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Research Article

First record of occurrence of the genus *Oesophagomermis* Artyukhovsky, 1969 (Nematoda: Mermithidae), a terrestrial mermithid from Iran, with an updated identification key for its species

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Abstract. During a survey conducted to study the mermithid fauna in the rangelands of Jolfa County in East Azarbaijan province of Iran, a population belonging to the genus *Oesophagomermis* was recovered. The specimen is characterized by its 8.60-11.60 mm long body, six cephalic papillae; no lip papillae; absence of cuticular recess at the frontal end; cuticle with very fine cross fibers; oral opening central and terminal; head rounded and 30-36 µm broad; amphidial fovea pocket-shaped; six hypodermal cords at mid-body; pharynx long, passes through the entire body, almost reaching near the trophosome end; female reproductive system didelphic-amphidelphic; vulva oblique, at 54-57% of body length; vagina S-shaped, 75-135 µm long, twisted in one plane, posterior loop is smaller in length than anterior loop; young female tail conical with the appendage of the previous molt stage; postparasitic juveniles with tail appendage, conoid and long. The newly collected population from Iran was compared with four previously known species of the genus, the Iranian population could mainly be separated based on presence of a long and conoid appendage in tail tip of post-parasitic juvenile. However, due to the lack of adult females and males as well, it was not identified up to the species level and therefore, the population is considered as *Oesophagomermis* sp.

Keywords: Description, morphology, morphometrics, taxonomy.

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Introduction

Although steinernematids have recently attracted greater commercial and scientific attention, mermithids continue to be studied intensively for potential or actual biocontrol applications (Holovachov & De Ley, 2006). Mermithid nematodes are obligate endoparasites of Arthropoda, especially insects. They are usually considered host-specific at the host species or host family level. Species parasitizing mosquitoes have probably been the most studied, as they can be used as biological agents to control their host populations (Martinet *et al.,* 2023).

Artyukhovsky (1969) proposed the genus *Oesophagomermis* with *O. terricola* (*Mermis terricola* Hagmeier, 1912) as its type species and placed it in the family Mermithidae Braun, 1883 to accommodate *O. brevivaginata* Artyukhovsky & Khartschenko, 1969 and *O. paramonovi* (Pologenzev & Artyukhovsky, 1958) Artyukhovsky, 1969 in the family. According to Artyukhovsky (1969) *Oesophagomermis* species are distinguished by having six cephalic papillae; cuticle with very fine cross fibers; mouth terminal or slightly shifted to the ventrad; pharynx very long, passes through the entire body, almost reaching the head of the spicules; vagina cylindrical, S-shaped; spicules paired, tail dome-shaped and short; parasitic and postparasitic juveniles with small tail appendage. Later on, Rubtsov (1972) described the species, *Oesophagomermis coriacea*, which shows the main characters of the genus,

but has distinct cross fibers, which is different from other members of the genus. Currently, the genus *Oesophagomermis* contains four nominal species (Hodda, 2022).

A population of *Oesophagomermis* was collected in a study conducted on the mermithid fauna of the rangelands in Jolfa County, East Azerbaijan province, Iran, during 2021-2022. Therefore, the objective of the present contribution is the characterization of the population. This is the first report of the genus from Iran.

Material and Methods

Extraction and processing of nematodes

Several soil samples were collected from 10 to 40 cm depth in the active plant root zone of the rangelands. The nematodes were extracted by modified Brown and Boag (1988) tray method. Before that, 500 gr of soil sample was poured into a plastic pan and some water was added to the soil sample. After stirring the suspension, it was kept for 40 seconds to allow the soil particles to settle. This was repeated three times. Then, each time, the supernatant solution was slowly passed through 20, 60, 100, and 200 mesh sieves, respectively, and the contents of the sieves were collected in a beaker. To extract the nematodes from this suspension, a plastic basket measuring 29×29 cm, lined with a thin layer of paper towel was placed in a pan containing water, so that the water in the pan was continuously in contact with the bottom of the basket. In the next step, the collected contents of the sieves were slowly transferred into the basket. After 48 hours, the top basket was removed and the water in the pan was passed through a 400mesh sieve. The contents of the sieve, which contained the extracted nematodes, were then collected in a Petri dish. The extracted nematodes were killed and transferred to dehydrated glycerin, according to De Grisse (1969), and permanent microscopic slides were prepared.

Light microscopy and line drawings

Nematodes were measured and photographed using an Olympus BX41 microscope equipped with differential interference contrast optics, a drawing tube, and a DP50 digital camera. Line illustrations were prepared using CorelDRAW® software version 12. Raw photographs were edited using Adobe® Photoshop® CS.

Results

Oesophagomermis sp.

(Figs 1 & 2), (Table 1)

Material examined

Three young females and one postparasitic juvenile, in a good state of preservation.

Description

Young female: Medium-sized nematodes. Body cylindrical, tapering towards both ends, but more so towards the posterior extremity as the tail is conical, caudal end narrows after the trophosome. Upon fixation, habitus regularly curved ventrad to spiral shape. Body filled with brown trophosome. Cuticle with very fine cross fibers, 1.8-2.5 µm thick at anterior region and mid-body, and 2.5-4.5 µm on caudal region. Lip region rounded, continuous with body contour, 39-60% of body diam. at the level of nerve ring. Six cephalic (head) papillae at the same plane, no lip papillae. Oral opening central and terminal. Stoma small, thin, and slightly sclerotized in the front. Amphidial fovea pocket-shaped, its aperture 8-12 µm or 25-35% of lip region diam., amphidial pouches slightly posterior to lateral head papillae. Six hypodermal cords at mid-body. Nerve ring encircling the anterior part of pharynx, located at 1.7% of body length. Pharynxs long, passes through the entire body, almost reaching near the trophosome end. Cardia not seen, if present. Reproductive system didelphic-amphidelphic. Vulva oblique, post-equatorially, located at 54-57% of body length. Vagina S-shaped, twisted in one plane, posterior loop length smaller than anterior loop, in median length, muscular, extending inwards 31-53 µm, reaching more than 42-63% of body diam.

Table 1. Morphometrics of Oesophagomermis sp. from Iran. All measurements are in µm except L in mm.

Population	
Characters	Young females
n	3
Body length	10.00 ± 1.50 (8.60-11.60)
a	111.0 ± 22.8 (80-140)
V%	55.3 ± 1.5 (54-57)
Lip region diam.	32.6 ± 3.0 (30-36)
Body diam. at the level of nerve ring	67.6 ± 1.5 (50-85)
Body diam. at mid-body	96.0 ± 40.0 (70-145)
Distance from head to the nerve ring	203.0 ± 40.0 (150-250)
Length of vagina	103.0 ± 3.1 (75-100)
Width of vagina	48.0 ± 11.0 (30-65)
Body diam. at posterior end of the trophosome	57.0 ± 10.0 (50-70)

in lateral view and curved slightly at the distal portion where it meets the branches of the uterus. Eggs not seen. Tail conical, ventrally somewhat straight, dorsally convex conoid with the appendage remaining from the previous molt stage. Vestigial genital papillae obscure.

Male: Not found.

Postparasitic juvenile (n = 1): Body length 6.50 mm, nearly J shape upon fixation, with a small piercing tooth (stylet) three µm long, cuticle without cross fibers; cephalic papillae and amphids smaller than those of adults; tail end with a conoid and 45 µm long appendage.

Distribution

The specimens were collected from the rangelands of Jolfa County, East Azarbaijan province, Iran (GPS coordinates: N 38°92'10", E 45°67'14", altitude 750 m a.s.l.).

Discussion

In having a comparatively long and conoid appendage in tail tip of postparasitic juvenile (*vs* small spinous), the understudy population is easily distinguished from other members of the genus. But, currently, due to the lack of adult females and males in our population, it was not possible to identify up to the species level and therefore, at present, considered as *Oesophagomermis* sp.

Oesophagomermis sp. resembles *O. coriacea*, but clearly separated from the latter by the smaller body length (8.60-11.60 *vs* 38 mm), narrower lip region (30-36 *vs* 45 µm width), posterior position of vulva (54-57% *vs* 50%), vagina shape and dimensions (S-shaped and 75-135 × 30-65 µm *vs* V-shaped and 600 × 75 µm), and narrower mid-body diam. (70-145 *vs* 280 µm). Furthermore, the under-study population differs from *O. terricola* by the shape of anteriormost part of body (absence *vs* presence of cuticular recess at the top of the head), terminal oral opening (*vs* slightly shifted ventrally, in the type population) and absence of males. *Oesophagomermis* sp. is distinguished from *O. brevivaginata* by the presence (*vs* absence) forward-directed first knee of the vagina, inconspicuous (*vs* conspicuous) collar, and absence of males.

No relevant new information on the genus *Oesophagomermis* has been available for the past five decades, and the available descriptions are in Russian and in compressed and incomplete form. The species of the genus *Oesophagomermis* are all terrestrial mermithids and have only been reported from Russia, so, have a limited distribution and have not been found in other parts of the world. Its insect hosts are unknown (Rubtsov, 1978). Despite several attempts to find its host and adults, the results were frustrated and its possible host(s) and adults remain to be collected and identified. The genus *Oesophagomermis* is distinguished from other genera of mermithids by having six cephalic papillae; head rounded; amphids medium-sized; cuticle with very fine cross fibers; mouth terminal or slightly shifted to the ventrad; pharynx very long, passes through the entire body, almost reaching the head of the spicules; six hypodermal chords; vulva oblique; vagina cylindrical, S-shaped, short and thick; spicules paired, medium sized, curved, with pointed tips; tail dome-shaped and short; parasitic and postparasitic juveniles with small tail appendage.

With six head papillae, oblique vulva, S-shaped, short vagina, and paired spicules, representatives of the genus *Oesophagomermis* come close to the species of the genera *Isomermis* Coman, 1953 and *Quadrimermis* Coman, 1961. But with a long pharynx, almost reaching the beginning of the spicules, it could be separated from the mentioned latter genera. Furthermore, *Oesophagomermis* differs from the genera *Isomermis* and *Quadrimermis* by the presence of six (*vs* eight) hypodermal chords in the mid-body; in addition compared with the genus *Quadrimermis* by anterior (*vs* posterior) location of the amphids and short dome-shaped tail (Artyukhovsky, 1969).

Type species

Oesophagomermis terricola (Hagmeier, 1912) Artyukhovsky, 1969

Syn. *Mermis terricola* Hagmeier, 1912

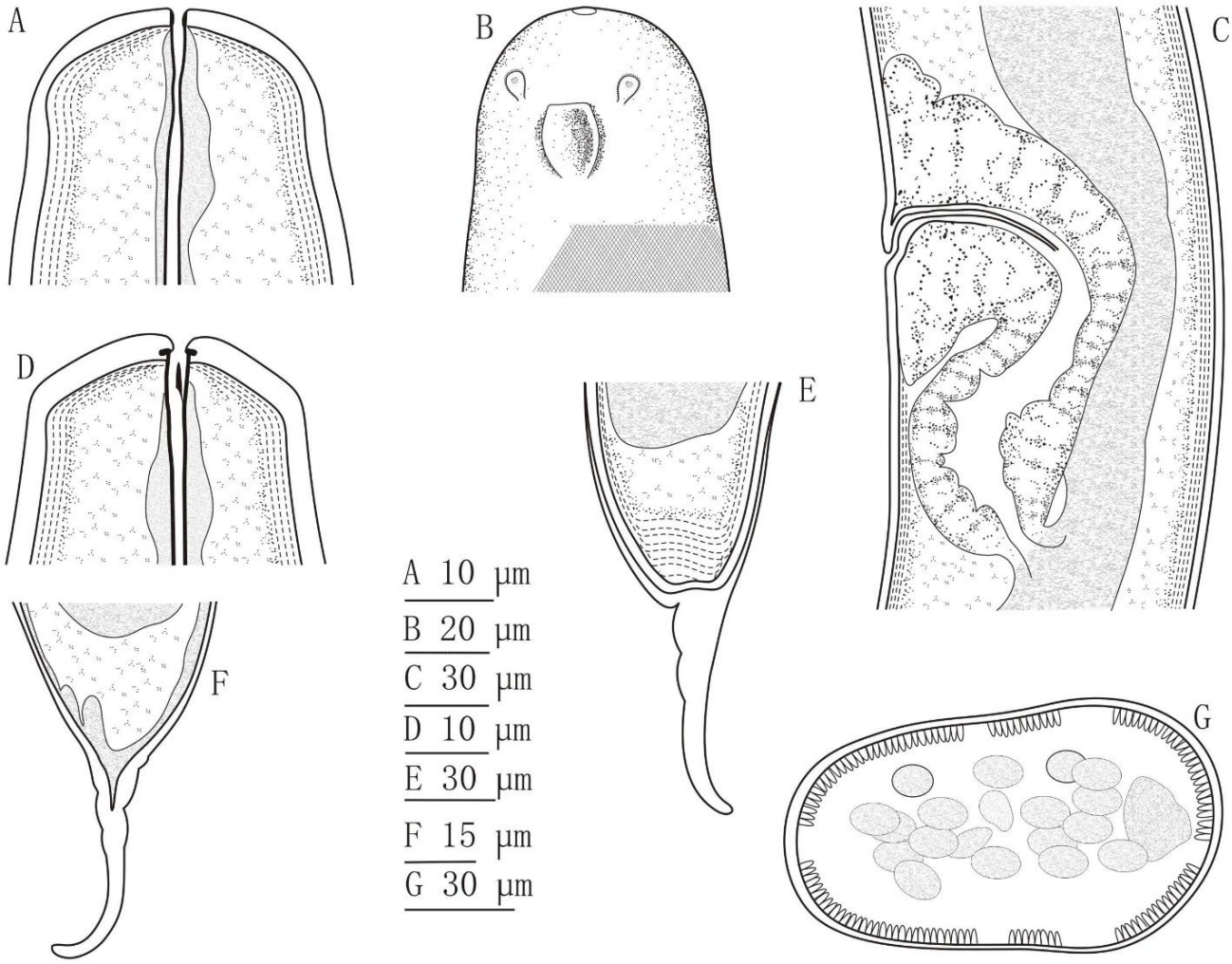

Fig. 1. *Oesophagomermis* sp. A: Young female anterior region in lateral median view; B: Young female anterior region in lateral surface view; C: Vulval region and vagina; D: Post-parasitic juvenile anterior region in lateral median view; E: Young female caudal region; F: Post-parasitic juvenile caudal region; G: Young female cross section, mid-body.

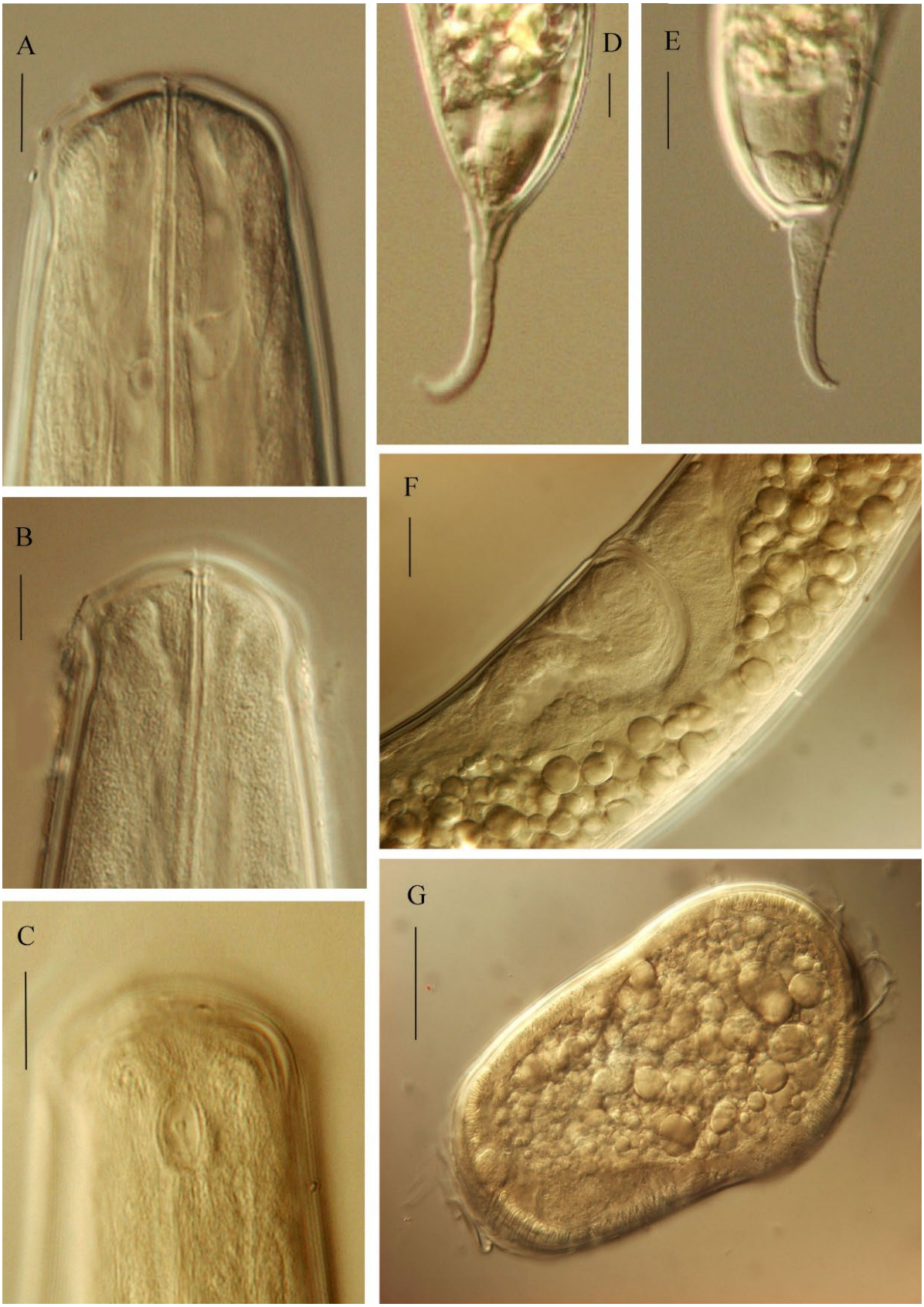

Fig. 2. *Oesophagomermis* sp. A: Young female anterior region in lateral median view; B: Post-parasitic juvenile anterior region in lateral median view; C: Young female anterior region in lateral surface view; D: Post-parasitic juvenile caudal region; E: Young female caudal region; F: Vulval region and vagina; G: Young female cross section, mid-body. (Scale bars: A, B and D = 10 µm; C = 20 µm; E-G = 30 µm).

Other valid species

O. brevivaginata Artyukhovsky & Khartschenko, 1969

O. coriacea Rubtsov, 1972

O. paramonovi (Pologenzev & Artyukhovsky, 1958) Artyukhovsky, 1969

Key to the species identification of the genus *Oesophagomermis* (modified after Artyukhovsky, 1969)

1- Cuticle with distinct cross fibers; vagina V-shaped …….....…….. *coriacea*
Cuticle with very fine cross fibers; vagina S-shaped …….....…….....…… 2
2- Long and narrow appendage in tail tip of postparasitic juveniles ……..…… *Oesophagomermis* sp.
Small spinous appendage in tail tip of postparasitic juveniles ……..…….. 3
3- The oral opening is located in the cuticular recess of the head; the 1st knee of the vagina is fused along its entire length with the 2nd knee and makes up about 1/3 of its length. ……...……...…… *terricola*
The cuticular recess at the top of the head is absent, the 1st knee of the vagina is not visible……..….. 4
4- The inner part of the head is apically elongated, forming a high collar covering the distal end of the esophagus (the length of the vestibulum and the height of the collar are almost the same) ……..…….....……..…… *brevivaginata*
The collar is inconspicuous, its height is significantly less than half the length of the tubular vestibulum……..……...…… *paramonovi*

Author's Contributions

Nasir Vazifeh: Soil sampling, preliminary identification of the specimens and preparation of the first draft; **Gholamreza Niknam**: Identification of the genus, manuscript review and revision at various stages; and **Nora B. Camino**: Final identification and approval of the genus.

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Data Availability Statement

The specimens examined in this study are deposited in the Nematode Collection of the Department of Plant Protection, College of Agriculture, University of Tabriz, Tabriz, Iran, and are available by the curator upon request.

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Ethics Approval

All applicable international, national, and institutional guidelines for the care and use of animals were followed. This article does not contain any studies with human participants performed by the author.

Conflict of Interest

No conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

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Research Article

اولین گزارش از وجود *Oesophagomermis* Artyukhovsky 1969 (Nematoda: Mermithidae) در ایران، جنسی از mermithid های خاکزی، همراه با کلید شناسایی به روز شده برای گونه‌های آن

نصیر وظیفه[1]، غلامرضا نیکنام[1] و نورا بی کامینو[2]

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چکیده: طی بررسی انجام شده به منظور بررسی فون mermithid های مراتع شهرستان جلفا در استان آذربایجان شرقی- ایران، جمعیتی متعلق به جنس *Oesophagomermis* به‌دست آمد. این جمعیت دارای بدنی به طول ۸/۶۰ تا ۱۱/۶۰ میلی‌متر، شش پاپیل سری؛ فاقد پاپیل لبی؛ عدم وجود فرورفتگی پوستی در بالای سر؛ پوست با شیارهای متقاطع بسیار ظریف؛ منفذ دهان مرکزی و انتهایی؛ سر گرد و عرض آن ۳۰ تا ۳۶ میکرومتر؛ آمفید کیسه‌ای‌شکل؛ دارای شش کورد هیپودرمی در وسط بدن؛ مری طوبل، در کل طول بدن امتداد داشته و تقریباً به انتهای تروفوزوم می‌رسد؛ سامانه جنسی دو شاخه؛ فرج خمیده و در ۵۴–۵۷ درصدی طول بدن؛ واژن S شکل و عمق آن ۷۵ تا ۱۳۵ میکرومتر، پیچ خورده در یک سطح، حلقه عقبی از نظر طول کوچک‌تر از حلقه جلویی؛ دم ماده جوان مخروطی با زائده باقی مانده از مرحله پوست اندازی قبلی. لارو پس از مرحله انگلی دارای زائده مخروطی و بلند در دم. جمعیت تحت بررسی با چهار گونه شناخته شده قبلی این جنس مقایسه شد که جمعیت به دست آمده از ایران با داشتن زائده مخروطی و بلند در دم لارو پس از مرحله انگلی از بقیه اعضای جنس متمایز می‌گردد. اما به دلیل عدم وجود افراد ماده و نر بالغ، این جمعیت در حد گونه شناسایی نگردید و به عنوان *Oesophagomermis* sp. در نظر گرفته شد.

کلمات کلیدی: آرایه بندی، توصیف، ریخت‌سنجی، ریخت‌شناسی

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