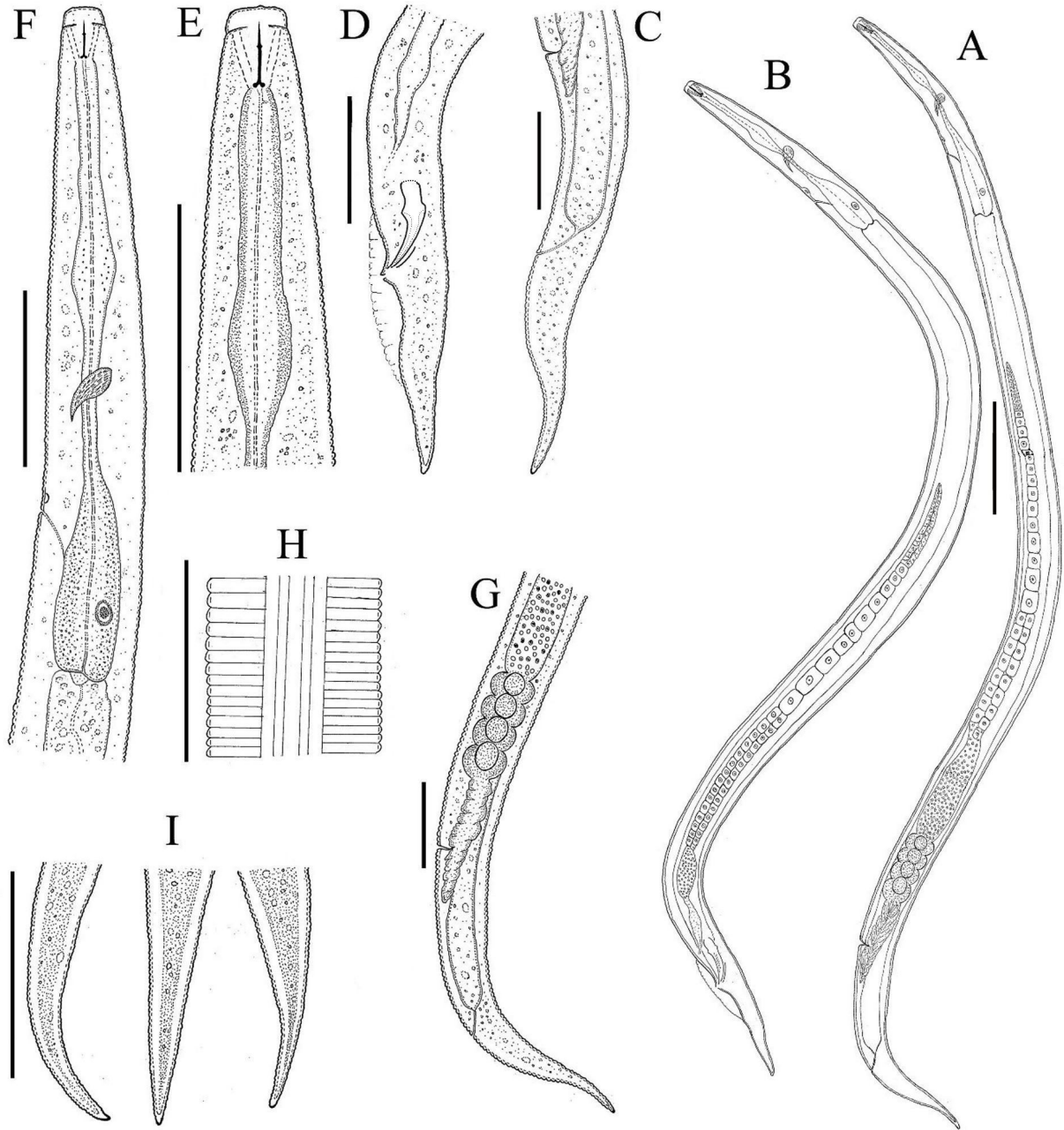
**Iranian population of *Ditylenchus hexaglyphus* (Khan and Siddiqi, 1968) Fortuner and Maggenti, 1987 (Figs 3 and 2; Table 3)**

**Female.** Body cylindrical, straight when relaxed and tapering gradually toward both ends. Cuticle finely annulated (annuli about 1.5  $\mu\text{m}$  wide at mid-body). Lip region continuous with body contour, apparently with 2-3 faint annuli, about 2.5-3.0  $\mu\text{m}$  high and 4.5-7.0  $\mu\text{m}$  wide at base. Lateral field with six incisures, 5-6  $\mu\text{m}$  wide. Stylet delicate, conus about 35.5-43.8% of total stylet length. Dorsal gland orifice opening at about 2  $\mu\text{m}$  posterior to stylet knobs. Pharynx with cylindrical procorpus. Median bulb of pharynx fusiform, not developed, non-muscular and without valve. Posterior bulb elongate, pyriform, set off from intestine. Excretory pore situated at the beginning of the basal pharyngeal bulb region. Nerve ring encircling isthmus at 60-85  $\mu\text{m}$  from anterior end. Oocytes few in number, arranged

in a single row. Spermatheca elongate, filled with large spheroid sperm cells. Uterine quadricolumellar, comprised of four rows, each including four cells. Vulva a transverse slit. Post-vulval uterine sac short, about half vulval body width (VBW) long. Tail conoid, ventrally arcuate, narrowing gradually, with a rounded terminus.

**Male.** Generally similar to female. Lip region slightly narrower than the rest of the body. Testis single, 380-487  $\mu\text{m}$  in length, outstretched, with spermatocytes arranged in a single row. Spicules paired, curved ventrally. Gubernaculum short. Bursa weakly crenated, leptoderan, occupying 30-45% of tail length. Tail elongate-conoid with rounded terminus.

*Ditylenchus hexaglyphus* has originally been recovered and described from soil around roots of potato (*Solanum tuberosum* L.) and cabbage (*Brassica oleracea* L.) in India by Khan and Siddiqi (1968). Morphological and morphometric characters of the Iranian population fit well with those given in original description (Khan and Siddiqi, 1968). The Iranian population of *D. hexaglyphus* comes close to *D. affinis* (Thorne, 1941) Fortuner and Maggenti, 1987, *D. medians* (Thorne and Malek, 1968) Fortuner and Maggenti, 1987, *D. kheirii* Fortuner and Maggenti, 1987 and *D. buckleyi* Das, 1960. From *D. affinis* it differs in having a shorter post-vulval uterine sac (0.4-0.6 vs 1.1-1.3 times VBW long) and longer spicules (20-21 vs 15-17  $\mu\text{m}$ ). It differs from *D. medians* by having shorter post-vulval uterine sac (0.4-0.6 vs 1.3-2.6 times VBW long) and longer spicules (20-21 vs 15-18  $\mu\text{m}$ ). It differs from *D. kheirii* by having shorter post-vulval uterine sac (0.4-0.6 vs 1.5-2.6 times VBW long) and longer spicules (20-21 vs 16  $\mu\text{m}$ ). From *D. buckleyi* it differs in having a longer body (689 vs 430  $\mu\text{m}$ ), stylet length (6.5-8 vs 11  $\mu\text{m}$ ) shorter post-vulval uterine sac (10-18% vs up to 50% of vulva to anus distance) and finely rounded tail terminus vs pointed. Presently studied population was collected from the rhizosphere of palm in Ghasr-e Shirin, Kermanshah province and is reported from Iran for the first time.



**Figure 3** *Ditylenchus hexaglyphus* from Kermanshah province, western Iran. A: Female entire body; B: Male entire body; C: Vulva to body end; D: Male posterior end; E: Female anterior end; F: Pharyngeal region; G: Female reproductive system; H: Lateral lines; I: Female posterior end (tail tip). (All scale-bars 30  $\mu\text{m}$ , except A & B which are 60  $\mu\text{m}$ ).

**Table 3** Morphometric data of Iranian population of *Ditylenchus hexaglyphus* from Kermanshah province, western Iran and its comparison with other populations.

Characters\Origin	Present study		Khan & Siddiqi, 1968	Brzeski, 1991	
	Female	Male	Female	Female	Male
n	10	2	5	2	2
L	689 ± 79.8 (651-820)	651, 738	660-720	654, 916	661, 732
a	31.2 ± 3.3 (25.7-35.7)	27.1, 28.4	32-33	26.0, 29.0	36.0, 38.0
b	6.3 ± 0.8 (4.9-7.2)	5.9, 5.9	5.6-6.2	5.7, 7.0	5.5, 6.0
c	12.6 ± 1.9 (10-16.4)	10.9, 12.3	11.5-12.7	13.2, 14.5	11.5, 12.7
c'	4.4 ± 0.8 (2.9-5.3)	3.5, 3.8	-	3.6, 3.7	3.7, 4.0
V or T	81.6 ± 2.1 (77.5-84.5)	58.4, 66	82-83	83, 84	-
Stylet	7.4 ± 0.7 (6.5-8.5)	7, 7	7.5-8.5	7.0, 7.5	8.0, 8.0
Excretory Pore	91.9 ± 11.6 (72-110)	90, 110	-	93.0, 112	100, 106
Pharynx	110.1 ± 11.2 (93-130)	-	-	115, 131	119, 123
VBW	18.5 ± 2.8 (15-25)	-	-	-	-
Post-vulval uterine sac	10.1 ± 0.9 (9-11)	-	-	-	-
PUS/VBW	0.6 ± 0.1 (0.4-0.6)	-	0.7-1.0	0.5, 0.7	-
Tail	55.1 ± 5 (50-63)	60, 60	-	49.0, 63.0	58
Tail/anal (cloacal) body width	4.5 ± 0.8 (3.6-5.0)	3.5, 3.8	-	-	-
Spicules	-	20, 21	-	-	21, 22
Gubernaculum	-	6.0, 6.5	-	-	6.0, 7.0

Measurements are in  $\mu\text{m}$ .

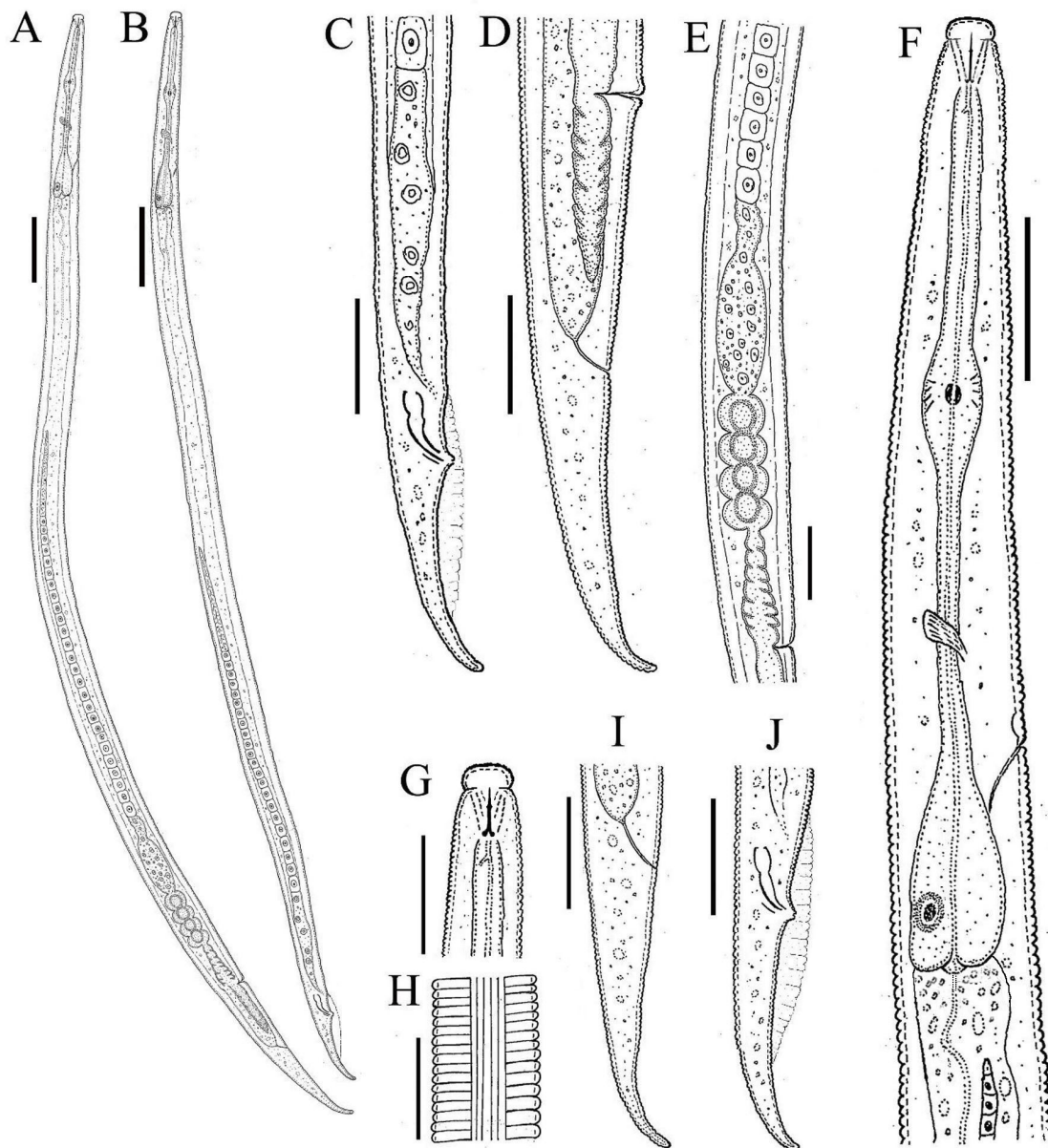
### Iranian population of *Ditylenchus nanus* Siddiqi, 1963

(Figs 4 and 2; Table 4)

**Female.** Body straight after fixation, gradually tapering toward both ends. Cuticle finely annulated (annuli 1.5  $\mu\text{m}$  wide at mid-body). Lateral field 5-6  $\mu\text{m}$  wide, with 6 equidistant lines. Lip region set off from body contour. Stylet short and delicate, knobs rounded and minute. Dorsal gland orifice opening 1.5-2.5  $\mu\text{m}$  posterior to stylet knobs. Pharynx with cylindrical procorpus. Median bulb oval, muscular, with small, prominent sclerotised valve, 42.0-48.5  $\mu\text{m}$  from anterior end. Posterior glandular region bulbular, pyriform, not overlapping intestine. Nerve

ring encircling isthmus at its middle, 70-85  $\mu\text{m}$  from anterior end. Excretory pore situated at beginning of the basal pharyngeal bulb region or posterior to nerve ring. Hemizonid prominent, 3-4 annuli anterior to excretory pore. Deirids 8-12  $\mu\text{m}$  posterior to excretory pore. Reproductive tract monodelphic-prodelphic, occupying 30.8-41.3% of the body length, sometimes extending to near base of pharynx, oocytes in a single row. Vulva lips protuberant. Post-vulval uterine sac long, extending about half vulva to anus distance (52.4-75.3% of VAD). Tail tapering regularly up to its middle, then narrowing sharply to a ventrally arcuate terminal portion with finely rounded tip.





**Figure 4** *Ditylenchus nanus* from Kermanshah province, western Iran. A: Female entire body; B: Male entire body; C: Male reproductive system; D: Vulva to body end; E: Female reproductive system; F: Pharyngeal region; G: Female anterior end; H: Lateral lines; I: Female posterior end; J: Male posterior end. (All scale-bars 20  $\mu$ m, except A & B which are 40  $\mu$ m).

**Table 4** Morphometric data of Iranian population of *Ditylenchus nanus* from Kermanshah province, western Iran and its comparison with other populations.

Characters/Origin	Present study		Siddiqi, 1963		Brzeski, 1991	
	Female	Male	Female	Male	Female	Male
n	10	2	6	3	6	7
L	765 ± 76.4 (610-845)	610, 670	480-600	370-400	746 (683-852)	687 (623-764)
a	37.1 ± 0.4 (27.7-42.1)	32.1, 33.5	30-37	32-35	32 (28-40)	36 (33-39)
b	6.1 ± 0.6 (4.7-7)	4.2, 4.4	5.4-7.7	4.3-5.7	5.9 (4.9-7.3)	5.2 (4.8-5.8)
c	14.9 ± 1.9 (12.2-18.7)	13.4, 13.6	17-19	15-16	16.4 (15.1-18.8)	14.4 (12.9-15.1)
c'	4.0 ± 0.6 (3.0-4.6)	3.0, 3.6	-	-	3.2 (2.9-3.6)	3.7 (3.5-4.0)
V or T	82.0 ± 1.8 (80-84.5)	31.3, 32.8	82-85	39-43	83 (81-84)	-
Stylet	6.5 ± 0.7 (6-7)	6, 7	7-7.5	7-7.5	7-8	7-8
Excretory Pore	97.9 ± 5.2 (90-105)	96, 100	-	-	100 (96-107)	89-107
Pharynx	124.8 ± 5.9 (115-133)	140, 160	-	-	127 (112-150)	132 (123-140)
VBW	18.4 ± 1 (17-20)	-	-	-	-	-
Post-vulval uterine sac	50.1 ± 7.3 (34-58)	-	-	-	-	-
PUS/VBW	2.6 ± 0.4 (2-3.4)	-	1.8-2.6	-	2.2 (1.8-2.6)	-
Tail	51.7 ± 5.4 (45-60)	45, 50	-	-	46 (42-48)	48 (43-54)
Tail/anal (cloacal) body width	4.1 ± 0.5 (3.0-4.6)	4, 5	-	-	-	-
Spicules	-	12, 13	-	14-15	-	13-15
Gubernaculum	-	4, 5	-	5-6	-	5-6

Measurements are in  $\mu\text{m}$ .

**Male.** Generally similar to female. Testis single, 200-210  $\mu\text{m}$  long, outstretched, with spermatocytes arranged in a single row. Spicules paired, relatively short, curved ventrally. Gubernaculum short. Bursa leptoderan, extending for 70% of tail length. Tail conoid with rounded terminus.

*Ditylenchus nanus* was originally described by Siddiqi (1963). It was recovered from soil and root samples of guava tree (*Psidium guajava* L.) in Jamalpur village, India. The morphology and morphometrics of the Iranian population of *D. nanus* in the present study fit the data given in original description of the species (Siddiqi, 1963). The Iranian population of *D. nanus* comes close to *D. mirus* Siddiqi, 1963, *D. dipsacoideus* (Andrássy, 1952)

Andrássy, 1956 and *D. triformis* Hirschmann and Sasser, 1955. It differs from *D. dipsacoideus* by having a shorter stylet (6-7 vs 8.3-9.0  $\mu\text{m}$ ), longer post-vulval uterine sac (2.6 vs 1.5 times VBW long), a more posteriorly located vulva ( $V = 80.0-84.5$  vs  $72.2-79.4\%$ ) and shorter spicules (12-13 vs 16  $\mu\text{m}$ ). It differs from *D. mirus* by having a slightly longer body (610-845 vs 540-720  $\mu\text{m}$ ), less rounded stylet knobs, shorter spicules (12-13 vs 17  $\mu\text{m}$ ), thin tail, ventrally arcuate, regularly tapering, ending in a smoothly rounded terminus vs thicker and straight, tapering to a broadly rounded terminus and bursa extended about 70% of tail length vs almost entire length of the tail. It differs from *D. triformis* by having a longer post-vulval uterine sac (52.4-75.3 vs 25-

33% of vulva to anus distance), a basal pharyngeal bulb set off from intestine vs overlapping anterior end of intestine for 2-7  $\mu\text{m}$ , thin tail, ventrally arcuate, regularly tapering, ending in a smoothly rounded terminus vs elongate-conoid, tapering evenly with a dull tip and bursa extended for 70-77% vs 35-50% of tail length. Presently studied population of this species was recovered from the rhizosphere of a juglans tree in city of Gilan-e Gharb, Kermanshah province during present study and is reported for the first time from Iran.

#### Key to *Ditylenchus* species reported from Iran

An identification key is provided based on morphological and morphometric characters for Iranian species of *Ditylenchus*. Expect for *D. equalis* Heyns, 1964 and *D. tuberosus* (Kheiri, 1971) Fortuner and Maggenti, 1987 which do not easily fit in this key and are included here.

#### Key for identification of species in Iran

1. Lateral fields with four lines ..... 2
  - Lateral fields with six lines ..... 9
2. Median bulb of pharynx without valve; non-muscular; not developed ..... 3
  - Median bulb of pharynx with valve; muscular; well-developed ..... 4
3. Pharynx mostly offset from intestine .. *acutus*
  - Pharynx mostly overlapping intestine .... *acris*
4. Tail ending in a filamentous process at the tip ..... *filimus*
  - Tail not ending in a filamentous process at the tip ..... 5
5. Stylet > 10  $\mu\text{m}$  ..... 6
  - Stylet < 10  $\mu\text{m}$  ..... 7
6. Body length less than 1000  $\mu\text{m}$  in both sexes ..... *dipsaci*
  - Body length more than 1000  $\mu\text{m}$  in both sexes ..... *gigas*
7. Short post-vulval uterine sac (< 2 times VBW) ..... *exilis*
  - Long post-vulval uterine sac (> 2 times VBW) ..... 8
8.  $V = 71-77$  ..... *parvus*
  - $V = 60-73$  ..... *longimatrixalis*

9. Median bulb without valve; non-muscular; not developed ..... 10
  - Median bulb with valve; muscular; well-developed ..... 14
10. Post-vulval uterine sac < VBW ..... 11
  - Post-vulval uterine sac > VBW ..... 12
11. Excretory pore and hemizonid located posterior to basal pharyngeal bulb ... *persicus*
  - Excretory pore and hemizonid located anterior to basal pharyngeal bulb ..... *hexaglyphus*
12. Short post-vulval uterine sac ( $\leq 1.3$  VBW) ..... *affinis*
  - Long post-vulval uterine sac (> 1.3 VBW) .. 13
13. Stylet = 8-9  $\mu\text{m}$  ..... *kheirii*
  - Stylet = 6.5-8  $\mu\text{m}$  ..... *medians*
14. Tail tip dull to finely rounded or sometimes mucronate-rounded ..... 15
  - Tail tip finely pointed (dull to rounded tip in some populations of *D. dryalis*) ..... 22
  - Tail tip pointed to rounded and always bent; tail very long (> 140  $\mu\text{m}$ ) ..... *longicauda*
15. Post-vulval uterine sac < VBW ..... *apus*
  - Post-vulval uterine sac > VBW ..... 16
16. Stylet > 10  $\mu\text{m}$  ..... *destructor*
  - Stylet < 10  $\mu\text{m}$  ..... 17
17. Spicules < 13  $\mu\text{m}$  ..... *virtudense*
  - Spicules > 13  $\mu\text{m}$  ..... 18
18. Spicules 15-23  $\mu\text{m}$  ..... 19
  - Spicules 13-15  $\mu\text{m}$  ..... 21
19. Bursa covering > 50% of tail length ..... *anchilisposomus*
  - Bursa covering < 50% of tail length ..... 20
- 20 Pharynx mostly overlapping intestine; Tail tip finely rounded ..... *myceliophagus*
  - Pharynx mostly offset from intestine; Tail tip mucronate-rounded ..... *valveus*
21. Short post-vulval uterine sac (< 50% of vulva to anus distance) ..... *triformis*
  - Long post-vulval uterine sac (> 50% of vulva to anus distance) ..... *nanus*
22. Stylet > 10  $\mu\text{m}$ ; Lateral fields with six to eight lines ..... *dryalis*
  - Stylet < 10  $\mu\text{m}$  Lateral fields with six lines ..... 23
23. Long post-vulval uterine sac (2.8-4.1 times VBW) ..... *acutatus*
  - Short post-vulval uterine sac (0.9-3.5 times VBW) ..... 24

24. Spicule < 15  $\mu\text{m}$  .....*ferpolitor*  
 - Spicule > 15  $\mu\text{m}$  .....25  
 25. Post-vulval uterine sac 18-37% of vulva to  
 anus distance; Spicule = 15-18  $\mu\text{m}$  ... *tenuidens*  
 - Post-vulval uterine sac 30-40% of vulva to  
 anus distance; Spicule = 15-22  $\mu\text{m}$  *medicaginis*

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## اولین گزارش از سه گونه شناخته شده از جنس *Ditylenchus* Filipjev, 1936 (Nematoda: Anguinidae) از استان کرمانشاه به همراه کلید گونه‌های جنس در ایران

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**چکیده:** پانزده گونه متعلق به جنس *Ditylenchus* براساس ویژگی‌های ریخت‌سنجی و ریخت‌شناسی شناسایی شدند. توصیف کامل، داده‌های ریخت‌سنجی، ترسیم‌ها و عکس‌های میکروسکوپ نوری برای سه گونه *D. filimus*، *D. hexaglyphus* و *D. nanus* به‌عنوان گزارش جدید برای فون نماتدهای ایران ارائه شده است. گونه *Ditylenchus filimus* دارای استایلت ظریف (۸-۷ میکرون)، چهار شیار جانبی، حباب میانی مری رشد یافته، ماهیچه‌ای با دریچه مشخص و دم مخروطی با دنباله‌ی بلند نخی است. گونه *D. hexaglyphus* دارای استایلت ظریف (۸-۶/۵ میکرون)، شش شیار جانبی، حباب میانی مری ضعیف و بدون دریچه و دم مخروطی با انتهای گرد است. گونه *D. nanus* دارای استایلت ظریف (۷-۶ میکرون)، شش شیار جانبی، حباب میانی مری رشد یافته با دریچه مشخص و دم مخروطی با انتهای گرد است. همچنین کلید شناسایی برای گونه‌های گزارش شده این جنس از ایران نیز ارائه شده است.

**واژگان کلیدی:** توصیف کامل، ریخت‌شناسی، *Ditylenchus filimus*، *D. hexaglyphus* و *D. nanus*