

## New species of the genus *Ektaphelenchus* Fuchs, 1937 isolated from dead wood in northern Iran

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### Abstract

A new species of the genus *Ektaphelenchus*, *E. golestanensis* n. sp., is described and illustrated based on morphological and morphometric characteristics. The new species was isolated from dead wood samples collected from natural forests in Golestan province, northern Iran. *E. golestanensis* n. sp. is mainly characterized by 347-378  $\mu\text{m}$  long females (the currently shortest representative species of the genus), having three lines in lateral field, slightly offset cephalic region flat in the anterior end, well-developed stylet, 15.1-16.6  $\mu\text{m}$  long, having a wide lumen and lacking basal knobs or swellings, excretory pore slightly more than one metacarpus length posterior to it, functional rectum and anus absent, posterior body region (tail) conical, narrowing towards the end, males with single precloacal papilla (P1), and paired third and fourth caudal papillae (P3 and P4), arcuate and separate spicules 7-10  $\mu\text{m}$  long along arc line with well-developed wide condylus, and tail with a small mucron at the terminus. The new species was morphologically compared with typologically similar small-sized species of *Ektaphelenchus* having three lines in the lateral field, conical posterior body end and stylet lacking basal knobs, namely *E. apophysatus*, *E. joyceae* and *E. taiwanensis*. It was further compared with *E. goffarti* and *E. olitorius* having a similar female posterior body end shape and unknown number of incisures in the lateral field, as well as *Seinura informis* and *S. paratenuicaudata* due to having obscure rectum and anus.

**Keywords:** Golestan province, morphometric data, predator, taxonomy

## توصیف گونه‌ی جدیدی از جنس *Ektaphelenchus* Fuchs, 1937 جدا شده از چوب مرده در شمال ایران

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### چکیده

گونه‌ی جدید *Ektaphelenchus golestanensis* n. sp. بر اساس داده‌های ریخت‌شناسی و ریخت‌سنجی توصیف شده است. این گونه از نمونه چوب‌های در حال پوسیدن از جنگل‌های استان گلستان، شمال ایران، جداسازی شد. این گونه عمدتاً با داشتن ماده‌هایی به طول ۳۴۷-۳۷۸ میکرومتر (کوچکترین گونه توصیف شده جنس تا کنون)، سطوح جانبی دارای سه شیار طولی، ناحیه‌ی سر کمی متمایز از ابتدای بدن و در جلو صاف، استایلت رشد یافته با مجرای مشخص به طول ۱۵/۱-۱۶/۶ میکرومتر و فاقد گره یا تورم‌های انتهایی، منفذ دفعی در فاصله کمی بیش از طول حباب میانی عقب‌تر از آن، منخرج و راست روده نامشخص، انتهای بدن مخروطی کشیده که به انتها باریک‌تر می‌شود، نرها دارای پاییل منفرد (P1)، جفت سوم (P3) و چهارم (P4)، آلت نرینه خمیده و جدا از هم به طول ۷ تا ۱۰ میکرومتر با کوندیلوس رشد یافته و دم با یک زائده کوتاه در انتها مشخص می‌شود. گونه جدید از نظر ریخت‌شناسی با گونه‌های مشابه با اندازه‌ی کوچک از جنس *Ektaphelenchus* دارای سه شیار طولی، انتهای بدنه مخروطی و استایلت فاقد گره به نام‌های *E. apophysatus*، *E. joyceae* و *E. taiwanensis* مقایسه شد. علاوه بر آن، با گونه‌های *E. goffarti* و *E. olitorius* که دارای شکل انتهایی بدن ماده مشابه و تعداد شیارهای طولی نامشخص بودند و هم‌چنین دو گونه *Seinura informis* و *S. paratenuicaudata* به دلیل نداشتن منخرج مقایسه شد.

واژه‌های کلیدی: استان گلستان، داده‌های ریخت‌سنجی، شکارگر، تاکسونومی

## Introduction

The genus *Ektaphelenchus* Fuchs, 1937, with *E. hylastophilus* (Fuchs, 1930) Skrjabin, Shikhobalova, Sobolev, Paramonov & Sudarikov, 1954, as the type species, belongs to the subfamily Ektaphelenchinae Paramonov 1964. Until now, *Ektaphelenchus* comprises 33 valid species, that have been reported from different countries of Europe, USA and Asia (Hunt, 2008; Alvani *et al.*, 2016; Miraeiz *et al.*, 2017; Golhasan, 2019; Pedram, 2019; Gu *et al.*, 2019a,b, 2021; Heydari and Pedram, 2021). Some species have been isolated from pod-like or cocoon-like structures on the dorsal membranous wings of bark beetles, and some are insect-related or predator (Kanzaki and Giblin-Davis, 2012). Most of the previously described species lack light microscopic figures or have been poorly described. So far, five species have been described from Iran, namely, *E. berbericus* Alvani, Mahdikhani-Moghadam, Giblin-Davis & Pedram, 2016, *E. oleae* Miraeiz, Heydari, Adeldoost & Ye, 2017, *E. cupressi* Golhasan, Abdollahpour, Fang, Abolafia & Heydari, 2019, *E. kanzakii* Pedram, 2019 and *E. masseyi* Heydari & Pedram, 2021. During samplings at natural forests of northern Iran in 2019, an ektaphelenchid nematode population was recovered from decaying bark and wood samples collected from the forests of Golestan province. It was assigned to the genus *Ektaphelenchus* by females lacking functional rectum and anus, having well-developed stylet and conical posterior body end. Detailed morphological comparisons with typologically similar species under the genus, and further comparison with all known *Seinura* spp., revealed it to be a new species. Herein, it is described and illustrated as *Ektaphelenchus golestanensis* n. sp. by using morphological and morphometric characteristics.

## Materials and Methods

Several wood and bark samples were collected from the forests of Golestan province in northern Iran. The samples were mostly taken from dead and fallen trunks and were stored in a cold room until nematode extraction. The nematodes were extracted from the samples using tray method (Whitehead and Hemming, 1965). Nematodes of interest were handpicked under a Nikon SMZ1000

stereomicroscope, heat-killed by adding hot 4% formalin solution, transferred to anhydrous glycerin according to de Grisse (1969), mounted on permanent slides, and examined using a Nikon Eclipse E600 light microscope. Photographs were taken using an Olympus DP72 digital camera attached to an Olympus BX51 microscope with differential interference contrast (DIC). Drawings were made using a drawing tube attached to the microscope and were digitally drawn using Corel DRAW software version 17.

## Results

*Ektaphelenchus golestanensis* n. sp.

## Description

### Female

Small sized. The body is slender, slightly ventrally arcuate after heat relaxation, gradually tapering towards both ends, more towards the posterior body end. Cuticle is finely annulated. Lateral field with three lines at mid-body. Cephalic region is offset by a shallow depression, flat in the anterior end. Stylet well developed, its lumen distinct, lacking conophore, basal knobs or swellings. Procorpus cylindrical, metacarpus strongly developed, oval with posteriorly located valve. Dorsal pharyngeal gland orifice opens into the lumen of metacarpus *ca.* one metacarpal valve length anterior to metacarpal valve. Pharyngo-intestinal junction just posterior to metacarpus. Nerve ring 8-10  $\mu$ m posterior to median bulb base. Pharyngeal glands well developed, dorsal one forming a remarkably long overlap over the intestine. Excretory pore between nerve ring and metacarpus base, sometimes slightly posterior to the base of metacarpus. Hemizonid 5-6  $\mu$ m posterior to excretory pore. Reproductive system monoprodelphic, ovary outstretched, its

tip sometimes reaching dorsal pharyngeal gland, oocytes mostly in two rows, oviduct tubular, visible in some individuals, spermatheca elongate, crustaformeria thick-walled, uterus spacious, vagina anteriorly directed, post-vulval uterine sac (PUS) 1.9-2.1 times as vulval body diameter. The posterior body end conical with a narrower distal end. Rectum and anus absent.

### Male

Body slightly shorter than that of female, J-shaped when heat-relaxed. Cuticle and the cephalic region similar to those of female. Genital system monorchic. Spicules paired, aphelenchoid-type, condylus well developed, large, wide, blunt at the tip, rostrum short, a small barely visible projection between condylus and rostrum tip was observed. Gubernaculum and bursa absent. The single precloacal papilla (P1) anterior to the cloaca, the second cloacal pair (P2) lacking, and the third and fourth caudal pairs (P3 and P4) posterior to mid-tail. Tail conical, dorsally convex, ventrally flat with a small mucron-like differentiation at terminus.

### Type host and locality

*Ektaphelenchus golestanensis* n. sp. was recovered from wood and bark samples collected from the natural forests of Golestan province in northern Iran, in October 2019. GPS coordinates: 36°44.579N, 54°19.144E.

### Etymology

The specific epithet refers to the Golestan province, the locality where the new species was originally recovered.

### Type material

Holotype female, nine paratype females, and four paratype males were deposited at the Nematode Collection of the Faculty of Agriculture, Tarbiat Modares University, Tehran, Iran. The ZooBank Life Science Identifier (LSID) for this publication is as follows: AB4E9C61-B9C9-4D8F-952B-E534D18738EA

### Diagnosis and relationships

*Ektaphelenchus golestanensis* n. sp. is mainly characterized by its small body size, 347-378  $\mu\text{m}$  long, representing the currently known smallest species of the genus, a cephalic region separated from the body by a depression, three lines in lateral field, stylet 15.1-16.6  $\mu\text{m}$  long in females lacking basal knobs, rectum and anus absent, posterior body region conoid with a sharp or finely rounded terminus, and males having a dorsally convex conoid tail with a mucron-like differentiation, spicules 7-10  $\mu\text{m}$  long (arc) with well developed, large and wide condylus.

It is typologically comparable to similar species of the genera *Ektaphelenchus* and *Seinura* Fuchs, 1931 having a not knobbed stylet, similar posterior body end in females, three

or unknown incisures in the lateral field, and small body size as follows:

*Ektaphelenchus golestanensis* n. sp. can be differentiated from *E. apophysatus* Gu, Munawar, Palomares-Rius & Castillo, 2021 by shorter females (347-378 vs. 509-626  $\mu\text{m}$ ), longer stylet (15.1-16.6 vs. 11.6-15.4  $\mu\text{m}$ ), common type stylet (vs. tripartite), smaller a value (25-30 vs. 36.8-48.9) and posterior body end in females conical with narrower distal end (vs. smoothly conical) and distal tip of spicules simple (vs. apophysate).

It differs from *E. joyceae* Kaisa, Harman & Harman, 1995 by shorter females (347-378 vs. 550-740  $\mu\text{m}$ ), lower a value (25-30 vs. 29-44), lower b value (5.6-6.8 vs. 7-13),

longer PUS (1.9-2.1 times vs. less than one vulval body width long), narrower distal body end and shorter spicules (7-10 vs. 13-14  $\mu\text{m}$ ).

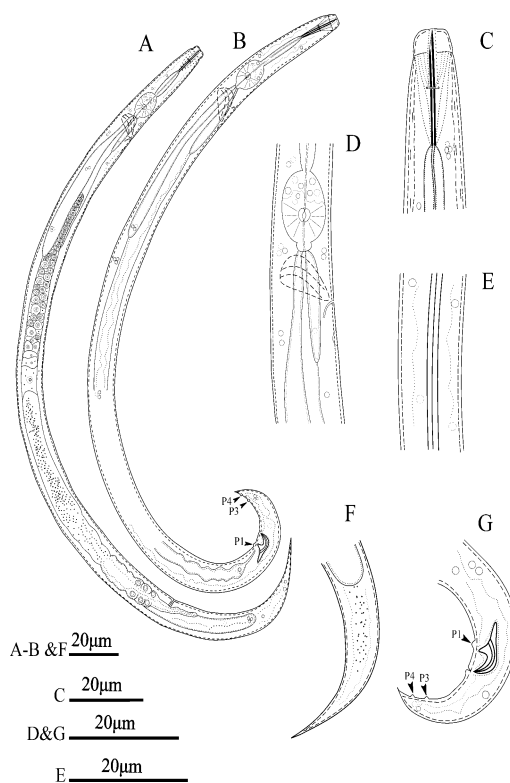
It differs from *E. taiwanensis* Gu, Wang & Chen, 2013 by shorter females (347-378 vs. 482-661  $\mu\text{m}$ ), lower b value (5.6-6.8 vs. 7.2-9.6), shorter spicules (7-10 vs. 12.5-14.4  $\mu\text{m}$ ), narrower distal body end and number and arrangement of caudal papillae (having single P1, P2 lacking and P4 present vs. P1 paired, P2 present and P4 lacking).

It differs from *E. goffarti* Rühm, 1956, a species with unknown lateral lines number, by shorter females (347-378 vs. 547-701  $\mu\text{m}$ ), a slightly offset cephalic region (vs. offset), females with a shorter stylet (15.1-16.6 vs. 19-20  $\mu\text{m}$ ) lacking knobs (vs. present), lower b value (5.6-6.8 vs. 10.3-11.6) and presence of PUS (vs. absence).

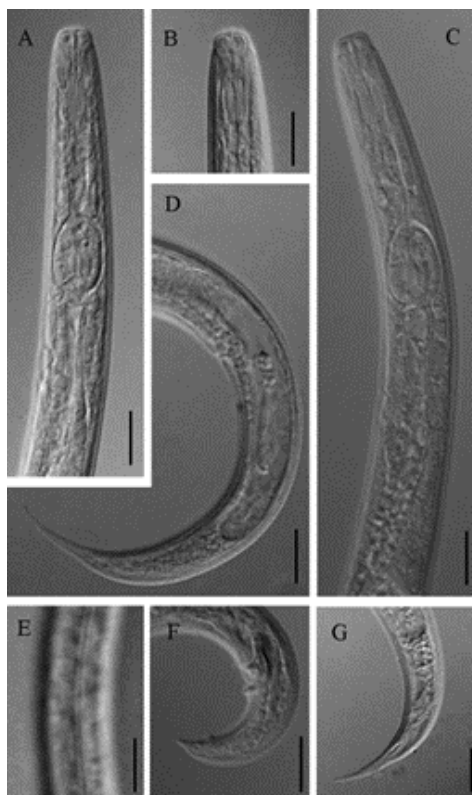
It differs from *E. olitorius* (Chaturvedi and Khera, 1977) Baujard, 1984 by slightly shorter females (347-378 vs. 480-550  $\mu\text{m}$ ), shorter stylet (15.1-16.6 vs. 21-22  $\mu\text{m}$ ) and longer PUS (1.9-2.1 times vulval body diameter long vs. rudimentary).

It differs from *Seinura informis* Gagarin, 2001 by shorter females (347-378 vs. 430-536  $\mu\text{m}$ ), shorter stylet (15.1-16.6 vs. 20-21  $\mu\text{m}$ ), shorter spicules (7-10 vs. 14-15  $\mu\text{m}$ ), P2 lacking (vs. present), male tail with a terminal mucron vs. lacking and rectum and anus absent (vs. present).

It differs from *S. paratenuicaudata* Geraert 1962 by shorter females (347-378 vs. 460-510  $\mu\text{m}$ ), shorter stylet (15.1-16.6 vs. 17-20  $\mu\text{m}$ ) and PUS length (13-16 vs. 8-10  $\mu\text{m}$ ).



**Fig. 1.** Line drawings of *Ektaphelenchus golestanensis* n. sp. A & B: Female and male entire body; C: Female anterior body region; D: Part of the male pharyngeal region; E: Lateral field; F: Female posterior body region; G: Male posterior body region (arrows pointing the genital papillae).



**Fig. 2.** Light microphotographs of *Ektaphelenchus golestanensis* n. sp. A & C: Female anterior body region and pharynx; B: Female anterior body end; D & G: Female posterior body region; E: Lateral field; F: Male posterior region and spicules (Scale bars = 10 µm).

**Table 1.** Morphometrics of *Ektaphelenchus golestanensis* n. sp. All measurements are in  $\mu\text{m}$  and the form mean  $\pm$  SD (range).

Characters	Females		
	Holotype	Paratype	Males
<b>n</b>	1	9	4
<b>L</b>	368	365 $\pm$ 10 (347-378)	337 $\pm$ 15.6 (326-360)
<b>a</b>	28.0	27.3 $\pm$ 1.7 (25-30)	32.2 $\pm$ 2.9 (30-36)
<b>b</b>	5.9	6.1 $\pm$ 0.4 (5.6-6.8)	6.0 $\pm$ 0.5 (5.4-6.5)
<b>c</b>	–	–	13.5 $\pm$ 0.8 (12.4-14.4)
<b>c'</b>	–	–	2.6 $\pm$ 0.3 (2.4-3.0)
<b>T or V</b>	76.1	78.1 $\pm$ 1.3 (76.0-79.5)	22.1 $\pm$ 3.1 (19.2-25.4)
<b>Cephalic region diameter</b>	6.0	6.0 $\pm$ 0.1 (6.0-6.3)	6.0 $\pm$ 0.8 (5.0-7.0)
<b>Cephalic region height</b>	4.0	4.0 $\pm$ 0.4 (3.5-5.0)	4.0 $\pm$ 0.8 (3.0-5.0)
<b>Stylet length</b>	15.9	15.8 $\pm$ 0.6 (15.1-16.6)	14.7 $\pm$ 1.0 (14-16)
<b>Median bulb length</b>	15	14.1 $\pm$ 0.8 (13-15)	13.0 $\pm$ 0.8 (12-14)
<b>Median bulb diameter</b>	9	8.6 $\pm$ 0.5 (8-9)	8.5 $\pm$ 1.3 (7-10)
<b>Pharynx</b>	62	59.9 $\pm$ 2.2 (55-62)	56.3 $\pm$ 3.8 (52-61)
<b>Anterior end to end of pharyngeal glands</b>	69	65.3 $\pm$ 7.4 (62.5-75.9)	60.9 $\pm$ 3.2 (56-62.9)
<b>Excretory pore from the anterior end</b>	60	58.8 $\pm$ 2.3 (53.0-60.8)	56.3 $\pm$ 2.5 (54-59)
<b>Anterior end to vulva</b>	280	284.4 $\pm$ 7.9 (272-298)	–
<b>Anterior end to anus or cloacal aperture</b>	–	–	311.7 $\pm$ 14.5 (302-333)
<b>Post-vulval uterine sac (PUS)</b>	15	14.7 $\pm$ 1.1 (13-16)	–
<b>Spicules (arc)</b>	–	–	7.8 $\pm$ 1.5 (7-10)
<b>Tail length</b>	–	–	25.0 $\pm$ 1.4 (24-27)

Abbreviations: L = total body length, a = body length/greatest body diameter, b = body length/pharynx, c = body length/tail length, c' = tail length/tail diameter at anus or cloacal aperture, V = position of vulva from the anterior end as a percent of the body length (Siddiqi, 2000)

## Remarks

According to Miraeiz *et al.* (2017) and Heydari and Pedram (2021), populations typologically resembling *Seinura* and three *ektaphelench* genera (*Ektaphelenchus*, *Ektaphelenchoides* Baujard, 1984 and *Devibursaphelenchus* Kakulia, 1967), need to be compared with all species under those genera. According to original descriptions, some species under *Seinura* e.g., *S. citri* (Andrássy, 1957) J.B. Goodey, 1960, *S. demani* (T. Goodey, 1928) J.B. Goodey, 1960, *S. oahueensis* (Christie, 1939) J.B. Goodey, 1960, and

*S. obscura* Grewal, Siddiqi & Atkey, 1992 lack functional rectum and anus, and by lacking molecular data from their topotypes, their placement under *Seinura* is questionable. Based on recent studies, *Seinura* could be monophyletic (Gu *et al.*, 2020; Kanzaki *et al.*, 2021).

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