

First Description of Deutonymph Male of *Eustigmaeus anauniensis* (Canestrini) (Trombidiformes: Stigmaeidae)

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Abstract

With more than 130 species, *Eustigmaeus* Berlese is one of the most diverse genera in the family of Stigmaeidae. The genus has a worldwide distribution and is found in all zoogeographic regions with the exception of Antarctica. The adult female, adult male, deutonymph, protonymph, and larva of *Eustigmaeus anauniensis* (Canestrini) are known till now, but the immature male stage is unknown. In this study, five deutonymph male specimens of *E. anauniensis* were found in Türkiye. The description, illustrations of deutonymph males of *E. anauniensis*, and its measurements of some body parts were made. This is the first record of deutonymph male of *E. anauniensis*.

Keywords: Acari, first record, immature, mite, Türkiye

Eustigmaeus anauniensis'in (Canestrini) (Trombidiformes: Stigmaeidae) Erkek Deutonimfinin İlk Tanımı

Öz

Eustigmaeus Berlese, 130'dan daha fazla türle Stigmaeidae familyasının en çeşitli cinslerinden biridir. Bu cins, tüm dünyada geniş bir dağılıma sahip olup, Antarktika hariç bütün zoocoğrafik bölgelerde bulunur. Şu ana kadar *Eustigmaeus anauniensis* (Canestrini) türünün ergin dişi, erkek, deutonimf, protonimf ve larvası bilinmekte; ancak ergin olmayan erkek bireyleri bilinmemektedir. Bu çalışmada, *E. anauniensis*'in beş deutonimf erkek örneği Türkiye'den bulunmuştur. *E. anauniensis*'in deutonimf erkeklerinin tanımı yapılarak görüntüleri verilmiş ayrıca vücut parçalarının ölçümleri alınmıştır. *E. anauniensis*'in deutonimf erkekleri ilk defa bu çalışmada kaydedilmiştir.

Anahtar Kelimeler: Acari, ilk kayıt, olgunlaşmamış, akar, Türkiye

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1. Introduction

Members of the family Stigmaeidae live on plants, in soil, plant litter, mosses and lichens, feeding on a variety of small arthropods, and some of which have long been considered economically important predators of plant feeding mites [1-6]. The family Stigmaeidae currently contains more than 640 species within 33 valid genera [3, 4, 6, 7].

Mites of the genus *Eustigmaeus* Berlese are generally free-living but a few are parasitic on sand flies [8, 9]. *Eustigmaeus* is one of the largest genera of the Stigmaeidae. This genus comprises more than 130 species worldwide [3, 4, 6, 7], 28 of which have been reported from Türkiye [9, 10].

Eustigmaeus anauniensis was originally described by Canestrini (1889). Summers (1957) synonymised *Eustigmaeus granulatus* Wilmann, 1951 with *Raphygnathus pectinatus* (sic) Ewing, 1917. Afterwards, Wood in 1973, synonymised *Raphygnathus pectinatus* Ewing, 1917 with *E. anauniensis* (Canestrini, 1889), and he stated that the specimens named as *Ledermuelleria pectinata* (Ewing) by Marshall and Kevan (1964) belonged a separate species and described them as *Ledermuelleria collegiensis* Wood, 1972 [11-15]. Faraji et al. (2007) and Dönel and Doğan (2011) suggested that *E. kentingensis* Tseng, 1982 to be a synonym of *E. anauniensis* (Canestrini, 1889); however, this possibility was not supported by Fan et al. (2016) [3, 16-18].

Eustigmaeus anauniensis (Canestrini) is widely distributed and has been recorded from many countries including Türkiye [3, 4, 10]. This species can be recognized by having eyes, dorsal dimples with punctuations, dorsal body setae bushy, not bearing hyaline sheaths, setae c_2 similar other dorsal body setae, endopodal shields fused, femur II with four setae, three pairs of aggenital setae in female.

Undescribed deutonymph males of *E. anauniensis* were collected from Türkiye. The aim of this study is to describe deutonymph male of *E. anauniensis*.

2. Materials and Methods

The mite specimens were extracted by using Berlese-Tullgren funnels, cleaned in 60% lactic acid, mounted on microscope slides in Hoyer's medium, and viewed with a Leica DM 4000B microscope [1, 19]. The designations for idiosoma, palp and leg setae follow those of Grandjean (1944, 1946) and Kethley (1990) [20-22]. Leica Application Suite (LAS) Software Version 4.8 was used to take in micrometers (μm) the measurements, which were provided as a range. Setal formulae of leg segments are given with solenidia in parentheses. The examined specimens were deposited in EBYU (Acarology Laboratory of Erzincan Binali Yıldırım University, Erzincan, Türkiye).

3. Results

Eustigmaeus anauniensis (Canestrini, 1889) (Figures 1-12)

Raphignathus anauniensis Canestrini, 1889: 511.

Description of the deutonymph male (n=5) (Figures 7, 8)

Length of body: 233-320. Width of body: 165-210.

Gnathosoma. Gnathosoma 49-58, chelicerae 61-69, palp 74-79 long. Subcapitulum with two pairs of adoral setae ($or_{1,2}$) and two pairs of subcapitular setae (m, n). Dimensions and distance between subcapitular setae, m 7-10, n 6-8, $m-m$ 16-19, $n-n$ 18-21, $m-n$ 6-10. Number of setae on palp segments: Tr 0, Fe 3, Ge 2, Ti 2 +1 claw, Ta 5 (+ 3 fused eupathidia, + 1 ω).

Dorsum. Dorsal shields slightly dimpled and punctuated. Eyes present, post-ocular bodies absent. Eyes 7-9 in diameter. Dorsal setae barbed. Lengths and distances of dorsal idiosomal setae as follows: vi 15-23, ve 16-20, sci 12-17, sce 14-22, c_1 13-18, c_2 18-33, d_1 14-19, d_2 12-19, e_1 18-24, e_2 18-27, f_1 36-40, h_1 22-25, h_2 22-28, $vi-vi$ 24-32, $ve-ve$ 65-72, $vi-ve$ 23-35, $sci-sci$ 109-127, $ve-sci$ 26-31, $sce-sce$ 136-156, $sci-sce$ 29-34, c_1-c_1 52-67, c_2-c_2 141-177, d_2-d_2 132-154, c_1-d_1 38-42, c_1-d_2 48-52, d_1-d_1 36-45, d_2-d_1 46-51, e_2-e_2 93-110, d_2-e_2 42-48, d_1-e_1 41-45, d_1-e_2 40-47, e_1-e_1 39-48, e_2-e_1 24-27, f_1-f_1 40-49, e_1-f_1 23-26, e_2-f_1 42-45, h_1-h_1 14-19, h_2-h_2 35-46, h_1-h_2 10-11.

Venter. Coxisternal shields divided in midline and bearing setae la , $3a$ and $4a$. Dimensions of the setae and distances between them as follows: la 8-10, $3a$ 10-12, $4a$ 6-9, $la-la$ 20-26, $3a-3a$ 20-26, $4a-4a$ 14-29. Aggenital shield with two pairs of setae. Three pairs of pseudanal setae present. Aggenital setae ag_1 6-8, ag_2 7-9. Pseudanal setae ps_1 4-7, ps_2 6-10, ps_3 9-10.

Legs. Formulae of setae and solenidia on legs I-IV: coxae 2-2-2-2, trochanters 1-1-2-0, femora 6-4-3-2, genua 3(+1 κ)-2(+1 κ)-0-0, tibiae 5(+1 ϕ +1 $\phi\rho$)-5(+1 $\phi\rho$)-5(+1 $\phi\rho$)-5(+1 $\phi\rho$), tarsi 13(+1 ω)-9(+1 ω)-7(+1 ω)-7. Measurements of legs I-IV 114-119, 94-121, 100-119, 110-124 respectively.

Materials examined

232 ♀♀, 17 ♂♂, 18 deutonymphs, 5 deutonymph males, 22 protonymphs, 17 larvae.

1 ♀ from litter under oak, 39°36'06.0"N 39°08'58.5"E, 1376 m a.s.l., 26 April 2022; 1 ♀ from litter under oak, 39°36'34.31"N 39°9'18.62"E, 1138 m a.s.l., 29 October 2022; 3 protonymphs, 3 larvae from litter under oak, 39°36'08.4"N 38°39'30.4"E, 1624 m a.s.l., 25 June 2022; 2 ♀♀, 1 deutonymph and 1 protonymph from same habitat, 31 July 2022; 6 ♀♀ from same habitat, 28 October 2022; 1 ♀ from same habitat, 24 December 2022; 4 ♀♀ and 1 deutonymph from same habitat, 28 January 2023; 9 ♀♀ from same habitat, 26 March 2023; 28 ♀♀ from litter under oak, 39°36'45.2"N 38°39'59.7"E, 1715 m a.s.l., 26 April 2022; 2 ♀♀ from same habitat, 29 May 2022; 1 ♀, 1 deutonymph male, 4 protonymphs and 7 larvae from same habitat, 26 June 2022;

1 deutonymph and 1 larva from same habitat, 31 July 2022; 17♀♀, 2♂♂ and 2 larvae from same habitat, 27 September 2022; 4♀♀ from same habitat, 28 October 2022; 3♀♀ from same habitat, 28 November 2022; 22♀♀ from litter under oak, 39°36'16.1"N 38°39'54.3"E, 1693 m a.s.l., 26 April 2022; 31♀♀ from same habitat, 29 May 2022; 4♀♀, 1 protonymph from same habitat, 26 June 2022; 16♀♀ 1♂, 1 deutonymph, 1 deutonymph male and 4 protonymphs from same habitat, 31 July 2022; 1♀, 1♂, 6 deutonymphs, 1 deutonymph male, 2 protonymphs and 3 larvae from same habitat, 27 August 2022; 21♀♀, 8♂♂, 4 deutonymphs and 4 protonymphs from same habitat, 28 September 2022; 2♀♀, 2♂♂ and 1 deutonymph from same habitat, 29 October 2022; 2♀♀ from same habitat, 25 December 2022; 1♀ from litter under oak, 39°12'31.84"N 38°34'36.21"E, 922 m a.s.l., 28 October 2022; 1♀ from soil, 39°36'34.31"N 39°9'18.62"E, 1138 m a.s.l., 29 May 2022; 21♀♀ from same habitat, 27 January 2023; 1♀ from soil, 39°36'45.2"N 38°39'59.7"E, 1715 m a.s.l., 27 August 2022; 1♀ from same habitat, 24 December 2022; 2♀♀ from soil, 39°36'16.1"N 38°39'54.3"E, 1693 m a.s.l., 26 April 2022; 1♀ from moss, 39°36'18.9"N 39°09'20.7"E, 1176 m a.s.l., 28 January 2023; 1♀ from moss, 39°36'34.31"N 39°9'18.62"E, 1138 m a.s.l., 25 March 2023; 1♀ from moss, 39°36'08.4"N 38°39'30.4"E, 1624 m a.s.l., 28 October 2022; 1 deutonymph from same habitat, 26 March 2023; 8♀♀, 2♂♂, 1protonymph from moss, 39°36'45.2"N 38°39'59.7"E, 1715 m a.s.l., 27 September 2022; 2♀♀ from same habitat, 24 December 2022; 10♀♀, 1 deutonymph from same habitat, 26 March 2023; 3♀♀ from moss, 39°36'16.1"N 38°39'54.3"E, 1693 m a.s.l., 26 June 2022; 1♂ from same habitat, 28 September 2022; 1♀ from grassy and mossy soil, 39°36'18.9"N 39°09'20.7"E, 1162 m a.s.l., 26 June 2022—the Karasu Valley, Erzincan, Türkiye. 1 deutonymph from moss, 39°35'08.7"N 39°52'12.4"E, 1357 m a.s.l., 13 October 2018; 1 deutonymph male from soil and litter under oak, 39°31'43.3"N 39°54'21.7"E, 1719 m a.s.l., 22 June 2019; 1 larva and 1 protonymph from moss, same habitat, 22 June 2019; 1 protonymph from soil and litter under oak, 39°23'51.4"N 39°46'50.3"E, 1508 m a.s.l., 22 June 2019; 1 deutonymph male from moss, 39°23'32.2"N 39°47'05.7"E, 1534 m a.s.l., 18 August 2019—Tunceli, Türkiye.

Distribution

Austria, Azerbaijan, Canada, China, Crimea, Holland, Hungary, Iran, Israel, Italy, Japan, Latvia, Lithuania, Poland, Russia, Slovakia, Taiwan, Türkiye, Ukraine and USA [3, 4, 13 ,15].

4. Discussion and Conclusion

Four active postembryonic developmental stages are typically present in members of the family Stigmaeidae: the six-legged larva, the eight-legged protonymph, the deutonymph, and the adult. The lack of genital setae allows the protonymph and deutonymph stages to be clearly distinguished from adult stages; the genitalia of the larva are absent [23].

During the nymphal examination, we noticed that five specimens of *Eustigmaeus anauniensis* are different from the other deutonymphs. They are identified as deutonymph males. In general, the male deutonymphs, are similar to female deutonymphs except for the numbers of aggenital

setae (Table 1). Male deutonymphs resemble adult males in having two pairs of aggenital setae (Table 1).

Table 1. Distinguishing features of mature and immature stages of *Eustigmaeus anauniensis*.

Characters	Larva	Protonymph	Deutonymph female	Deutonymph male	Adult female	Adult male
Number of setae on coxae I-IV	1-0-0	2-2-2-0	2-2-2-2	2-2-2-2	2-2-2-2	2-2-2-2
Number of setae on trochanters I-IV	0-0-0	0-0-1-0	1-1-2-0	1-1-2-0	1-1-2-1	1-1-2-1
Number of setae on femora I-IV	4-4-3	4-4-3-1	6-4-3-2	6-4-3-2	6-4-3-2	6-4-3-2
Number of setae on genua I-IV	2(+1κ)-2(+1κ)-0	3(+1κ)-2(+1κ)-0-0	3(+1κ)-2(+1κ)-0-0	3(+1κ)-2(+1κ)-0-0	3(+1κ)-3(+1κ)-1-1	3(+1κ)-3(+1κ)-1-1
Ventral setae 4a	-	-	+	+	+	+
Number of pairs of subcapitular setae	0	1	2	2	2	2
Number of pairs of aggenital setae	0	1	3	2	3	2

+ present, - absent

Although all life stages of this species have been recorded, deutonymph males have not been identified yet. With this study, this life stage is described and illustrated for the first time. To the best of knowledge, this stage in the genus has only been detected in *Eustigmaeus bochkovi* by Khaustov (2019) [24].

Ethics in Publishing

There are no ethical issues regarding the publication of this study.

Author Contributions

Salih Doğan: Conceptualization, investigation, methodology, resources, funding acquisition, supervision, visualisation, validation, writing – original draft, writing – review & editing. Sibel Doğan: Investigation, methodology, data curation, writing – original draft. Şifanur Uğurlu & Nisanur Polat: Investigation, methodology, data curation.

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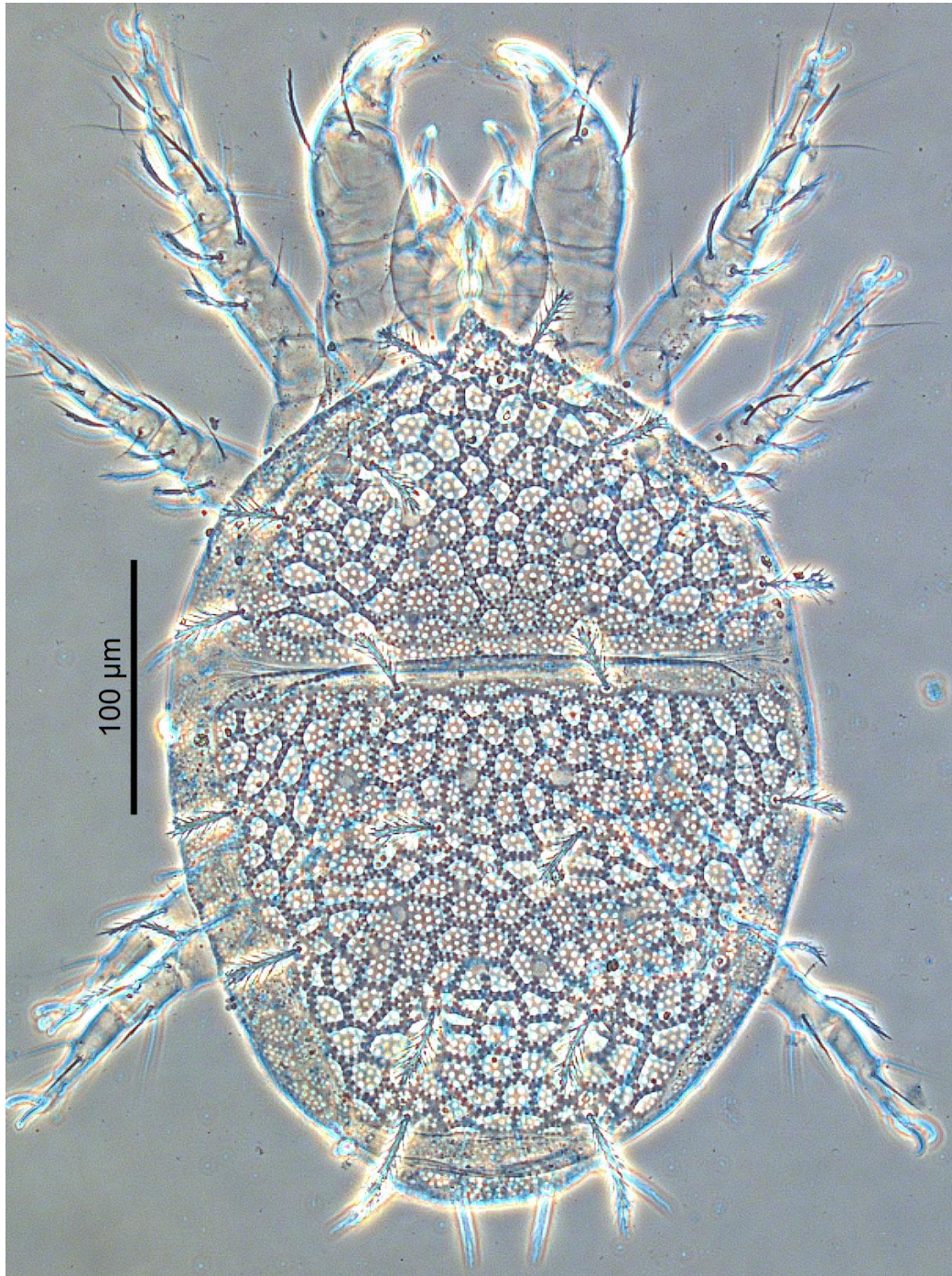


Figure 1. *Eustigmaeus anauniensis* (Canestrini) (female). Dorsal view.

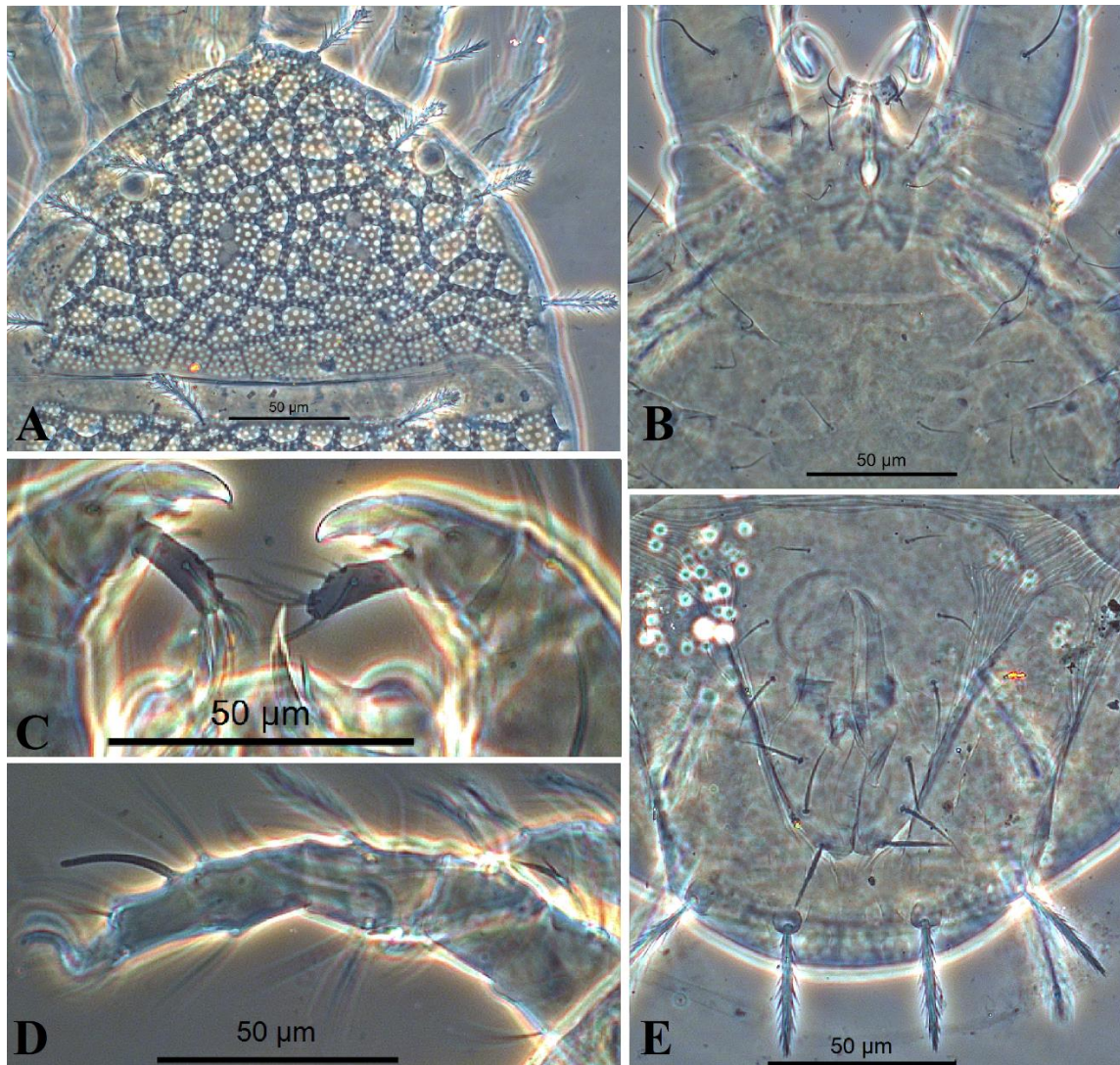


Figure 2. *Eustigmaeus anauniensis* (Canestrini) (female). A) Prodorsum, B) Coxisternal region, C) Palp, D) Leg I, E) Anogenital region.

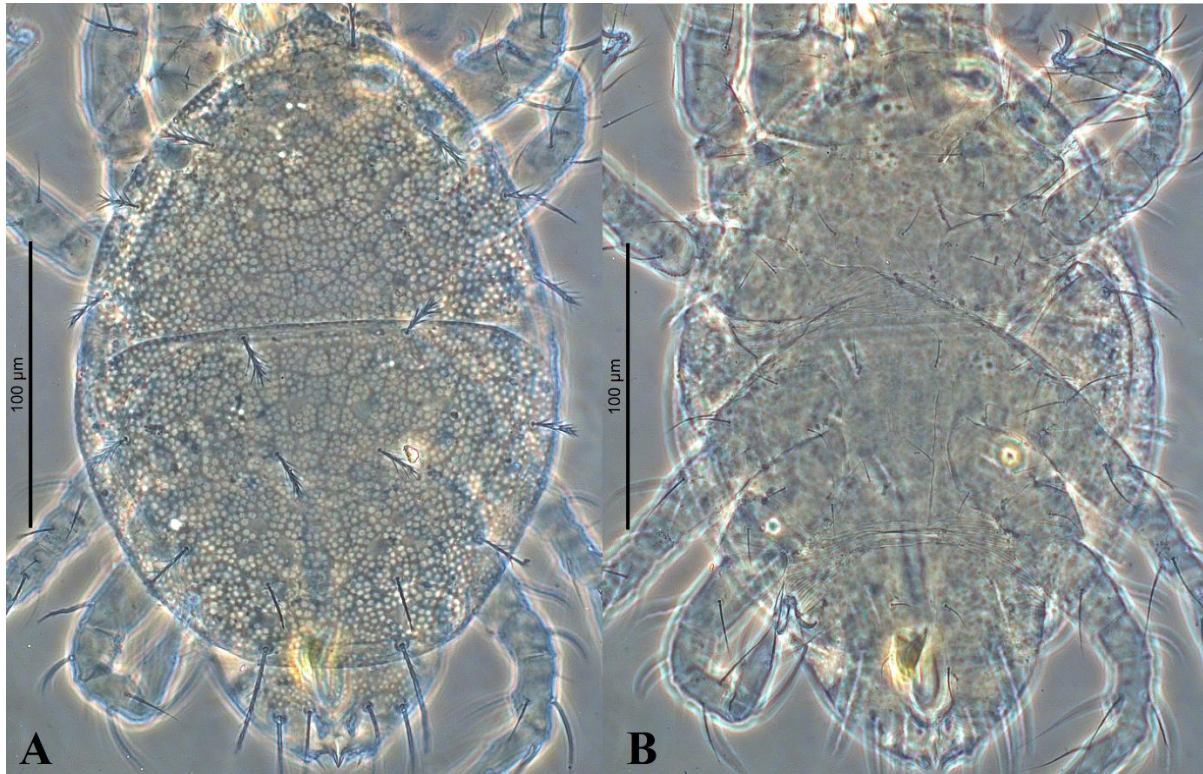


Figure 3. *Eustigmaeus anauniensis* (Canestrini) (male). A) Dorsal view, B) Ventral view.

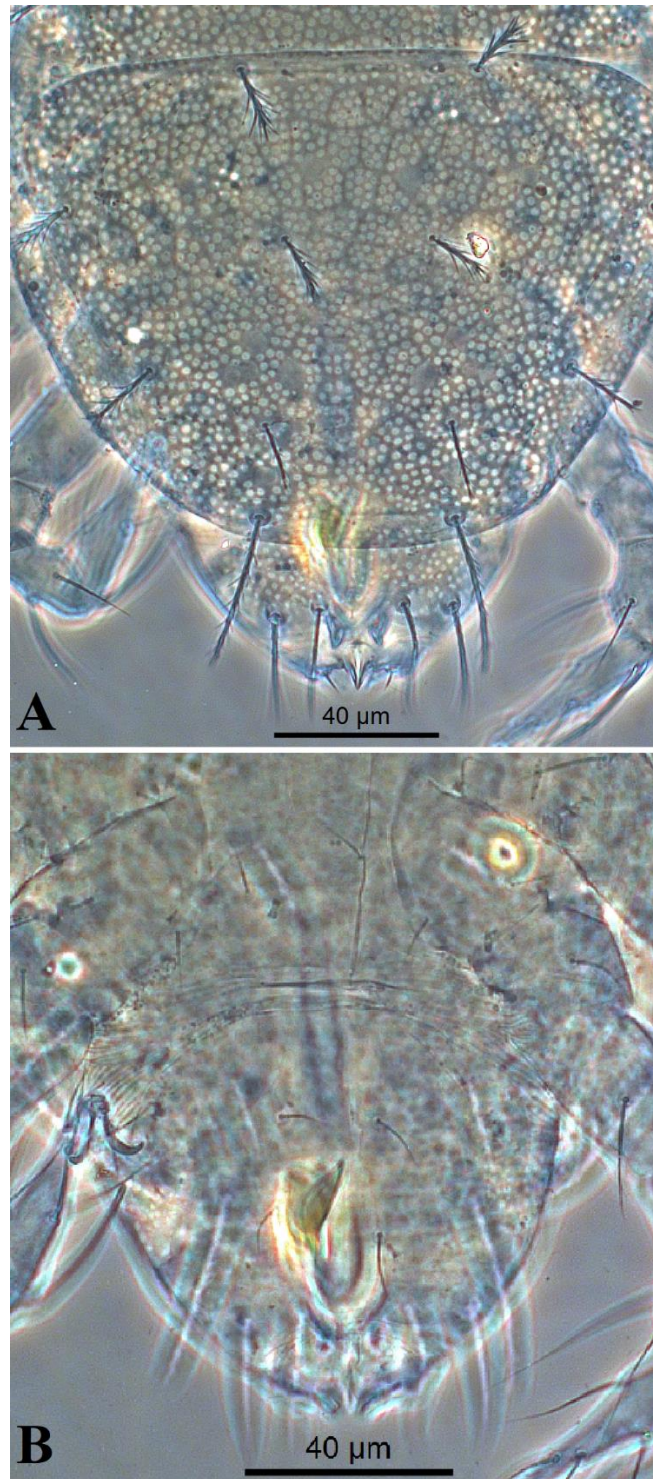


Figure 4. *Eustigmaeus anauniensis* (Canestrini) (male). A) Dorsal hysterosoma, B) Ventral hysterosoma.

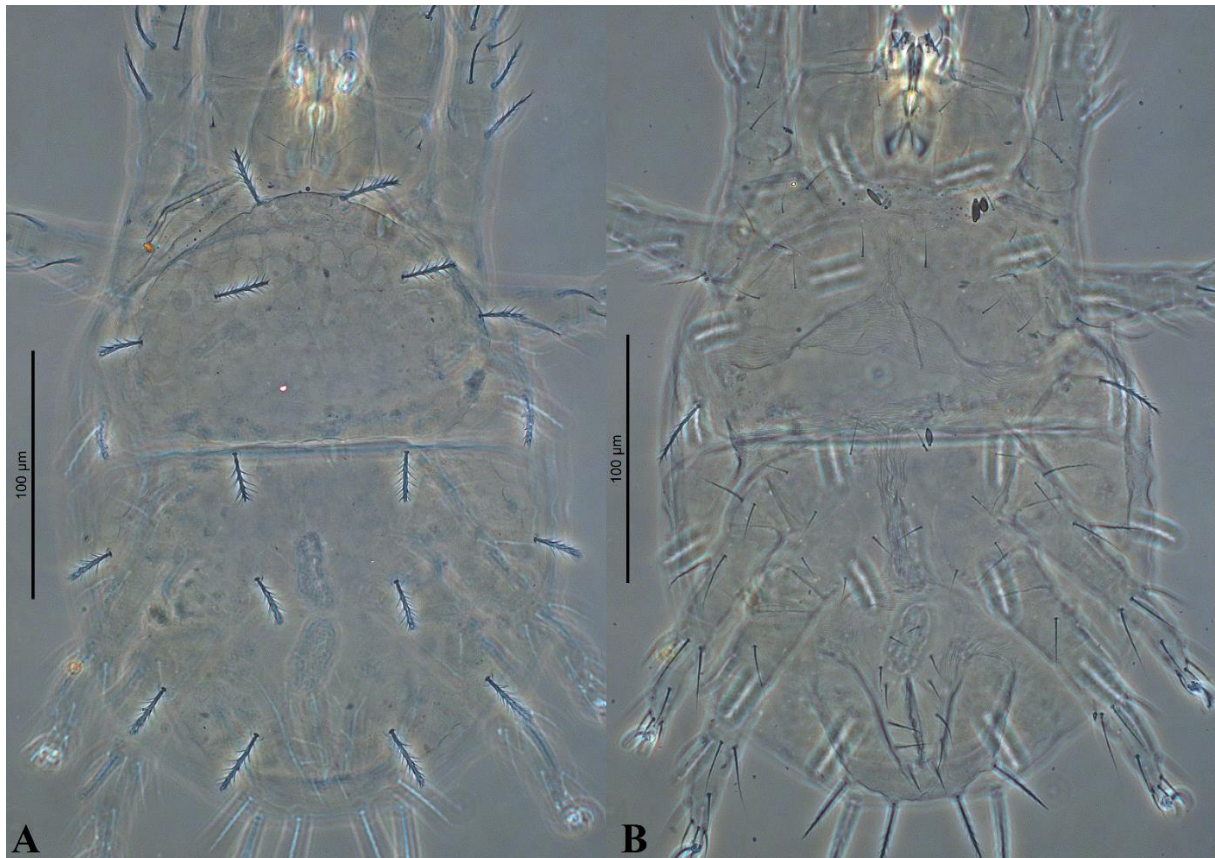


Figure 5. *Eustigmaeus anauniensis* (Canestrini) (deutonymph female). A) Dorsal view, B) Ventral view.

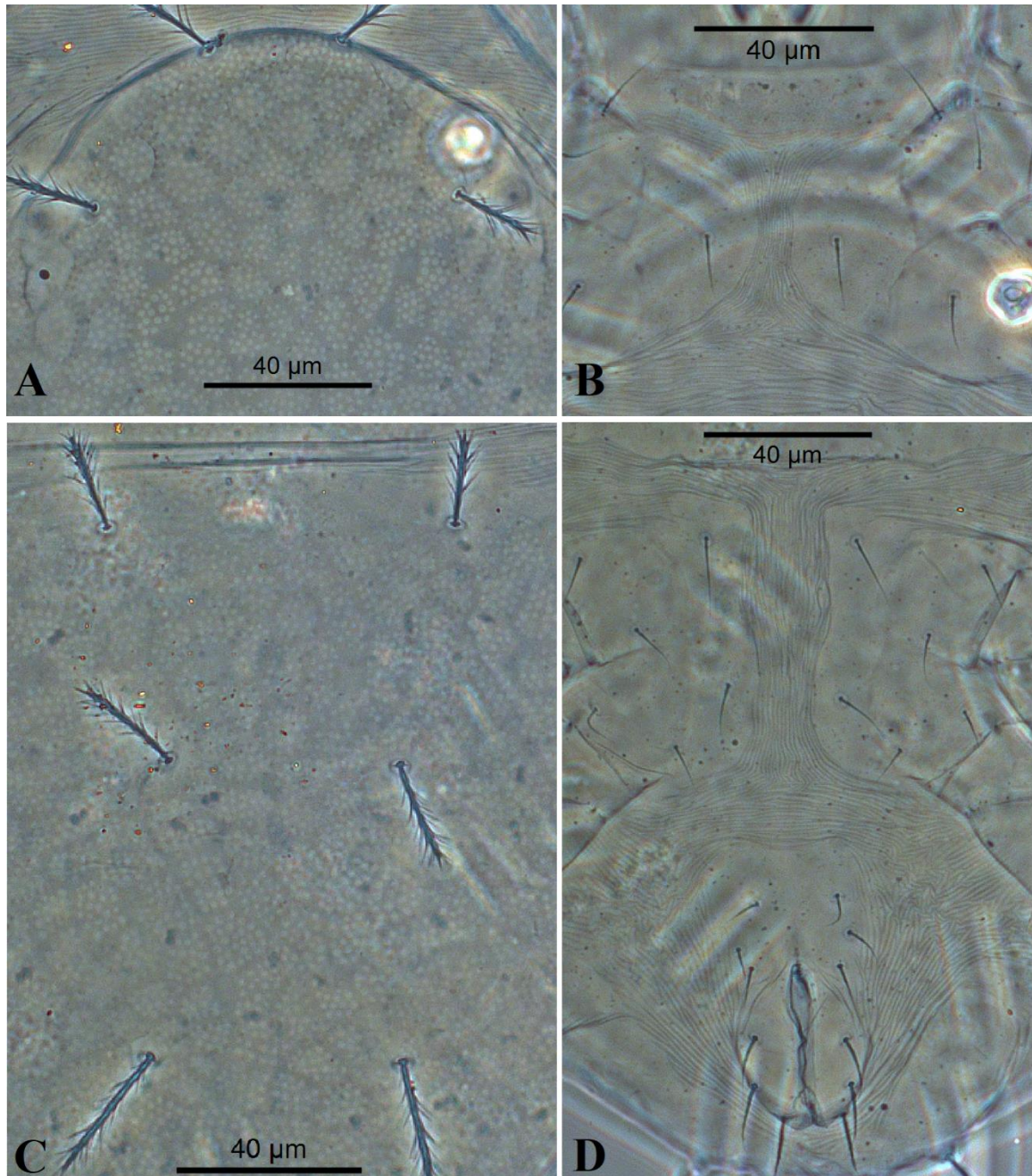


Figure 6. *Eustigmaeus anauniensis* (Canestrini) (deutonymph female). A) Prodorsum, B) Coxisternal region, C) Dorsal hysterosoma, D) Ventral hysterosoma.

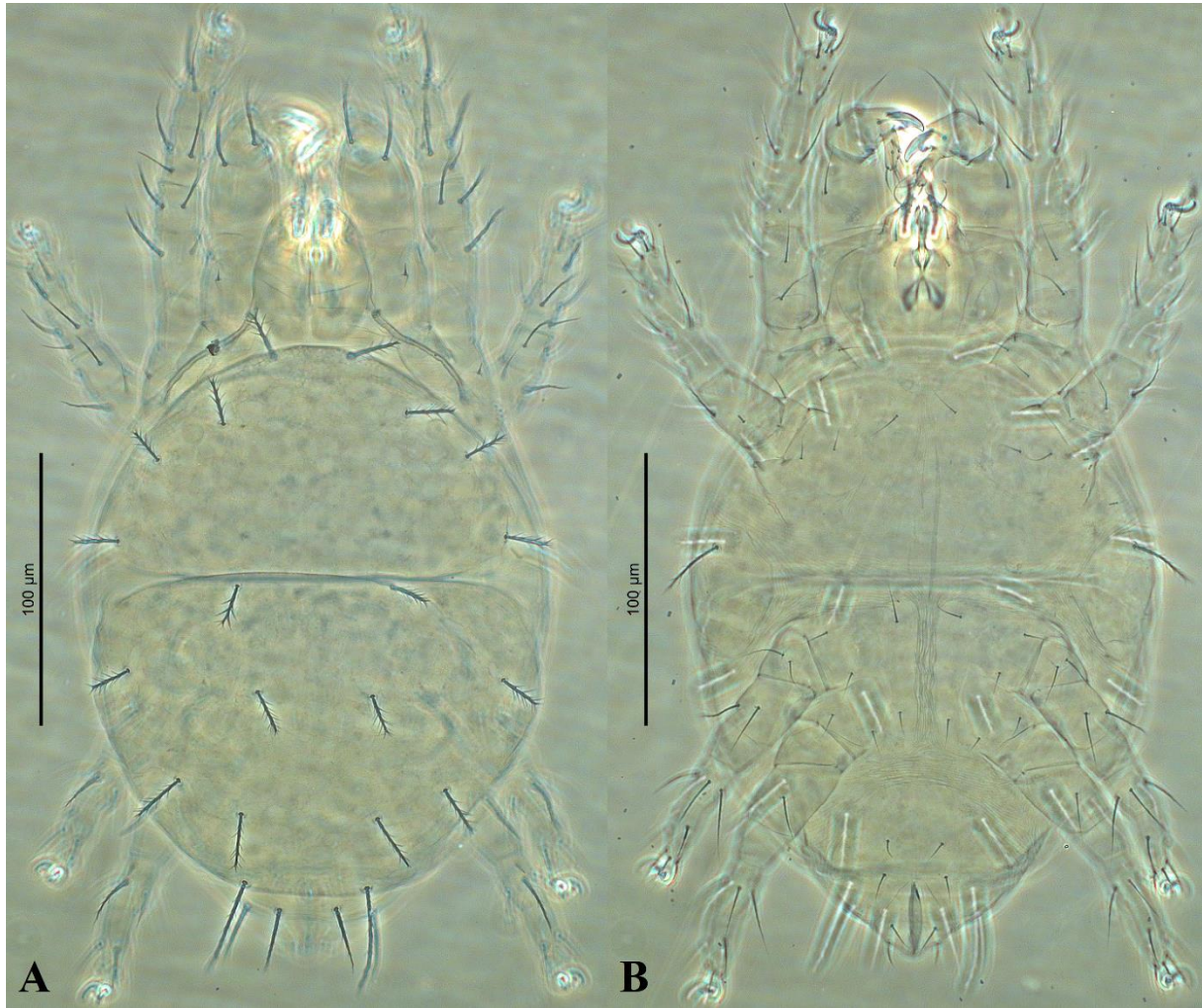


Figure 7. *Eustigmaeus anauniensis* (Canestrini) (deutonymph male). A) Dorsal view, B) Ventral view.

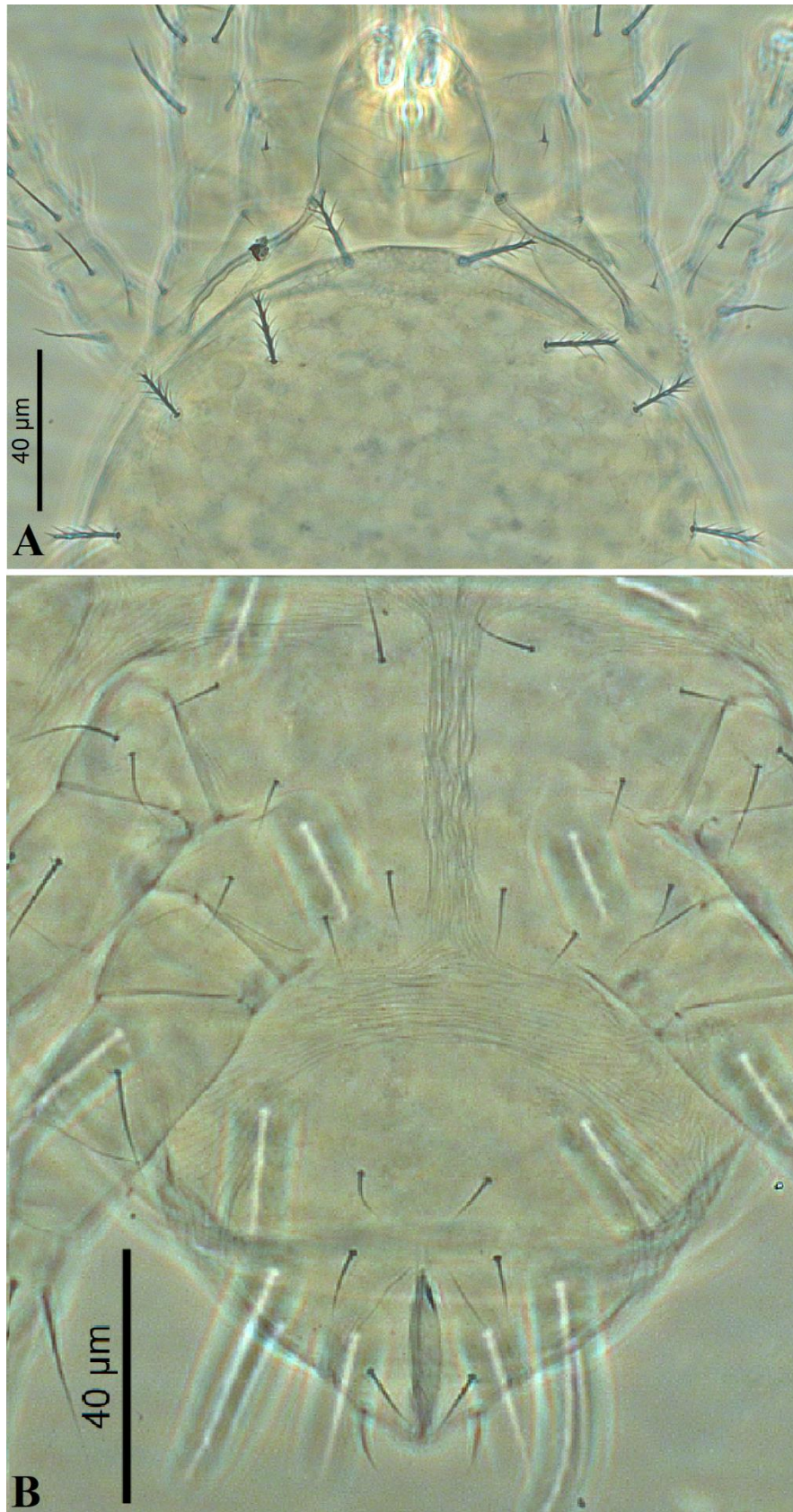


Figure 8. *Eustigmaeus anauniensis* (Canestrini) (deutonymph male). A) Prodorsum, B) Ventral hysterosoma.

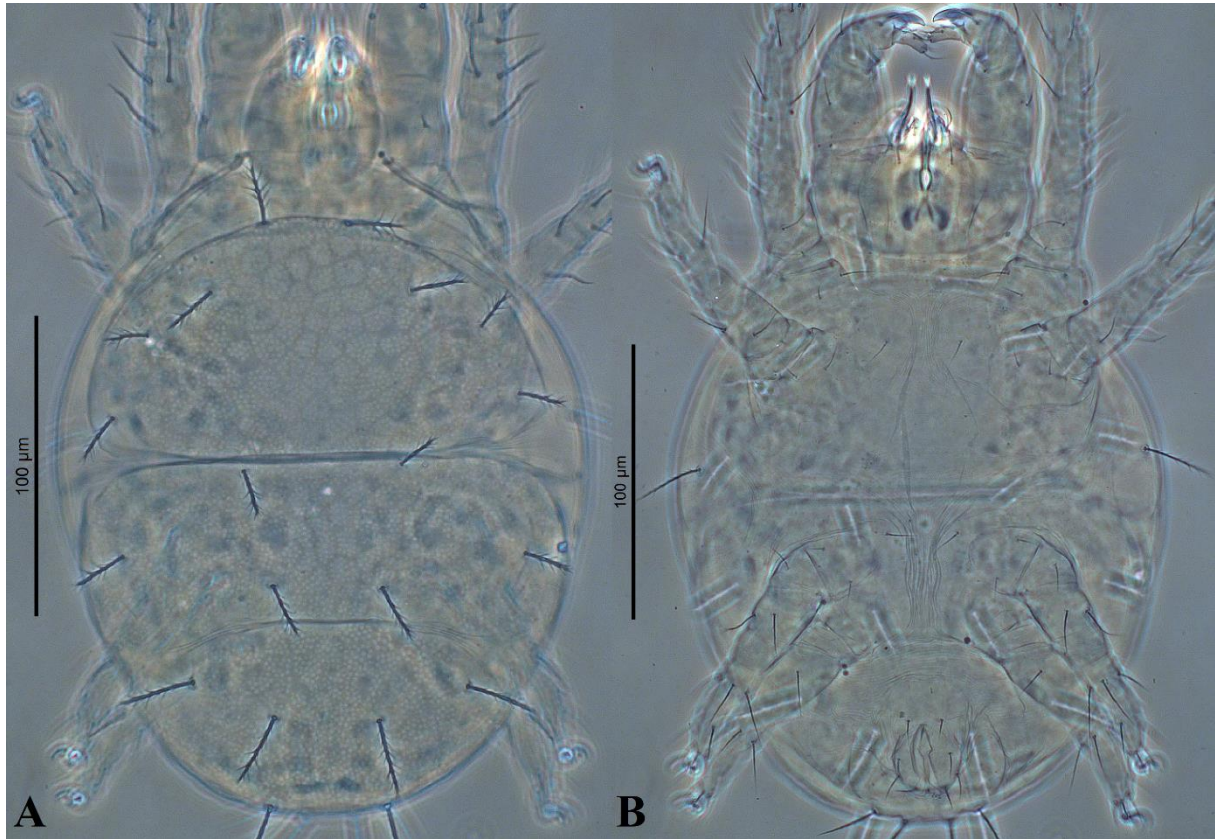


Figure 9. *Eustigmaeus anauniensis* (Canestrini) (protonymph). A) Dorsal view, B) Ventral view.

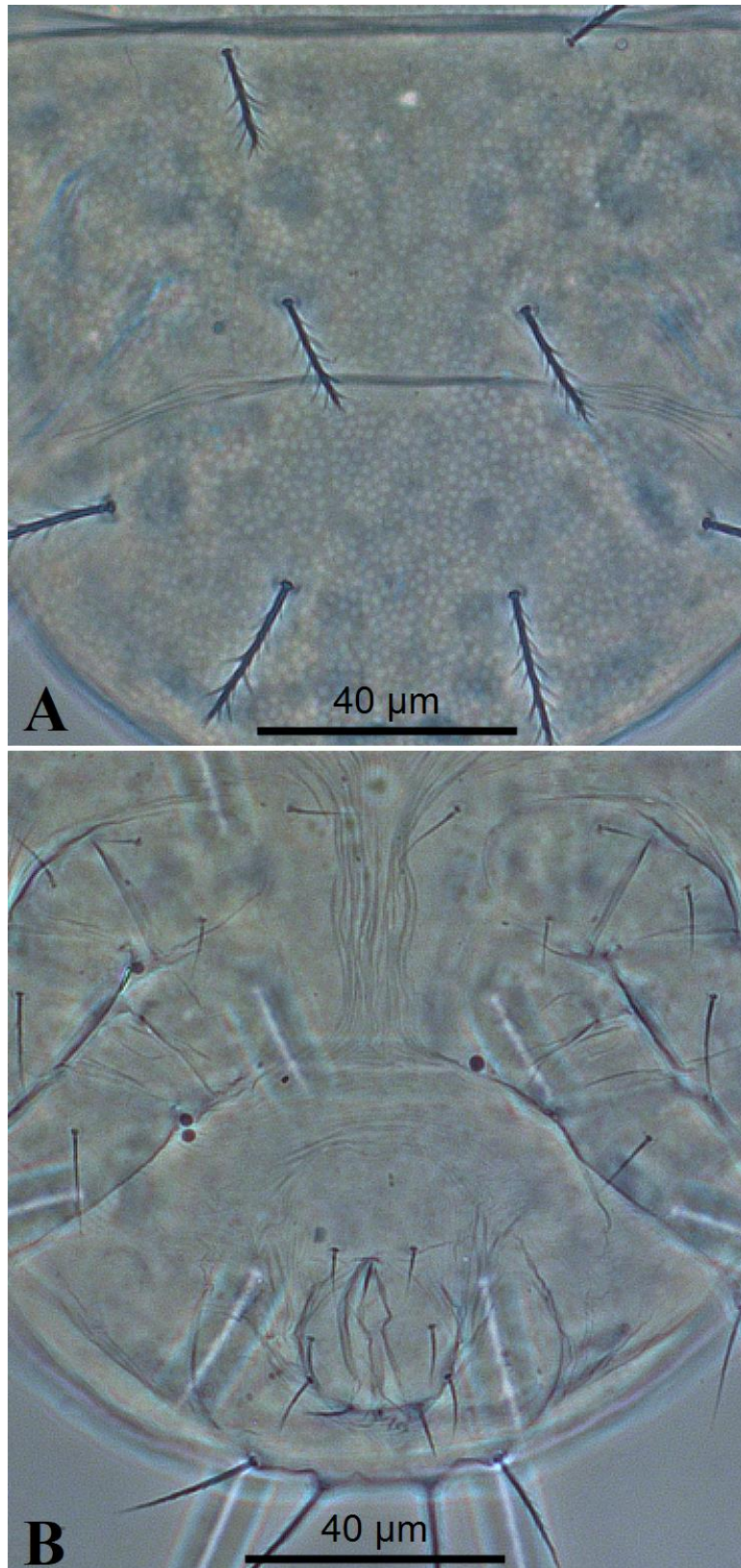


Figure 10. *Eustigmaeus anauniensis* (Canestrini) (protonymph). A) Dorsal hysterosoma, B) Ventral hysterosoma.

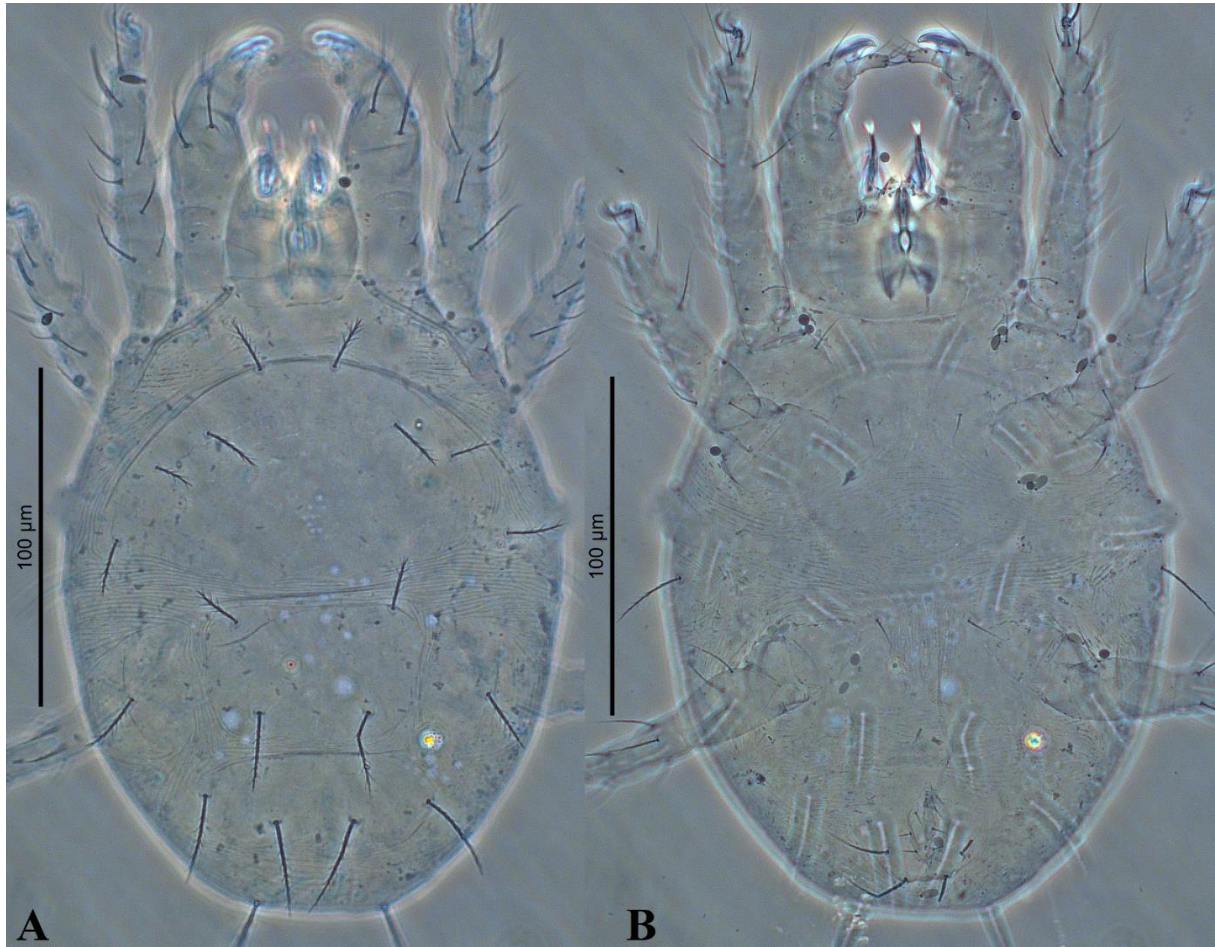


Figure 11. *Eustigmaeus anauniensis* (Canestrini) (larva). A) Dorsal view, B) Ventral view.

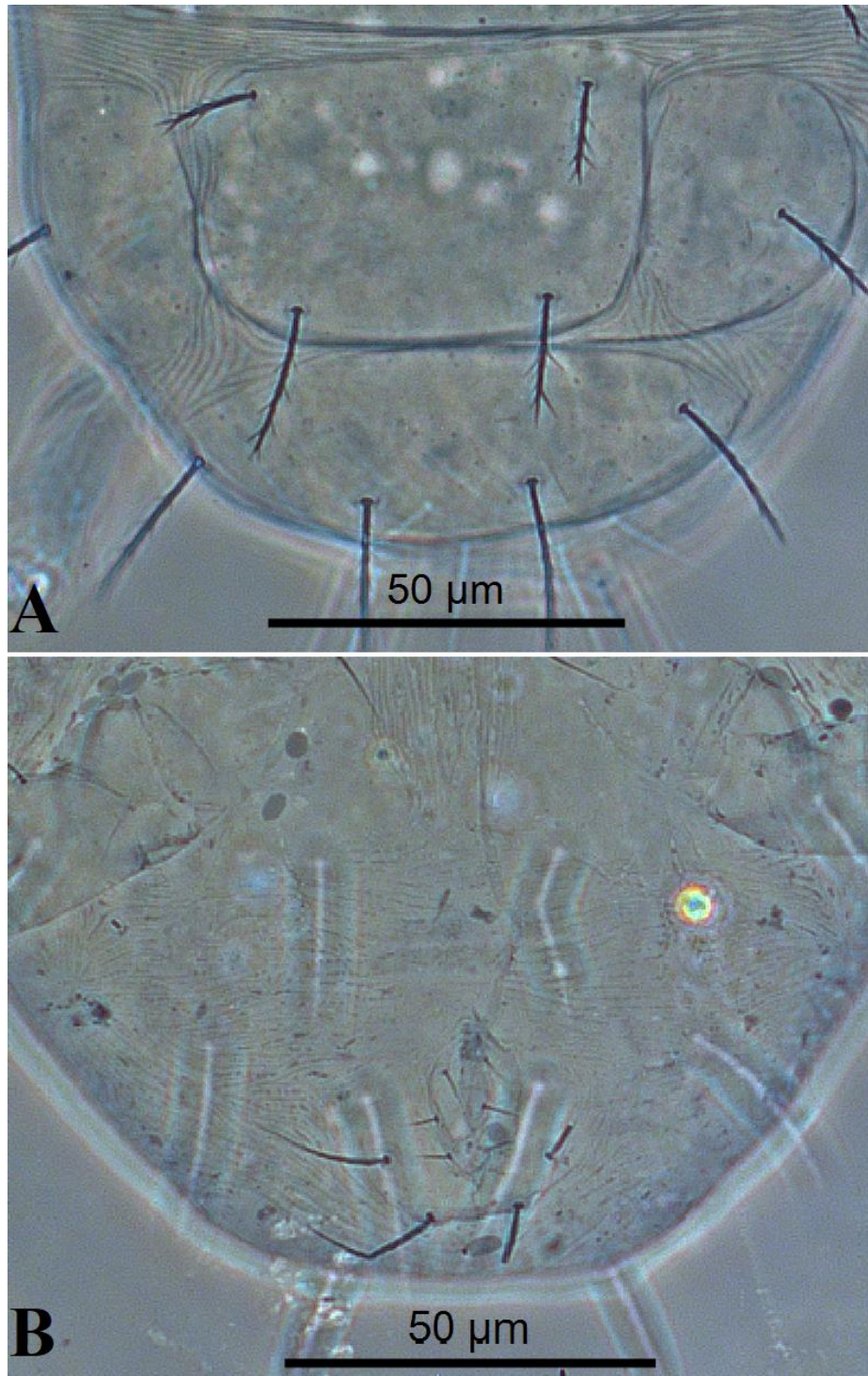


Figure 12. *Eustigmaeus anauniensis* (Canestrini) (larva). A) Dorsal hysterosoma, B) Ventral hysterosoma.