

# Morphology of a new species of water mites *Linobia porosa* (Astigmata, Linobiidae) collected from roots of floating plant, *Eichhornia crassipes*

Somaia A. Ramadan, Marwa M. Abd-Elrady, Asmaa N. Mustafa\*

Zoology Department, Faculty of Science, Sohag University, Sohag 82524, Egypt

\*Email: [asmaa.ahmed1@science.sohag.edu.eg](mailto:asmaa.ahmed1@science.sohag.edu.eg)

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**Abstract:** The adult specimens of the water mite *Linobia porosa* were collected from the roots of the floating aquatic plant *Eichhornia crassipes* in the Nile River, Sohag Governorate, Egypt. The morphological characters of the present species align with those of the family Linobiidae and the genus *Linobia*. The specific characters of the present species were compared with those of other published species of the same genus. These characters are summarized as follows: The body is broadly oval-shaped with a triangular rostral shield. The fixed digit of each chelicera bears three serrated setae and two simple setae behind its movable digit. The palpal tarsus is inverted trapezoidal in shape and carries ten setae and five solenidia of varying sizes. The propodosomal region bears a long simple sensory seta, a pair of serrated setae, and three exobothridial setae. The hysterosomal region is adorned with raised circular warts and consists of seven plates (five central, one lateral, and one opisthosomal). The central plates are guarded by a row of circular pores. The lateral plate is inverted U-shaped and bears two pairs of tiny simple setae, while the opisthosomal plate carries a pair of simple setae, a pair of opisthosomal glands, and a group of scattered pores.

**Keywords:** Water mites; Linobiidae; *Linobia*; *Eichhornia crassipes*

## 1. Introduction

Numerous species of water mites are found on the surface of stagnant water bodies, such as ponds and lakes, and they also remain attached to aquatic and submerged vegetation [1]. Astigmata is a megadiverse lineage of mites that has spread into a wide range of ecosystems by forming relationships with both vertebrate and invertebrate hosts [2–5]. The suborder Astigmata is a clade of mites belonging to the order Sarcoptiformes [6,7].

In general, astigmatid mites are soft-bodied, white to brownish in color, and devoid of peritremes or stigmatal openings. Their gnathosoma consists of a pair of chelicerae, which are usually chelate-dentate in shape. The opisthosomal glands are present and typically well-developed [8,9]. Mites in the genus *Linobia* and the family Linobiidae Oudemans, 1908, have broadly oval-shaped bodies, chelate-dentate chelicerae, simple palpi, and empodial components that are usually clawed [8].

To the authors' knowledge, only four species of the genus *Linobia* have been formally described: *Linobia coccinellae* (Scopoli) from Italy [10], a parasite of ladybird beetles (Coccinellidae), and three additional species—*L. nilotica*, *L. rplacementica*, and *L. eichhornia*—reported from the roots of the floating plant *Eichhornia crassipes* in the Nile River near Sohag, Egypt [11]. This study aims to identify and describe a new astigmatid mite species, *Linobia porosa*, collected from the roots of *Eichhornia crassipes* in a small bay of the Nile River, approximately 7 km from Tahta City in Sohag Governorate, Egypt.

## 2. Materials and methods

### 2.1. Collection Site

The collection site is a narrow irrigation channel that branched from the western bank of the Nile River, located approximately 7 km from Tahta City in Sohag Governorate, Egypt (31° 30' 16.7" N and 49° 26' 5" E). The area was fully sun-exposed and subject to wind currents, with a muddy-sandy substrate, slow water flow, and dense stands of the floating aquatic plant *Eichhornia crassipes* (Fig. 1).

### 2.2. Sampling

Adult specimens of the newly discovered species were collected from the roots of the floating aquatic plant *Eichhornia crassipes* between January and December 2024. The root samples were transported to the laboratory in plastic containers, carefully cut into smaller pieces, and processed using the Baermann wet funnel extraction technique to separate adult mites. The collected specimens were preserved in 70% ethyl alcohol with 5% glycerol for initial storage and subsequently mounted in Hoyer's medium for further examination.

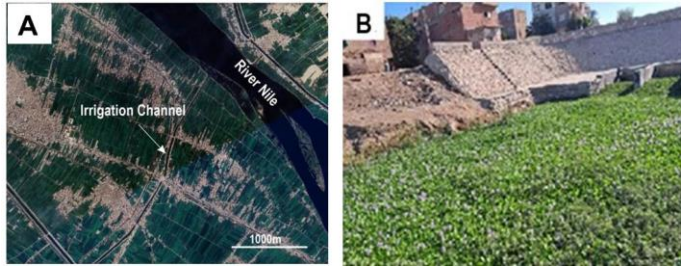
For scanning electron microscope (SEM) studies, standard SEM processing schedules were applied [12]. The paratype specimens were viewed under a JEOL 5300 Scanning Electron Microscope at an operating voltage ranged from 10-30V. Drawings were made with a camera Lucida attached to a research microscope and the measurements (in µm) were taken by means of micrometer eye piece.

### 2.3. Identification

The present species identified according to the keys of [4,8,11,13]. Abbreviations of the mite setae are reported according to [4,14,15].

**Types deposition:** Holotype and paratypes of the present

species are deposited in the Zoology Department, Faculty of Science, Sohag University.



**Fig.1. A:** A Google map showing the location of the collection site (irrigation channel) about 7 km from Tahta city, Sohag Governorate; **B:** a photograph showing the host plant *Eichhornia crassipes* floating on the water surface of the channel.

3. Results

*Linobia porosa* sp. nov.

3.1. Diagnosis

The adult of the present species is characterized by a broad oval-shaped body. Rostral shield is triangular in shape with two pairs of serrated setae (ro1-ro2). The dorsal surface of idiosoma is divided into two parts: propodosoma and hysterosoma. The two parts of idiosoma separated by slightly straight line. The hysterosomal margin carries four pairs of trichobothria (t1-t4) and two pairs of serrated setae (ps1-ps2). Genital opening is elongated in shape and with three genital discs. Legs with a single tibial sensory hair.

3.2. Description of the adult (Fig. 2A-G; Pls 1A-J, 2A-H, 3A-H)

**Holotype** - one adult, a narrow irrigation channel that branched from the western bank of the Nile River, about 7 km from Tahta City, Sohag Governorate, Egypt (31° 30' 16.7" N and 49° 26' 5" E).

**Paratypes** - 30 adults, same location, Table (1).

"The body of the newly described species is broadly oval in shape, exhibiting a white to brownish coloration. The body measures approximately 446 μm in length and 330 μm in width. Morphologically, the body comprises two distinct regions: the gnathosoma (mouthparts) and the idiosoma (Fig. 2A, B).

The rostral shield is smooth and triangular in shape, bearing two pairs of serrated setae (ro1-ro2). The gnathosoma consists of paired pedipalps and chelicerae. Each pedipalp is composed of five segments: the first segment is rectangular and the longest, carrying a single long, simple seta; the second segment is shorter than the first and carries a pair of simple setae; the third and fourth segments are nearly equal in size, bearing two and three setae respectively; the fifth palpal segment (tarsus) is shaped like an inverted trapezoid and possesses ten setae along with five solenidia of varying sizes (Fig. 2C).

Each chelicera is chelate-dentate with an oval base and consisting of two digits (one movable and one fixed) and a cheliceral fossa. Five setae (three serrated and two simple) are positioned on the lateral margins of the fixed digit and posterior to the movable digit (Fig. 2D).

**Table (1):** Morphometric measurements (μm) for 30 paratype specimens.

Body:	Length Width	Min.	Max.	Mean
		301 184	508 330	420 249
Genital area:	Length	29	52	41
	Width	21	36	27
Anal area:	Length	78	146	110
	Width	47	114	75
Trichobothria: length				
	t1	302	472	365
	t2	251	440	337
	t3	194	420	297
	t4	183	388	275
Legs: length				
	I	185	282	223
	II	166	234	200
	III	200	294	237
	IV	208	312	260

The hysterosoma is ornamented with raised warts and comprises seven dorsal plates, arranged as follows: five central plates (cp1–cp5), one lateral plate (lp), and one opisthosomal plate (op). The lateral edges of the central plates are bordered by a row of circular pores. The first (cp1), second (cp2), and fifth (cp5) central plates are nearly equal in size, with only cp1 bearing a pair of tiny, simple setae. In contrast, the third (cp3) and fourth (cp4) central plates are larger and each carries a pair of tiny, simple setae.

The lateral plate (lp) is inverted U-shaped and features two pairs of tiny, simple setae. The opisthosomal plate (op) is semicircular and possesses: a pair of simple setae, a pair of glands, a group of scattered pores, two pairs of serrated setae (ps1–ps2), and four pairs of trichobothria (t1–t4) (Fig. 2A). The trichobothrium (t1) is the longest one followed by t2, t3 and t4, respectively.

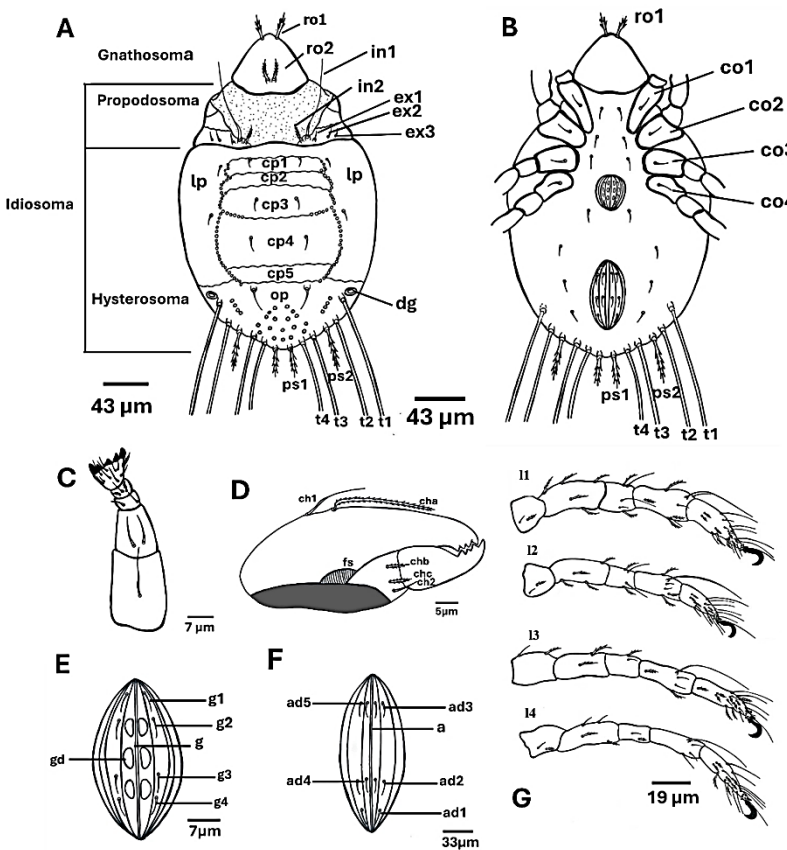
In the holotype specimen, the trichobothria (from outermost to innermost, t1–t4) measure approximately 320 μm, 301 μm, 291 μm, and 290 μm in length, respectively.

The ventral view of the present species displays seven pairs of simple setae along with distinct genital and anal areas. The simple setae are arranged with three pairs situated between the coxae of the legs and four pairs scattered around the anal opening (Fig. 2B). The genital opening is elongated in shape and contains three genital discs aligned in a longitudinal line, guarded by three pairs of genital valves. Each aggenital valve (ag) bears four small simple setae (g1–g4) (Fig. 2E), and the genital area measures approximately 47 μm in length and 27 μm in width.

The anal opening is similarly elongated and features three valves on each side: an outer valve lacking setae, a middle valve carrying three adanal setae (ad1–ad3), and an inner valve bearing two adanal setae (ad4–ad5) (Fig. 2F). The anal region measures about 114 μm in length and 86 μm in width. It should be noted that the anal area is larger than the genital one.

Each leg consists of six segments, all equipped with different types of setae, including both simple and serrated forms. The coxa of each leg possesses a single simple seta. Notably, the tibiae of the legs exhibit distinct long, whip-like sensory hairs,

while the tarsi terminate in claws (Fig. 2G). The lengths of legs I to IV are 195  $\mu$ m, 185  $\mu$ m, 208  $\mu$ m, and 247  $\mu$ m, respectively, showing that leg IV is the longest, followed by leg III, then leg I, and finally leg II.



**Fig. 2.** Camera Lucida drawings of adult, *Linobia porosa* sp. nov. showing A, dorsal view; B, ventral view; C, palp; D, chelicera; E, genital area; F, anal area; G, legs (I-IV).

4. Discussion

According to the diagnostic keys for family, genus, and species, the present species aligns with the morphological characters of the family Linobiidae, which typically exhibits a soft-bodied, white to brownish integument lacking stigmatal openings or peritremes. The gnathosoma comprises a pair of chelate-dentate chelicerae, and the opisthosomal glands are prominent and well-developed. The specimen under study displays a broad oval body, chelate-dentate chelicerae, simple palpi, and claw-like empodial elements on the legs, all of which conform to the genus *Linobia*.

The diagnostic characters of the species:

- 1- Type host: Floating aquatic plant, *Eichhornia crassipes*
- 2- Distribution of the host: a narrow irrigation channel that branched from the western bank of the Nile River, about 7 km from Tahta City, Sohag Governorate, Egypt.
- 3- Location of the parasite inside the host: Roots of *Eichhornia crassipes*.

The specific characters of the present species:

- 1. The body is broadly oval-shaped.

- 2. The rostral shield is triangular in shape and bears two pairs of serrated setae.
- 3. Three serrated setae are present on the lateral margin of the fixed cheliceral digit, while two simple setae are located behind the movable digit.
- 4. The palpal tarsus is inverted trapezoidal in shape and carries ten setae along with five solenoids of varying sizes.
- 5. The dorsal surface of the idiosoma is divided into two parts: the propodosoma (consisting of polygonal and triangular regions) and the hysterosoma, which are separated by a slightly straight line.
- 6. The polygonal region of the propodosoma is dotted and bears one pair of long sensory simple setae and one pair of serrated setae.
- 7. Each triangular region is smooth and carries three exobothridial setae.
- 8. The hysterosomal region is ornamented with raised circular warts and comprises seven plates (five central, one lateral, and one opisthosomal plate).
- 9. The five central hysterosomal plates are each bordered by a row of circular pores.
- 10. The lateral plate is inverted U-shaped and bears two pairs of tiny simple setae.
- 11. The opisthosomal plate is semicircular in shape and carries:
  - One pair of simple setae,
  - One pair of opisthosomal glands,
  - A group of scattered pores,
  - Two pairs of serrated setae,
  - And four pairs of trichobothria.

The diagnostic and specific characters of this species were compared with those of other congeneric species [11,16]. Comparative analysis revealed that the present species possesses distinct morphological features that differentiate it from all previously described members of the genus *Linobia*. Furthermore, this represents the first documented occurrence of a *Linobia* species inhabiting the roots of *Eichhornia crassipes* in the Nile River, Tahta City in Sohag Governorate. Based on these distinguishing characteristics and novel host-location association, we conclude that this specimen represents a new species, which we hereby add to the known species within this genus.

Unfortunately, sexual differentiation was not possible in the present specimens because the external genitalia were not clearly discernible.

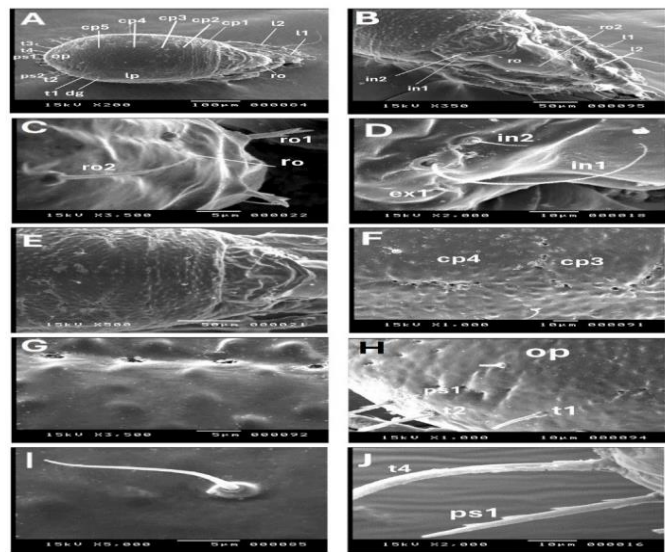
**Nomenclature of this species:** This species is named for the presence of pores on the dorsal side.

5. List of Abbreviations

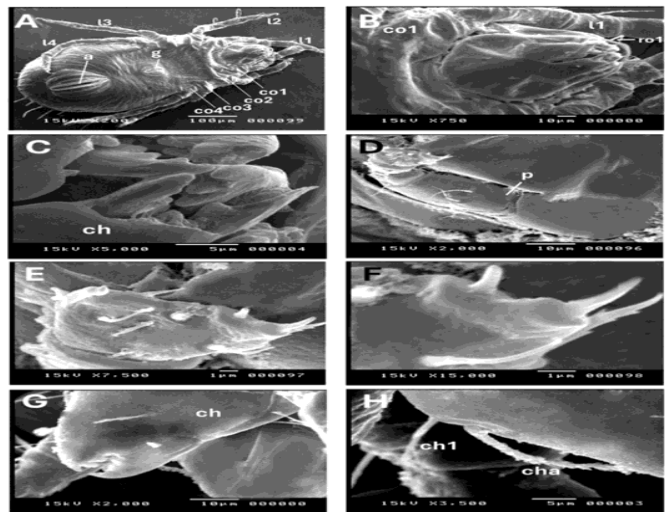
A	Anus	g1 -g4	genital setae
ad1 - ad5	adanal setae	Gd	genital disc
C	Claw	in1 – in2	interlamellar setae
Ch	Chelicera	II -I4	legs



ch1, ch2	cheliceral simple setae	lp	lateral plate
cha, chb, chc	cheliceral serrated setae	op	opithosomal plate
co1 - co4	coxae of legs	p	Palp
cp1 - cp5	central plates	ps1-ps2	Posterior serrated setae
Dg	dorsal gland	Ro	Rostrum
ex1-ex3	exobothridial setae	ro1-ro2	rostal setae
Fs	Fosa	t1 – t4	trichobothria
G	genital opening		

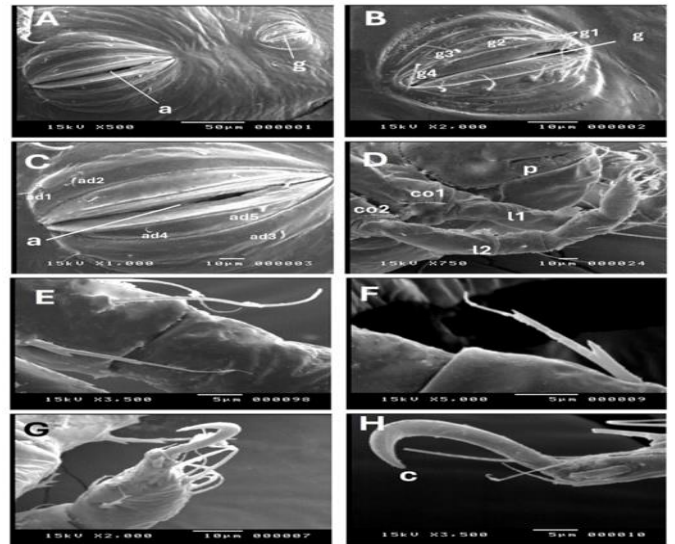


**Plate 1A-J:** Scanning electron micrographs of adult *Linobia porosa* sp. nov. showing: **A**, dorsal view; **B**, rostral shield; **C**, rostral setae; **D**, interlamellar setae; **E**, propodosomal region and dorsal plates; **F**, central plate 3 and 4 surrounded by circular pores; **G**, a row of circular pores; **H**, opithosomal plate; **I**, simple seta on dorsal plate and **J**, serrated setae and trichobothria.



**Plate 2A-H:** Scanning electron micrographs of adult *Linobia porosa* sp. nov. showing: **A**, ventral view; **B**, gnathosoma; **C**, chelicerae and mandible; **D**, palp; **E**, palpal tarsus; **F**, palpal solenidion and setae; **G**, chelicerae and **H**, cheliceral serrated setae.

*porosa* sp. nov. showing: **A**, ventral view; **B**, gnathosoma; **C**, chelicerae and mandible; **D**, palp; **E**, palpal tarsus; **F**, palpal solenidion and setae; **G**, chelicerae and **H**, cheliceral serrated setae.



**Plate 3A-H:** Scanning electron micrographs of adult female *Linobia porosa* sp. nov. showing: **A**, genital and anal region; **B**, genital region; **C**, anal region; **D**, leg l1 and l2; **E**, **F**, simple and serrated setae of legs; **G**, tarsus of leg l2 and **H**, claw of legs.

**CRedit authorship contribution statement:**

Somaia A. Ramadan suggested the idea and designed methodology. Marwa M. Abd-Elrady carried out the fieldwork, analyzed the data and photographed the specimens. Somaia A. Ramadan and Asmaa N. Mustafa were responsible for organizing, writing, and revision of the manuscript. The published version of the work has been reviewed and approved by all authors.

**Data availability statement**

All data analyzed in this manuscript is included in the published article.

**Declaration of competing interest**

The authors declare no competing interests.

**Ethical approval**

Specimens collection and handling were approved by the Committee for Scientific Research Ethics (CSRE), Faculty of Science, Sohag University, Sohag, Egypt (No. CSRE-11-24).

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