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Species Composition, Morphological Characterization, and Dominance Structure of the Fauna of Parasitic Nematodes of Vegetable Crops in the Fergana Valley, Uzbekistan

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Abstract. *The present study investigates the species composition, morphological characteristics, and distribution patterns of parasitic nematodes infesting vegetable crops in the Fergana Valley, Uzbekistan. A total of 283 soil and root samples were collected from tomato (Solanum lycopersicum), bell pepper (Capsicum annuum), and eggplant (Solanum melongena) cultivated under protected ground conditions across the Andijan, Fergana, and Namangan regions. Nematode extraction was performed using the Baermann funnel method, soil washing analysis, and root incubation techniques. A total of 177 temporary and 72 permanent microscopic preparations were produced for morphological and morphometric analysis. Thirteen parasitic nematode species belonging to the order Tylenchida were identified: Meloidogyne arenaria, M. incognita, M. javanica, M. hapla, Pratylenchus pratensis, P. penetrans, P. thornei, P. tumidiceps, Helicotylenchus multicinctus, H. digitiformis, H. dihystera, Ditylenchus dipsaci, and D. destructor. Dominance analysis based on the scale proposed by V.F. Paliy revealed that root-knot nematodes of the genus Meloidogyne are absolutely dominant in the regional nematode fauna, collectively comprising more than 84% of the total species abundance. Meloidogyne incognita recorded the highest dominance index (37.25%), followed by M. arenaria (30.85%) and M. javanica (15.87%), all classified as eudominant species. The high prevalence of thermophilic Meloidogyne species is attributed to the favorable soil-climatic conditions of the Fergana Valley, characterized by warm temperatures, intensive irrigation, and an extended growing season. The Andijan region demonstrated the greatest species richness, whereas the Namangan region yielded rare and previously unrecorded species.*

Keywords: *parasitic nematodes, Meloidogyne, Fergana Valley, vegetable crops, species composition, dominance index, phytosanitary risk, Tylenchida*

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Introduction

The Fergana Valley is one of the largest agricultural regions of Uzbekistan, where vegetable crops are intensively cultivated: tomato, cucumber, pepper, eggplant, onion, carrot, cabbage, and melon plants. The favorable soil-climatic conditions of the region simultaneously contribute not only to the development of crop production, but also to the mass distribution of phytoparasitic nematodes, causing significant reduction in crop yield and deterioration of product quality.

Parasitic nematodes are one of the most dangerous groups of phytopathogens. According to international research data, annual crop losses from phytonematodes amount to 10–15%, and in foci of severe infestation may reach 40–60%. Representatives of the genera *Meloidogyne*, *Pratylenchus*, *Ditylenchus*, and *Helicotylenchus* are particularly dangerous. The fauna, biomass, distribution, morphobiological characteristics of parasitic nematode species, as well as their impact on plants and the damage they inflict on vegetables, are of both scientific and practical significance.

Materials and Methods

The study was conducted on raised beds in the Andijan, Fergana, and Namangan regions of the Fergana Valley on crops of tomato (*Solanum lycopersicum*), bell pepper (*Capsicum annuum*), and eggplant (*Solanum melongena*) (Ferris et al., 2001). A total of 283 samples were collected from roots and rhizosphere soil of the aforementioned plants. To extract parasitic nematodes from plant roots and soil, the Baermann funnel method, soil washing analysis, and root incubation methods were employed (Matveeva et al., 2018). From the extracted nematodes, 177 temporary and 72 permanent preparations were prepared. For the determination of nematode species composition, a widely recognized identification key was used (Maleita et al., 2022).

Results

Under protected ground conditions of the Fergana Valley, during the cultivation of tomatoes, cucumbers, bell peppers, eggplants, and vegetable crops in the Andijan, Namangan, and Fergana regions, 13 nematode species were identified: *Meloidogyne arenaria*, *M. incognita*, *M. javanica*, *M. hapla*, *Pratylenchus pratensis*, *P. penetrans*, *P. thornei*, *P. tumidiceps*, *Helicotylenchus multicinctus*, *H. digitiformis*, *H. dihystera*, *Ditylenchus dipsaci*, *D. destructor*, belonging to the order Tylenchida.

Meloidogyne arenaria (Neal, 1889) Chitwood, 1949 (Fig. 1)
Females. Body length with neck 643–1100; body width 400–520. Neck length 102–220, width 68–84. Body rounded or oval. Cuticle weakly annulated. Two annules are visible on the head. Basal plates of the head capsule well developed. Stylet 13–15.5, robust, with rounded knobs. Egg size 76–101 × 32–44.

Perineum. Anal-vulval plate from rounded to oval. General dimensions approximately 83–120 × 79–132. Vulva width 24–30, distance between phasmids 26–30, from vulva to midline between phasmids 19–24, from vulva center to anus 16–18, from anus to phasmids 14–17. No tail whorl. Plate pattern variable. Dorsal arch low, weakly trapezoidal. Lateral fields poorly expressed. Most commonly they are indicated by interruptions and irregularities in the circular lines. In addition, at the site of the lateral fields, the dorsal and ventral lines may converge at an angle, sometimes forming "wings". No dots in the tail region.

Males. L = 1270–2000; a = 44–65; b = 11–16; c = 116–138. Stylet 20–24. Head cap broad, rectangular in lateral view. Height of head capsule 5–6, width at base 12–14. Behind the labial annule there are 4 additional annules, the first being the widest. Cuticle annulated. Lateral field with 4 lines, converging posterior to the cloaca on the dorsal side. Stylet 20–24. Knobs rounded; knob width 4–5, height 3.

Oesophagus 96–98. Metacorporal bulb oval, 20–24 × 11–12, with valve. Spicules 30–34. Gubernaculum 6–8, curved. Tail short, rounded. Phasmids anterior to cloaca. Second-stage juveniles. L = 450–490; a = 26–32; b = 7.2–7.8; c = 6–10. Stylet 10–12. Knob width 2–5, height 1–2, merging inconspicuously with the stylet. Cuticle annulated. Oesophagus 62–70.

Geographical distribution. Andijan region: Andijan city, Pakhtaabad district, Bulakbashi district, Izboskan district, Oltinko'l district, Shahrikhan district. Fergana region: Fergana city, Margilan city, Oltiariq district, Quvasoy district, Quva district, Toshloq district. Namangan region: Chust district, Pop district, Turakurgan district, Davlatabad district, Kosonsoy district, Chortoq district, Mingbuloq district.

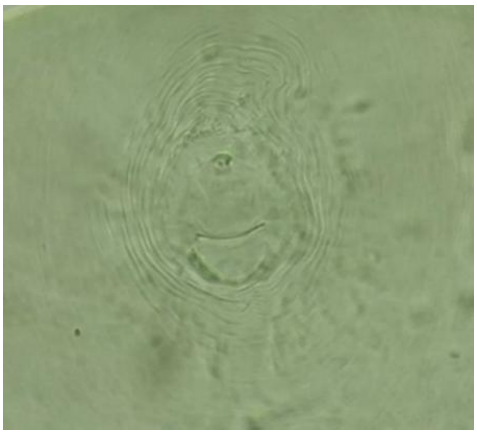


Figure 1
Meloidogyne arenaria

Meloidogyne incognita (Kofoid et White, Chitwood, 1949) (Fig. 2.)
Females. Body length with neck 505–680; body width 300–430. Body pearly white, from spherical to pyriform in shape. Head not offset, bearing a labial annule and two postlabial annules. Internal head structure weakly developed. Stylet 14–16, robust, with rounded knobs. Knob width 4–5, height 1.8–2.0. Opening of the dorsal oesophageal gland located at a distance of 2–4 from the stylet knobs. Excretory pore situated at the level of the dorsal oesophageal gland opening or at a distance of 13–98 from the anterior body end. Eggs relatively small, 77–98 × 30–48.

Perineum. Anal-vulval plate rounded-oval in shape. Dorsal arch high, composed of closely spaced wavy and zigzag lines. Right and left sides of the dorsal arch frequently asymmetrical. Tail vestige outlined by a whorl-like line that is not interrupted laterally. From the posterior vulval lip toward the anal opening, two short straight folds typically extend, arranged vertically to the vulval slit. Lateral fields may be poorly expressed, indicated by bifurcation of the dorsal and ventral lines along the lateral fields.

Males. L = 1200–2450; a = 32–52; b = 6–17; c = 122–372. Head slightly offset. Labial annule massive. Stylet 21–26; knobs rounded, occasionally bifurcated. Knob width 5.5–6.5, height 3.0–3.5. Second-stage juveniles. L = 360–393; a = 29–33; b = 5.6–6.4; c = 8.0–9.4. Head bearing 4 cuticular annules. Stylet 10; knobs rounded. Knob width 2, height 1.3–1.5.

Geographical distribution. Andijan region: Andijan city, Pakhtaabad district, Bulakbashi district, Izboskan district, Oltinko'l district, Shahrikhan district, Jalaquduq district. Fergana region: Fergana city, Margilan city, Oltiariq district, Quvasoy district, Quva district, Toshloq district. Namangan region: Namangan city, Chust district, Pop district, Turakurgan district, Davlatabad district, Kosonsoy district, Chortoq district, Mingbuloq district.

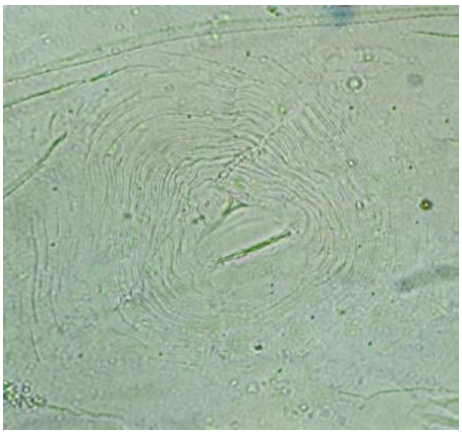


Figure 2
Meloidogyne incognita

Meloidogyne javanica Chitwood, 1949 (Fig. 3)
Females. Body length 540–850, body width 300–550. Body flask-shaped. Neck usually long. Stylet 16–17. Knobs rounded, width at base 4–5, height 2. Opening of the dorsal oesophageal gland at a distance of 3–4 from the stylet knob base. Egg size 76–100 × 31–45.

Perineum. Anal-vulval plate typically rounded, with simple circular lines interrupted in the lateral field region. Lateral fields appearing as distinct bands not crossed by cuticular folds of the dorsal and ventral sides. Characteristically, the lateral fields are very clearly visible beyond the perineum, extending far along the body. Dorsal arch low. Tail vestige clearly expressed. Phasmids distinct, located on both sides of the tail at a distance of 19–26 from the terminus.

Males. L = 940–1440; a = 26–42; b = 7–13. Head region elevated, bearing 4 cuticular annules. Labial annule broad and rather flat. Additionally, 3 postlabial annules of equal width are visible. Lateral lips: height 4, width 2. Stylet 20–21. Knob width 5, height 3.0–3.5. Opening of the dorsal oesophageal gland at 3 posterior to the stylet knobs. Spicules 30–31.

Second-stage juveniles. L = 340–400; a = 24–26; b = 8; c = 5.8–6.6. Stylet 10. Opening of the dorsal oesophageal gland located at a distance of 4 posterior to the stylet knobs.

Geographical distribution. Andijan region: Pakhtaabad district, Oltinko'l district. Fergana region: Fergana city, Margilan city, Oltiariq district, Quvasoy district, Toshloq district. Namangan region: Davlatabad district, Kosonsoy district.

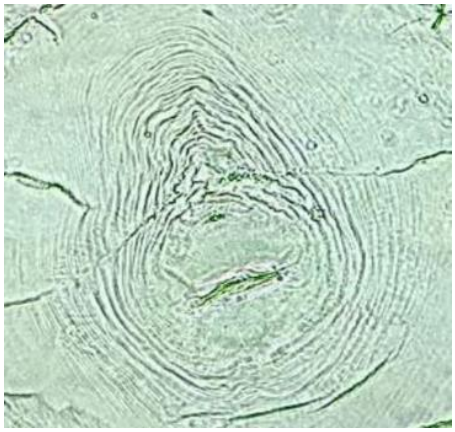


Figure 3
Meloidogyne javanica

Meloidogyne hapla Chitwood, 1949 (Fig. 4)
Females. Body length 550–790, width 400–450.
Body shape rounded-oval, with a relatively short neck. Stylet 12–14. Stylet knobs weakly rounded. Knob base width 3, height 1.5–2.0. Opening of the dorsal oesophageal gland located posterior to the stylet knobs at a distance of 5–6. Egg size 84–108 × 32–43. Eggs deposited in colorless egg sacs of relatively low durability.

Perineum. Anal-vulval plate rounded. Cuticular folds posterior to the anus appear as nearly parallel lines. At the site of the tail vestige and anus, a group of dots is usually present. Occasionally, dots are scattered without particular order in the space between the lines of the tail region. Dorsal arch low, rounded or angular. Cuticular folds in the lateral field region are formed by converging, branching lines of the dorsal and ventral arches. Frequently, lines of the ventral sector forming the lateral field extend far laterally, forming "wings" highly characteristic of the anal-vulval plate of this species. In older females, such wings are sometimes particularly well developed, with dots in the tail vestige region being poorly expressed or entirely absent.

Males. L = 1000–1330; a = 30–40; b = 12–15. Stylet 17–18. Head bearing 2 cuticular annules, the first rounded and narrower than the second. Stylet knob width 3.5–4.0, height 1.7–2.0. Opening of the dorsal oesophageal gland at a distance of 4–6 from the stylet knobs. One or two testes. Spicules 29–31, moderately arcuate. Phasmids situated at the level of or slightly posterior to the anus, diameter 3.5–4.0.

Second-stage juveniles. L = 395–466; a = 28–35; b = 6.5–7.3; c = 7.5–8.2. Stylet 10, knobs rounded. Stylet knob base width 1.5. Lateral field with 4 lines, non-areolated. Opening of the dorsal oesophageal gland at a distance of 3–4 from the stylet knobs. Tail tip of juveniles highly variable. Within the progeny of a single female, juveniles may possess either a bifurcated or non-bifurcated tail tip.

Geographical distribution. Andijan region: Izboskan district. Fergana region: Oltiariq district, Quva district. Namangan region: Chust district, Kosonsoy district.

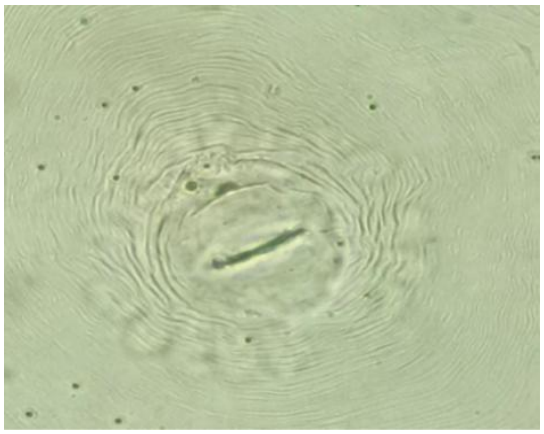


Figure 4
Meloidogyne hapla

Pratylenchus pratensis (de Man, 1880) Filipjev, 1936 (Fig. 5)
Female: L = 0.46 mm; a = 28; b = 3.6; c = 20; V = 77; stylet length = 15 µm.
Body slender, nearly straight when relaxed. Cuticular annulation fine (0.9 µm in the mid-body region), inconspicuous, sometimes very difficult to distinguish. Lateral fields with four longitudinal lines. Lip region almost continuously merging into the body contour, consisting of three annules; its margins rounded. Basal lip sclerotization extending posteriorly approximately one annule. Stylet

robust, with well-separated basal knobs. Opening of the dorsal pharyngeal gland located approximately 2.5 µm posterior to the stylet base. Median pharyngeal bulb broadly oval. Pharyngeal glands overlapping the intestine ventrally or ventrolaterally. Excretory pore usually situated immediately anterior to the pharyngeal-intestinal junction. Hemizonid located immediately anterior to the excretory pore. Vulva transverse. Uterus with a large oval or rectangular spermatheca filled with spermatozoa. Ovary with oocytes arranged in a single row, except for a short proliferation zone. Post-vulval uterine sac slightly longer than the body diameter; its length 14–28 µm or 22–32% of the vulva-to-anus distance; usually undifferentiated, occasionally containing a single separate cell. Tail with 20–28 annules, excluding those around the terminus; annulation continuing around the terminus, which is variable in shape — usually oblique, sometimes more symmetrically conical or slightly mucronate. Phasmids located approximately at mid-tail.

Male: L = 0.48–0.63 mm; a = 28–36; b = 5.3–6.6; c = 17–21; T = 38–60; stylet length = 13–14 µm. Similar to female. Single testis, elongated. Spicules curved, 17–19 µm in length. Gubernaculum 6–7 µm in length. Bursa enveloping the tail, its margin weakly crenate. Phasmids extending into the bursa and located posterior to the mid-tail region.

Geographical distribution. Andijan region: Andijan city, Pakhtaabad district, Bulakbashi district, Shahrikhan district, Jalaquduq district. Fergana region: Fergana city, Margilan city, Oltiariq district, Toshloq district. Namangan region: Chust district, Turakurgan district, Davlatabad district, Kosonsoy district, Chortoq district.

Figure 5
Pratylenchus pratensis

Pratylenchus penetrans (Cobb, 1917) Filipjev & Schuurmans Stekhoven, 1941 (Fig. 6)
Female: L = 0.53 mm; a = 26; b = 5.8; c = 16; V = 81; stylet = 17–19 µm.
Body moderately slender, nearly straight when heat-relaxed. Cuticular annulation fine. Lateral fields usually with four lines; outer bands may be partially areolated; central band sometimes with oblique striae in the vulval region, becoming areolated posterior to the vulva and not reaching the tail tip. Lip region slightly offset from the body, low, anteriorly flattened with rounded outer margins, consisting of three annules. Lip region with a robust, well-developed framework. In en face view, characterized by rectangular subdorsal and subventral lips, noticeably wider than the oral disc, and separated from the lateral lips by two mutually perpendicular grooves (Hernández & Gibson, 2000). Stylet basal knobs broadly rounded, occasionally cup-shaped anteriorly. Pharynx overlapping the intestine ventrally as a lobe approximately 1.5 body diameters in length. Excretory pore situated approximately opposite the pharyngeal-intestinal junction; hemizonid occupying approximately two body annules immediately anterior to it. Post-vulval uterine sac short, undifferentiated, approximately 1–1.5 body diameters in length at the vulval level. Spermatheca spherical or nearly spherical. Tail usually rounded, with a smooth terminus; ventral surface with 15–27 annules.

Male: L = 0.44–0.56 mm; a = 23–30; b = 5.2–6.0; c = 15–20; T = 43–52; stylet = 16–18 µm.
Common. Slightly smaller than female but similar in form. Lateral fields with four lines, terminating at the bursa; occasionally with oblique lines in the central band in the mid-body region. Spicules slender, with well-developed manubria and ventrally curved shafts, 14–17 µm in length; gubernaculum simple, 3.9–4.2 µm in length. Tail approximately twice the body diameter at the cloacal level; bursa with irregularly crenate margin, enveloping the tail tip.

Geographical distribution. Fergana region: Quva district. Namangan region: Turakurgan district.

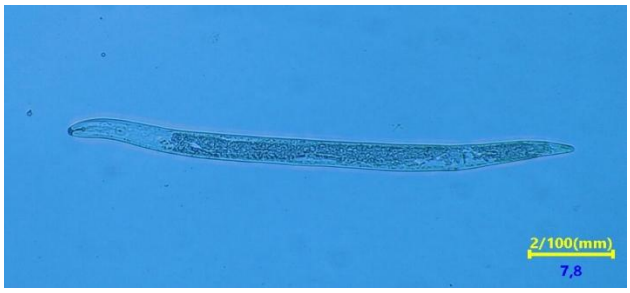


Figure 6
Pratylenchus penetrans

Pratylenchus thornei Sher & Allen, 1953 (Fig. 7)
Female: L = 0.45–0.77 mm; a = 26–36; b = 5.5–8.0; c = 18–22; V = 73–80; stylet = 17–19 µm.
Body large and slender, assuming an open C-shaped posture upon death by gentle heating. Cuticle with transverse striation, distance between striae approximately 1 µm, inconspicuous. Lateral fields with four lines; outer lines straight or weakly crenate. In one specimen, Loof observed oblique striae in the central zone. Labial region with three annules, not offset from the body. The outer margin of the sclerotized labial framework extends noticeably approximately two annules into the body and one annule into the labial region. In en face view, lateral lips clearly separated from the subdorsal and subventral lips by corresponding grooves concave relative to the lateral lips (Hernández & Gibson, 2000). Stylet guiding apparatus extending posteriorly from the basal plate approximately four annules. Stylet of medium length (17–19 µm), with broadly rounded or nearly anteriorly flattened basal knobs. Opening of the dorsal pharyngeal gland located approximately 3 µm posterior to the stylet base. Nerve ring situated immediately posterior to the pharyngeal bulb; hemizonid approximately two annules in length, positioned one annule anterior to the excretory pore. Ovary not reaching the pharynx. Oocytes arranged in a single row, except for the anterior proliferation zone; oviduct indistinct; uterus short. Spermatheca poorly distinguishable, spermatozoa absent (males very rare); post-vulval uterine sac slightly longer than 1.5 body diameters at the vulval level. Phasmids located slightly posterior to mid-tail; all four lateral lines continuing beyond the phasmids. Tail dorsally convex-conical; terminus bluntly rounded or truncate, without striation.

Figure 7
Pratylenchus thornei

Male: L = 0.48 mm; a = 32; b = 5.6; c = 20; T = 30; stylet = 16 µm.
Very rare (previously only four specimens recorded). Similar to female. Testis elongated, spermatocytes arranged in a single row, followed by a zone with multiple rows. Phasmids located slightly posterior to mid-tail and not extending into the bursa. Spicules very long (21–26 µm), curved (arcuate), with a hafted structure, resting on a trough-shaped gubernaculum (5–7.5 µm). Yu recorded a male from axenic culture on excised maize roots. In addition, nine further specimens from axenic cultures on carrot discs, obtained from a population infecting chickpea in Jerez (southern Spain), are reported here, completing the description of the morphology and morphometrics of this life cycle stage.

Geographical distribution. Andijan region: Andijan city, Izboskan district, Shahrikhan district. Fergana region: Quvasoy district and Quva district.

Pratylenchus tumidiceps Merzheevskaja, 1953 (Fig. 8)
Female: L = 325–500 µm; a = 27.9–28.8; b = 3.8–5.1; c = 19.8–30.6; V = 75–77%
Male: L = 315–430 µm; a = 27–30; b = 4.0–5.1; c = 14–15
Cuticle finely annulated. Body width from head to anal opening nearly uniform, with slight widening in the gonadal region. Anteriorly the body narrows, forming a characteristically blunt anterior end at the lip base. Posterior to the vulva in the female, and in the posterior quarter of the body in the male, the body gradually tapers toward the tail. Head bearing six closely appressed lips, at the base of which is a circle of 12 clearly visible tubercles. Stylet 14–15 µm, with a well-developed triple expansion at the base. Oesophagus cylindrical, with a well-developed, nearly spherical bulb. Oesophageal glands clearly visible. Excretory pore situated in the region of the oesophageal glands. Gonads unpaired; only the anterior genital tube present, the posterior being rudimentary. Female tail conical, rounded at the tip. Male tail pointed, surrounded by a well-developed bursa. Spicules rather slender; gubernaculum small. A phytohelminths with specific pathogenic effect.

Geographical distribution. Andijan region: Shahrikhan district.

Figure 8
Pratylenchus tumidiceps

Helicotylenchus digitiformis Ivanova, 1967 (Fig. 9)
Female: L = 551–688 (633 ± 21) µm; a = 28–40 (35 ± 1.1); b = 4.2–5.6 (4.9 ± 0.7); c = 16–30 (23 ± 2.1); V = 75–82 (78 ± 4.6); stylet = 10–18 (15 ± 1.4) µm.

Body straight or slightly ventrally curved when relaxed. Annulation well expressed; body tapering from the vulval region toward the tail. Lateral field with four lines. The two outer bands irregularly areolated; oblique striae occasionally observed in the central zone at mid-body, and an additional band sometimes appearing, giving the impression of six lines.

Lip region rounded, with four annules; tail with 10–15 annules. Labial framework massive, with an oval oral aperture. Stylet robust, with angular basal knobs; opening of the dorsal gland located 2–4 µm posterior to the stylet base. Oval median bulb and well-developed nerve ring encircling the narrow isthmus at the anterior part of the glandular pharyngeal region. Posterior pharynx overlapping the intestine laterally and ventrally for 20–50 µm. Excretory pore located 80–95 µm from the anterior end, slightly anterior to the pharyngeal-intestinal junction. Hemizonid situated anterior to the excretory pore. A single anterior ovary present; spermatheca small and non-functional. Double cuticular annulation observed on the dorsal side of the body opposite the anus. Tail rounded, smooth, often with a slight indentation.

Males: not found.
Geographical distribution. Andijan region: Andijan city, Izboskan district, Oltinko'l district, Shahrikhan district. Fergana region: Fergana city, Margilan city, Oltiariq district, Toshloq district. Namangan region: Turakurgan district, Davlatabad district, Kosonsoy district.

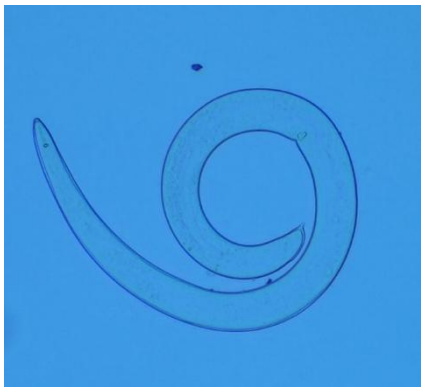


Figure 9
Helicotylenchus digitiformis

Helicotylenchus dihystera (Cobb, 1893) Sher, 1961 (Fig. 10)
Females: L = 0.59–0.79 mm; a = 27–35; b = 5.8–6.9; c = 35–49; V = 60–65%; stylet 24–26 µm.
Body usually spiral in posture. Lip region hemispherical, with four or five narrow and often poorly distinct cuticular annules. Width of cuticular annules in the mid-body region approximately 1.5 µm. Stylet knobs typically concave anteriorly. Excretory pore at the level of the anterior part of the posterior bulb. Hemizonid situated immediately anterior to the excretory pore. The latter located 100–119 µm from the anterior body end. Spermatheca without spermatozoa. Tail with a small ventral projection.

Males: (very rarely encountered); L = 0.59–0.65 mm; a = 25–32; b = 5.1–6.1; c = 31–33; stylet 22–27 µm; spicules 7–8 µm.

Geographical distribution. Andijan region: Pakhtaabad district, Bulakbashi district, Shahrikhan district. Fergana region: Fergana city, Margilan city, Oltiariq district, Quvasoy district, Quva district. Namangan region: Namangan city, Turakurgan district, Mingbuloq district.

Figure 10
Helicotylenchus dihystera

Helicotylenchus multicinctus (Cobb, 1893) Golden, 1956 (Fig. 11)
Females: L = 460–680 µm; a = 24–29; b = 4.5–6; c = 48–63; V = 64–72%.
Males: L = 440–560 µm; a = 27–33; b = 3.8–4.8; c = 28–36.
Cuticle coarsely annulated. Head clearly offset from the body, with four annules. Height of the head capsule equal to the diameter of its base. Stylet robust; length 25–28 µm. Stylet basal knobs large. Oesophagus tylenchoid. Metacorporal bulb small, oval. Glandular cardial bulb elongated. Excretory pore at the level of the beginning of the glandular cardial bulb. Nerve ring slightly anterior to the level of the excretory pore. Lateral fields with four longitudinal lines, encircling the tail posterior to the phasmids. Female reproductive system paired, symmetrical. Vulva deeply invaginated into the body cavity. This species belongs to phytohelminths with a specific pathogenic effect.

Figure 11
Helicotylenchus multicinctus

Geographical distribution. Andijan region: Andijan city, Bulakbashi district, Izboskan district, Oltinko'l district, Shahrikhan district, Jalaquduq district. Fergana region: Fergana city, Margilan city, Oltiariq district, Quva district, Toshloq district. Namangan region: Pop district, Davlatabad district, Kosonsoy district, Chortoq district.

Ditylenchus dipsaci Filipjev, 1936 (Fig. 12)
Female: L = 1000–1300 µm; a = 36–40; b = 6.5–7.1; c = 14–18; V = 80%.
Male: L = 1000–1300 µm; a = 37–41; b = 6.5–7.3; c = 12–15.

Figure 12
Ditylenchus dipsaci

Females: Body slender, tapering toward both the head and tail ends. Head slightly offset from the body contour, with a delicate supporting framework. Cuticle finely annulated; width of cuticular annules approximately 1 µm. Stylet with well-developed rounded basal knobs, 11–13 µm in length. Procorpus cylindrical. Median bulb convex-oval; cardial bulb clearly demarcated from the midgut. Isthmus narrow. Nerve ring situated near or at the beginning of the cardial bulb. Excretory pore located at the level of the mid-cardial bulb. Hemizonid situated close to the excretory pore, occupying approximately 6 cuticular annules. Ovary oligopropagate, reaching the level of the cardial bulb, sometimes with one or two flexures. Spermatheca primitive, tubular, containing spermatozoa. Oviduct short, with well-developed large eggs. Egg length 60–65 µm, diameter 17–19 µm. Posterior uterus equal to half the vulva-to-anus distance or slightly shorter.

Male with bursal wings of the leptoderm type, occupying 3/4 of the tail length. Spicules ventrally curved, with well-developed cylindrical heads. Gubernaculum dorsally thickened, 10–12 µm in length, linear in profile. Distance from vulva to anus equal to or shorter than tail length. Tail in both sexes short, gradually tapering. Tail terminus acute. This species is a parasite of numerous agricultural crops.

Geographical distribution. Andijan region: Pakhtaabad district, Bulakbashi district, Oltinko'l district, Shahrikhan district, Jalaquduq district. Fergana region: Fergana city, Margilan city, Oltiariq district, Toshloq district. Namangan region: Chust district, Turakurgan district, Mingbuloq district.

Ditylenchus destructor Thorne, 1945 (Fig. 13)
Females: L = 0.72–1.44 mm; a = 33–35; b = 8–10; c = 15–20; V = 78–83; stylet 10 µm.
Males: L = 0.75–1.30 mm; a = 34–40; b = 7–8; c = 12–16; stylet 10 µm.

Females. Ovary origin reaching the base of the oesophagus. Oogonia in the germinative zone arranged in 2–3 rows; oocytes in the growth zone arranged in a single row. Distance from the head end to the valve of the metacorporal bulb 57–68 (61) µm. Oesophagus length 150–183 (165) µm. Total gonad length 583–1178 (884) µm. Pre-uterine gland relatively short, consisting of 4 rows of cells with 6 cells per row (24 cells in total). Egg length slightly greater than the body diameter. Posterior uterus usually equal to or slightly longer than half the vulva-to-anus distance. Vulval lips generally prominent. Anus and rectum clearly observable. Tail tip blunt.

Males. Genital tube generally straight, shorter than in the female and generally not reaching the oesophageal base, length 488–905 (719) µm. Distance from the head end to the germinal cell of the gonad 175–450 (309) µm. Distance to the valve of the metacorporal bulb 52–73 (60) µm. Oesophagus length 130–185 (156) µm. Bursa well developed, originating at the level of the spicule base, length 42–75 (60) µm, not reaching the tail tip, leaving it free.

Geographical distribution. Andijan region: Bulakbashi district, Shahrikhan district. Fergana region: Fergana city, Margilan city, Oltiariq district. Namangan region: Namangan city, Chust district, Turakurgan district, Mingbuloq district.

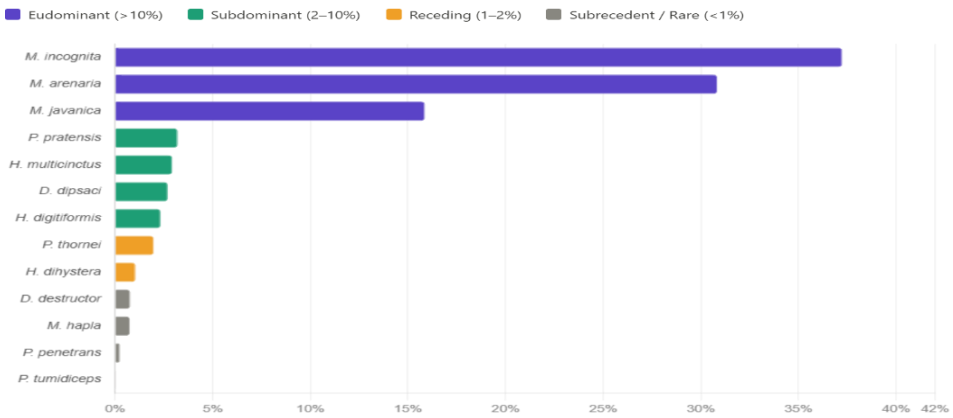
Figure 13
Ditylenchus destructor

Among the dominance groups of parasitic nematode species in the agrocenoses of the Fergana Valley, root-knot nematodes of the genus Meloidogyne predominate. In particular, Meloidogyne incognita recorded the highest dominance index of 37.25%. This species was registered in nearly all surveyed areas, with notably high individual counts in Oltiariq district, Fergana city, and Quvasoy district of Fergana region. Its widespread distribution is attributed to the high adaptive capacity of this species, its ability to acclimate to diverse soil-climatic conditions, and its capability to infest a broad range of agricultural crops (Tab. 1).

The second eudominant species is Meloidogyne arenaria, with a dominance index of 30.85%. It was likewise encountered in nearly all surveyed areas, with particularly high population density recorded in Fergana region. This pattern indicates that the species has established itself as a stable parasite within the agroecosystems of the region (Matveeva et al., 2018).

Meloidogyne javanica also entered the eudominant group with an index of 15.87%. Its particularly high prevalence was recorded in warm-climate irrigated lands. The high occurrence of this species confirms that the soil-climatic conditions of the Fergana Valley are favorable for root-knot nematode development (EPPO, 2024).

Table 1
Distribution of species by dominance groups



Thus, the three principal *Meloidogyne* species collectively constituted more than 84% of the total nematode fauna, demonstrating that root-knot nematodes are the predominant group among phytoparasitic nematodes in the Fergana Valley (Perry et al., 2009).

Discussion

The subdominant group comprised *Pratylenchus pratensis* (3.21%), *Helicotylenchus multicinctus* (2.93%), *Ditylenchus dipsaci* (2.70%), and *Helicotylenchus digitiformis* (2.33%), distinguished by their relatively stable distribution across agrocenoses. These species are in most cases associated with specific crop types or particular soil conditions. For instance, the elevated occurrence of *Ditylenchus dipsaci* in certain districts reflects its association with moist soils and perennial plants.

The recedent group, represented by *Pratylenchus thornei* (1.98%) and *Helicotylenchus dihystera* (1.05%), exhibited relatively low prevalence, although both species were recorded consistently in certain areas. *Helicotylenchus dihystera* is characterized by its confinement to limited local territories.

The subrecedent group, comprising *Ditylenchus destructor* (0.78%) and *Meloidogyne hapla* (0.76%), was classified among the least prevalent species. *Meloidogyne hapla* is distinguished by its predominant occurrence in cooler and more humid areas; accordingly, its low prevalence under the conditions of the Fergana Valley is considered a natural outcome.

The lowest dominance indices were observed for *Pratylenchus penetrans* (0.25%) and *Pratylenchus tumidiceps* (0.04%). These species belong to the very rare group, with their distribution restricted to isolated localities. This pattern may be attributed to their specific ecological requirements or incomplete adaptation to the regional conditions.

In the parasitic nematode fauna of the Fergana Valley, root-knot nematodes of the genus Meloidogyne are absolutely dominant, forming the principal phytohelminths complex in agrocenoses. The high dominance levels of M. incognita, M. arenaria, and M. javanica in particular indicate that these species pose a substantial phytosanitary threat to agricultural crops. The remaining species are distributed within the subdominant, recedent, and subrecedent groups, constituting a relatively minor proportion of the biocenosis (Maleita et al., 2022).

In contemporary nematological research, Meloidogyne species are likewise regarded as the most economically significant phytoparasitic nematodes. According to Jones J. T. and co-authors, these species are distributed across virtually all agricultural regions owing to their high reproductive potential, broad host range, and ecological plasticity. A sharp increase in population density has been particularly documented in intensively irrigated agrocenoses (Jones et al., 2013).

The highest dominance of M. incognita in the Fergana Valley is attributed to the exceptional ecological plasticity of this species. Studies by Trudgill D. L. and Blok V. C. have emphasized that M. incognita and M. javanica develop rapidly under conditions of elevated temperature and humidity, posing a considerable phytosanitary threat particularly in warm-climate regions. The irrigated agroecosystems of the Fergana Valley, characterized by an extended growing season, represent favorable environments for these species (Trudgill & Blok, 2001).

The analysis recorded Pratylenchus pratensis and Pratylenchus thornei within the subdominant and recedent groups respectively. In the works of Castillo P. and Vovlas N., Pratylenchus species are described as migratory endoparasites that damage root tissues and reduce the capacity of plants to absorb water and mineral nutrients, thereby leading to impaired plant growth and decreased yield (Castillo & Vovlas, 2007).

Furthermore, Nicol J. M. and co-authors identified Pratylenchus thornei as a significant parasite of cereal crops in arid and semi-arid climatic regions, which accounts for its occurrence in certain districts of Namangan and Fergana regions (Nicol et al., 2011).

The inclusion of Ditylenchus dipsaci in the subdominant group may be associated with its polyphagous nature. According to data provided by Sturhan D. and Brzeski M. W., this species is capable of parasitizing more than 500 plant species, and rapid population growth has been documented particularly under conditions of elevated humidity (Sturhan & Brzeski, 1991). The classification of Meloidogyne hapla within the subrecedent group is explained by its primary adaptation to cool and temperate climatic conditions. In the works of Eisenback J. D. and co-authors, M. hapla is noted to be distributed predominantly in temperate climate zones; accordingly, its distribution under the warm climatic conditions of the Fergana Valley is restricted (Eisenback et al., 1981).

Thus, root-knot nematodes of the genus Meloidogyne have been found to be absolutely dominant in the phytoparasitic nematode fauna of the Fergana Valley. This situation indicates the presence of a high phytosanitary risk in the regional agrocenoses and confirms the necessity of developing effective phytosanitary measures against root-knot nematodes.

In general, the Fergana Valley is characterized by the dominance of root-knot nematodes of the genus Meloidogyne, which possess the greatest ecological plasticity and the widest distribution. The Andijan region is the most species-rich in the study area, whereas the Namangan region yielded rare species not previously recorded for the country.

Conclusion

Analysis conducted on the basis of the dominance scale proposed by V. F. Paliy (1961) demonstrated that species belonging to the genus Meloidogyne are absolutely dominant in the agrocenoses of the Fergana Valley. According to the research findings, Meloidogyne incognita (37.25%), Meloidogyne arenaria (30.85%), and Meloidogyne javanica (15.87%) constituted the eudominant group, confirming that root-knot nematodes are the leading phytoparasites in the agroecosystems of the Fergana Valley.

Declaration of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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