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# Complementary description of *Flagroseius euflagellatus* (Karg) (Mesostigmata: Phytoseiidae) from Cat Tien National Park, Southern Vietnam

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## ABSTRACT

The phytoseiid mite *Flagroseius euflagellatus* (Karg) is redescribed based on female and male specimens collected on *Citrus maxima* (Burm.) Merr. in Cat Tien National Park, Southern Vietnam, representing the first record of the species from the country. Previous descriptions are incomplete and contain inaccuracies in leg chaetotaxy and cheliceral dentition. We provide a comprehensive redescription with detailed illustrations and measurements of both sexes, and documenting previously overlooked morphological structures, including the complete setation patterns of all leg segments.

## KEYWORDS

Biological control, morphology, predatory mites, Southeast Asia, taxonomy

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## INTRODUCTION

Mites of the family Phytoseiidae are well-known for their role as natural predators of a variety of plant pests, including spider mites, thrips, and whiteflies, as well as other small arthropods with soft bodies (McMurtry *et al.* 2013). Southern Vietnam forms part of the Indo-Burma biodiversity hotspot, characterized by exceptionally high concentrations of endemic species and significant habitat loss (Myers *et al.* 2000). This region supports a remarkable diversity of fauna, yet comprehensive knowledge of its arthropod communities, particularly predatory mites of Phytoseiidae family, is still lacking. At present, only 24 species from 10 genera are recorded in Vietnam (Fang *et al.* 2020; Kreiter *et al.* 2020; Nguyen T.P.T. *et al.* 2016; Nguyen D.T. and De Clercq 2018; Nguyen D.T. *et al.* 2019; Khaustov *et al.* 2025).

The genus *Flagroseius* (Karg), currently represented solely by the species *F. euflagellatus* (Karg), belongs to the subfamily Amblyseiinae Muma, tribe Amblyseiini Muma, subtribe Proprioseiopsina Chant and McMurtry (Chant and McMurtry 2005, 2007). This species is one of the most hypotrichous within the subfamily, characterized by the presence of only 28 pairs of idiosomal setae (including one unpaired *Pst*). The dorsal setae *j5*, *J2*, *Z1*, *S2*, and *S4* are absent. Additionally, *Flagroseius* is distinguished by the length of the dorsal seta *Z5*, which appears to be among the longest reported in phytoseiid mites, measuring approximately 2.5 times the length of the dorsal shield. The species has been reported exclusively from Southeast Asian countries, inhabiting shrubs or trees.

The original description of *F. euflagellatus*, as well as subsequent redescriptions (Chant and

McMurtry 2005; Ehara 2005), are incomplete and contain inaccuracies, particularly in the description of the chelicera and the leg chaetotaxy. To resolve these uncertainties, we provide a comprehensive redescription based on newly collected specimens from Vietnam, where this species is recorded for the first time.

## MATERIAL AND METHODS

During an expedition to Southern Vietnam in November–December 2022, plant inhabiting mites were collected from leaves, branches, and barks from various plants using the shaking method described by Kuznetsov and Petrov (1984). Subsequently, the mites were collected in 2 ml tubes containing 96% ethyl alcohol using a fine camel brush (000 size).

Some mite specimens were subsequently cleared with 80% lactic acid and mounted in Hoyer's medium for detailed morphological analysis, following the protocols outlined by Walter and Krantz (2009). The taxonomy of mites belonging to the family Phytoseiidae was based on the classification provided by Chant and McMurtry (2007). The nomenclature for dorsal setae followed the system established by Lindquist and Evans (1965) and subsequently adapted for adult phytoseiids by Rowell *et al.* (1978). Ventral idiosomal setal nomenclature was in accordance with Chant and Yoshida-Shaul (1991). Leg setal nomenclature adhered to the standards set by Evans (1963). The terminology for dorsal solenostomes (gland pores) and poroids was based on Athias-Henriot (1975).

Measurements were recorded in micrometers (μm) and presented as means with ranges. Morphological observations, illustrations, and measurements were carried out using an Axio Imager A2 compound microscope (Carl Zeiss, Germany), equipped with differential interference contrast (DIC) and phase contrast optical systems. Digital images were captured using an Axiocam 506 color camera (Carl Zeiss, Germany). Line drawings were created using Adobe Photoshop CS2 on a Wacom Cintiq 16 (DTK1660K0B) interactive display with a Wacom Pro Pen 2.

The length of the dorsal and ventrianal shields was measured along the midline from the anterior to posterior margins. Leg lengths were measured from the basal margin of the coxa to the tarsus apex, excluding the ambulacrum. All examined specimens are deposited in the Zoology Museum in Department of Biology of Joint Vietnam-Russia Tropical Science and Technology Research Center, Ho Chi Minh, Vietnam.

## RESULTS

## TAXONOMY

### Family Phytoseiidae Berlese

### Genus *Flagroseius* (Karg, 1983)

**Type species:** *Proprioseiopsis* (*Flagroseius*) *euflagellatus* Karg, 1983: 305.

#### *Flagroseius euflagellatus* (Karg, 1983) (Figs 1–28)

*Amblyseius mahabaeus* Schicha and Corpuz-Raros, 1992: 29.

***Diagnoses***

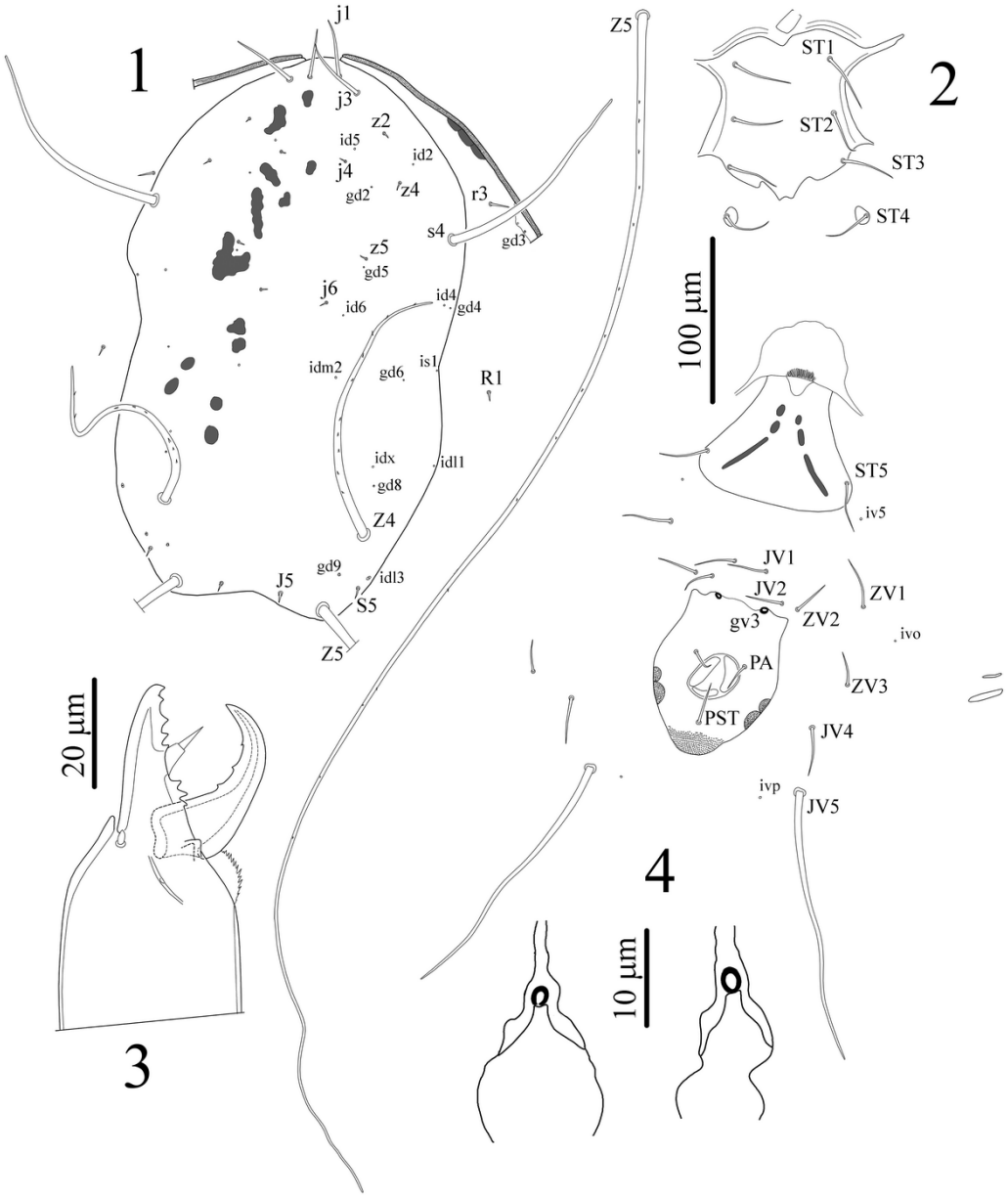
Idiosomal setal pattern 9A:5E/ *JV*–3: *ZV*. Dorsal shield poorly sclerotized, smooth with six pairs of small solenostomes *(gd2*, *gd4*, *gd5*, *gd6*, *gd8*, and *gd9)*. Dorsal seta *Z5* ultralong and flagellate, 2.5 the length of the dorsal shield, setae *s4*, *Z4* and *JV5* long and flagellate, setae *j1* and *j3* elongated, remaining dorsal setae short, minute. All dorsal setae smooth, except *Z4* and *Z5* with small barbs. All ventral shields poorly sclerotized, smooth; sternal shield with three pairs of setae and median posterior projection; genital shield much wider than ventrianal shield; ventrianal shield reduced, with pair of para-anal setae and unpaired post-anal seta, with crescentic pre-anal solenostomes *gv3*; three pairs of pre-anal setae (*JV1*, *JV2*, *ZV2*) situated on soft cuticle anteriorly to ventrianal shield, setae *JV2* migrated anteriorly. Calyx of spermatheca cup-shaped with thick walls, atrium large nodular, connected to calyx without neck. Fixed digit of chelicera with seven teeth; movable digit with three teeth. Genu II with seven setae (2 2/0 2/0

1), genu III with six setae (1 2/0 2/0 1). Macrosetae present on leg I (*Sge*, *Sti*, *StIa*, *StIb*), leg II (*Sge*, *Sti*, *St*), leg III (*Sge* and *Sti*) and leg IV (*Sge*, *Sti*, *St*). Microsetae present on leg I (setae *pl2* on genu and tibia), leg III (seta *pd2* on tibia), and leg IV (seta *pd2* on tibia).

## *Description*

*Female (n = 5)*

**Dorsal idiosoma (Fig. 1) –** Dorsal setal pattern 9A: 5E (*r3* and *R1* off shield). Dorsal shield poorly sclerotized, smooth with six pairs of solenostomes (*gd2*, *gd4*, *gd5*, *gd6*, *gd8*, and *gd9*), and nine pairs of visible poroids (sensillae) (*id2*, *id4*, *id5*, *id6*, *idm2*, *idx*, *is1*, *idl1*, and *idl3*). Muscle-marks (sigilla) visible mostly on podosoma, length of dorsal shield 334 (324–342), width at level of *s4* 206 (195–215). Dorsal seta *Z5* ultralong and flagellate, 2.5 the length of the dorsal shield, setae *s4*, *Z4* long and flagellate, setae *j1* and *j3* elongated, remaining dorsal setae short, minute. All dorsal setae smooth, except *Z4* and *Z5* with small barbs. Measurements of dorsal setae as follows: *j1* 34 (32–36), *j3* 46 (40–49), *j4* 4 (4–5), *j6* 5 (4–6), *J5* 5 (4–5), *z2* 4 (4–5), *z4* 4 (4–5), *z5* 4 (4–5), *Z4* 181 (170–186), *Z5* 768 (721–788), *s4* 149 (135–158), *S5* 5 (5–6), *r3* 15 (12–17), and *R1* 8 (7–9). Peritremes extends to base of setae *j1*. Peritremal shield with a pair of solenostomes *gd3* and poroids *id3*.

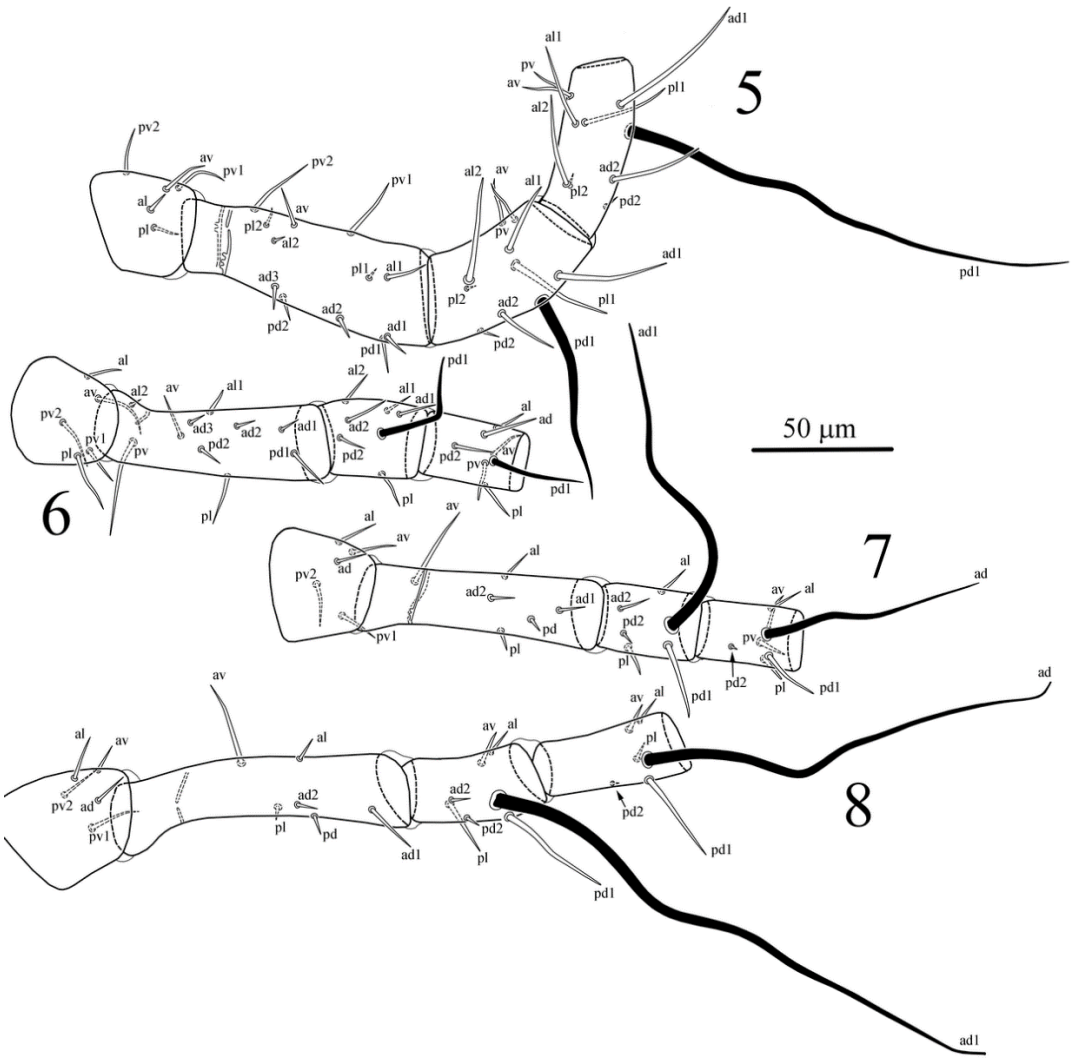



**Figures 1–4.** *Flagroseius euflagellatus* (Karg, 1983) (female) – **1.** Dorsal idiosoma; **2.** Ventral idiosoma; **3.** Chelicera; **4.** Spermathecae.

**Ventral idiosoma (Figs 2, 18–19) –** Ventral setal pattern 14: *JV–3*: *ZV*. Sternal shield smooth, with three pairs of setae, *ST1* 32 (30–33), *ST2* 31 (30–31), *ST3* 31 (30–32), and median posterior projection, poroids *iv1* and *iv2* not visible; distance between *ST1–ST3* 62 (58–66), width distance between setae *ST2* 63 (60–65). Metasternal setae *ST4* 26 (25–27) and poroids *iv3* on metasternal shields. Genital shield smooth, with one pair of setae *ST5* 30 (28–32); width at level of *ST5* 88 (84–90); one pair of para-genital poroids *iv5* on soft cuticle. Ventrianal shield poorly sclerotized, reduced and smooth, with pair of para-anal setae *PA*, unpaired post-anal seta *PST*, and a pair of crescentic solenostomes (*gv3)* on anterior margin of shield, distance between solenostomes 31 (30–32). Pre-anal setae *JV1* 22 (16–26), *JV2* 23 (21–24), and *ZV2* 24 (22–25) situated on soft cuticle anteriorly to ventrianal shield. Length of ventrianal shield 99 (98–100), width at level of anus 79 (75–86). Four pairs of caudoventral setae, *ZV1* 24 (23–25), *ZV3* 18 (16–21), *JV4* 26 (23–32), and *JV5* 153 (136–164) in length, smooth and two pairs of visible poroids (*ivo* and *ivp*) situated on soft cuticle surrounding ventrianal shield.

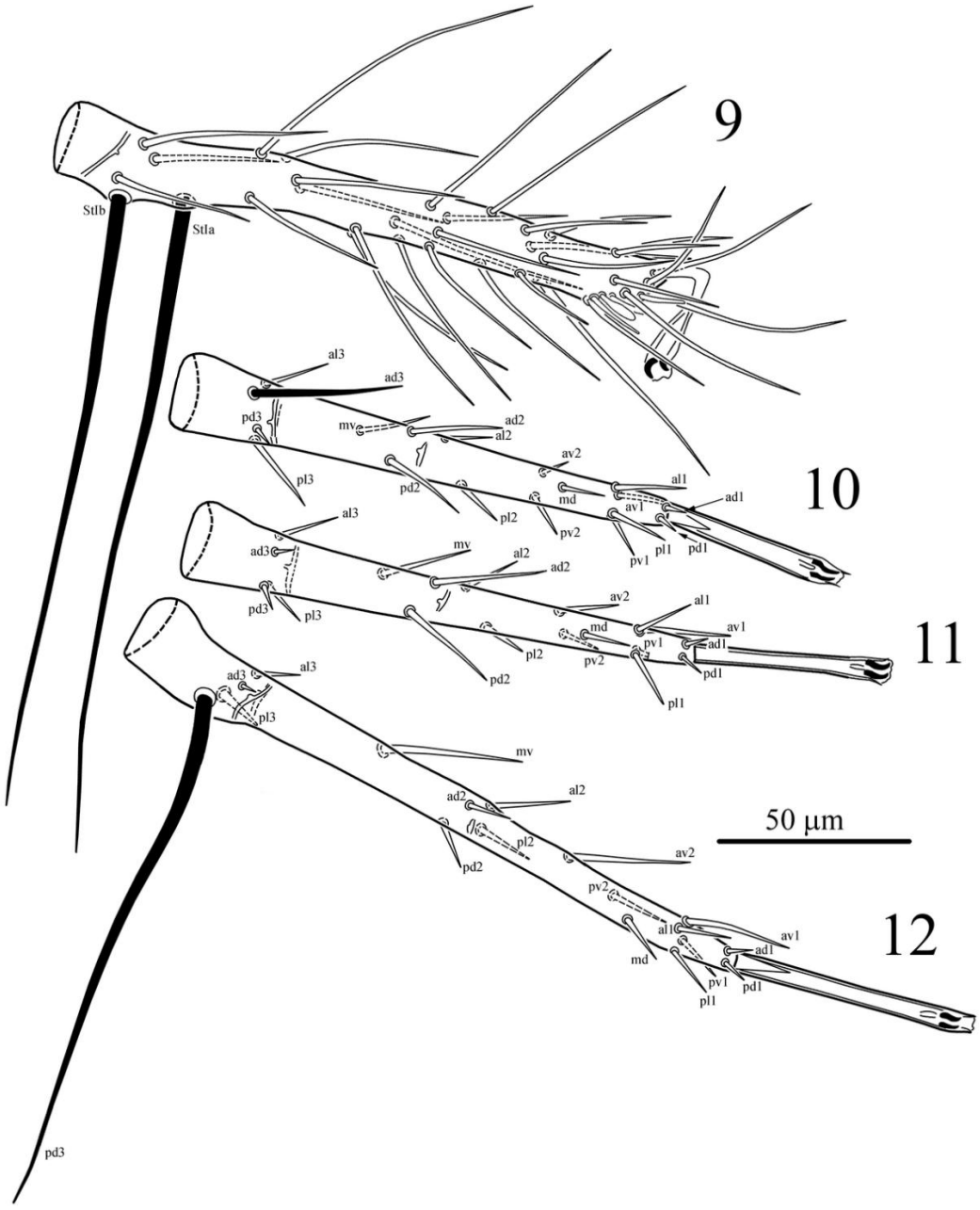
**Gnathosoma (Figs 3, 17, 21) –** Hypostomal groove with seven transverse rows of denticles, each row with three-four teeth, except basal row with four small teeth along lateral margins on either side. The width of hypostomal groove at fourth row 4 (4–5). Fixed digit of chelicera 29 (27–30) long, with seven teeth, evenly distributed along the digit and pilus dentilis; movable digit 29 long, with three teeth.

**Spermatheca (Figs 4, 20) –** Calyx short, cup-shaped with thick walls, 7 (6–8) long, atrium large nodular, connected to calyx without neck, major duct broad and minor duct not visible.




**Figures 5–8.** *Flagroseius euflagellatus* (Karg, 1983) (female) – **5.** Leg I (coxa and tarsus omitted); **6.** Leg II (coxa and tarsus ommited); **7.** Leg III (coxa and tarsus omitted); **8.** Leg IV (coxa and telotarsus omitted).

**Legs (Figs 5–12, 24–28) –** Leg I 429 (415–443), II 369 (347–396), III 381 (362–411), IV 481 (469–497) in length. Chaetotaxy of legs as follows: leg I: coxa 0 0/1 0/1 0, trochanter 1 0/1 0/2 1, femur 2 3/1 2/2 2, genu 2 2/1 2/1 2, tibia 2 2/1 2/1 2; leg II: coxa 0 0/1 0/1 0, trochanter 1 0/1 0/2 1, femur 2 3/1 2/1 1, genu 2 2/0 2/0 1, tibia 1 1/1 2/1 1; leg III: coxa 0 0/1 0/1 0, trochanter 1 1/1 0/2 0, femur 1 2/1 1/0 1, genu 1 2/0 2/0 1, tibia 1 1/1 2/1 1; leg IV: coxa 0 0/1 0/0 0, trochanter 1 1/1 0/2 0, femur 1 2/1 1/0 1, genu 1 2/1 2/0 1, tibia 1 1/1 2/0 1. Measurements of macrosetae as follows: *SgeI* 81 (73–87), *StiI* 169 (163–177), *Sti*a and *Sti*b 151 (148–155), *SgeII* 43 (40–48), *StiII* 33 (30–36), *StII* 36 (35–38), *SgeIII* 135 (123–145), *StiIII* 82 (78–85), *SgeIV* 205 (196–217), *StiIV* 158 (149–166), and *StIV* 131 (126–133). All macrosetae pointed apically, except on leg IV with small knob. Microsetae, *pl2* on genu and tibia I, *pd2* on tibia III and IV extremely short, (2–3 μm).

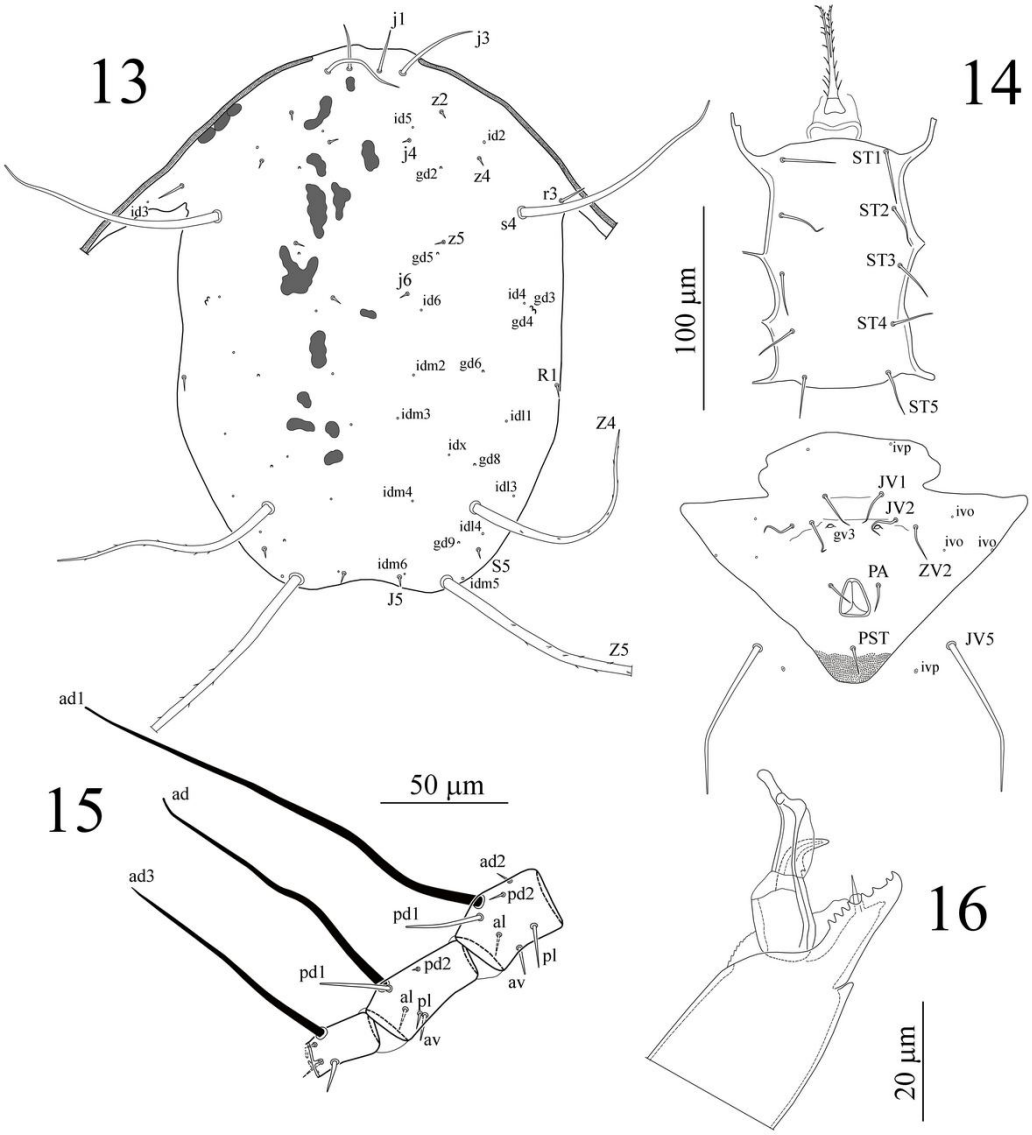



**Figures 9–12.** *Flagroseius euflagellatus* (Karg, 1983) (female) – **9.** Tarsus of leg I; **10.** Tarsus of leg II; **11.** Tarsus of leg III; **12.** Tarsus of leg IV.

*Male (n = 5)*

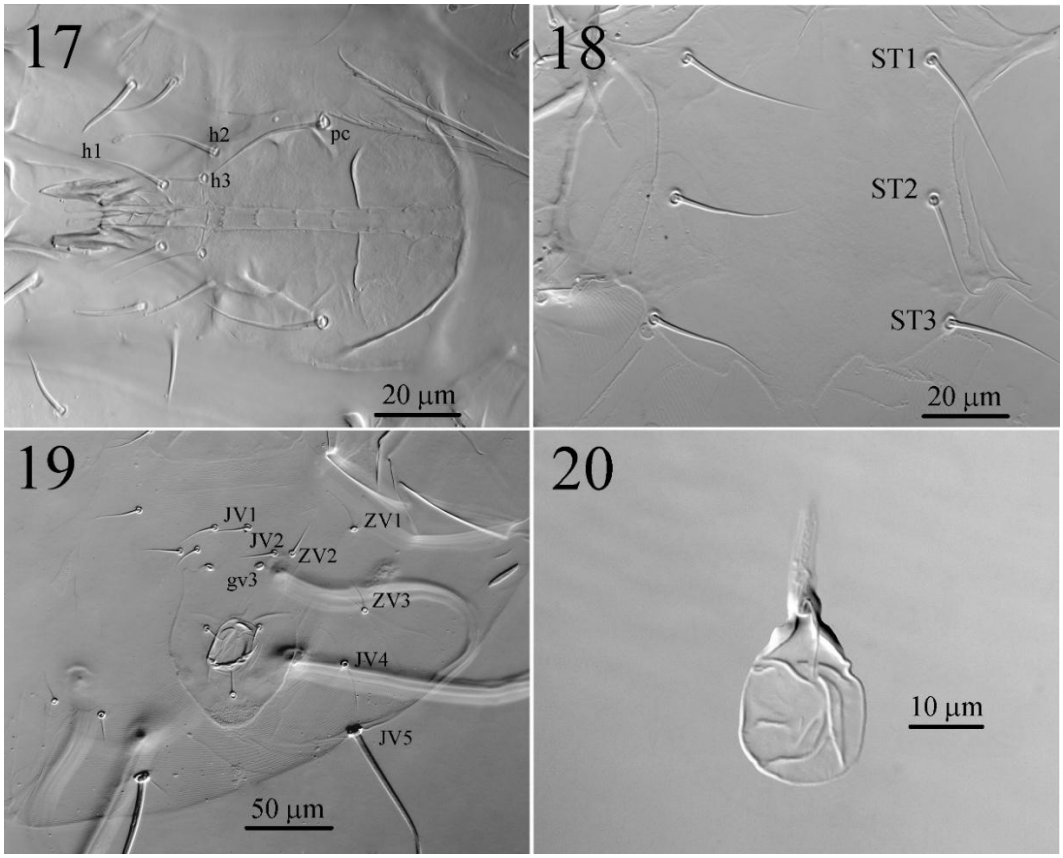
**Dorsal idiosoma (Fig. 13) –** Dorsal shield smooth, with 14 pairs of setae (*r3* and *R1* on shield), seven pairs of solenostomes (*gd2*, *gd3*, *gd4*, *gd5*, *gd6*, *gd8*, and *gd9*), and 12 pairs of visible poroids (sensillae)

(*id2*, *id4*, *id6*, *idm2*, *idm3*, *idm4*, *idm5*, *idm6*, *idx*, *idl1*, *idl3*, and *idl4*). The length of dorsal shield 260 (247–271), width at level of *s4* 179 (167–187). Dorsal solenostomes *gd3* and *gd4* close to each other. Shape of all dorsal setae as in female. Measurements of dorsal setae as follows: *j1* 25 (20–27), *j3* 40 (38–45), *j4* 4 (3–4), *j6* 3 (3–4), *J5* 4 (3–4), *z2* 4 (3–4), *z4* 4 (3–4), *z5* 4 (3–4), *Z4* 113 (102–120), *Z5* 533 (487–581), *s4* 110 (95–120), *S5* 4 (4–5), *r3* 14 (13–17) and *R1* 6 (5–7). Peritreme extending to level of setae *j3*. Peritremal shield with a pair of poroid *id3*.

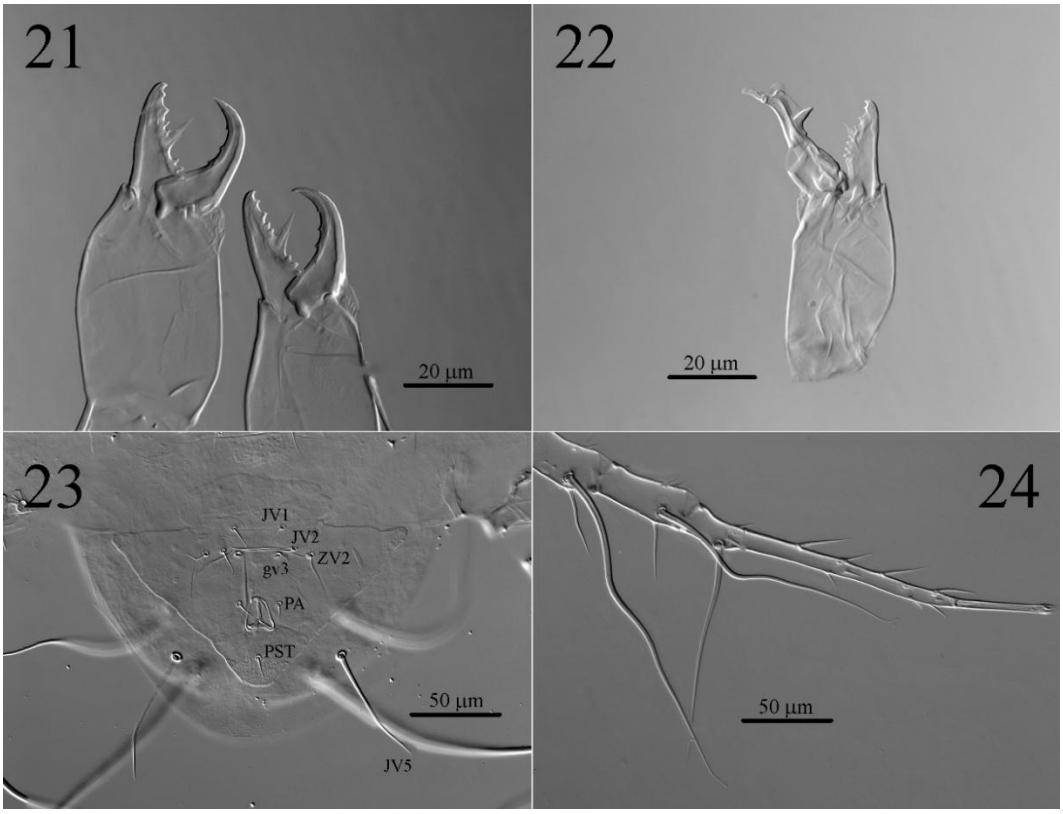



**Figures 13–16.** *Flagroseius euflagellatus* (Karg, 1983) (male) – **13.** Dorsal idiosoma; **14.** Ventral idiosoma; **15.** Genu, tibia and basitarsus of leg IV; **16.** Chelicera.

**Ventral idiosoma (Figs 14, 23) –** Sternogenital shield smooth, with five pairs of setae, *ST1* 25 (24–27), *ST2* 23 (21–25), *ST3* 22 (21–23), *ST4* 20 (18–20), *ST5* 23 (22–23), poroids (*iv1*, *iv2*, *iv3*) not visible; length (distance between bases of setae *ST1–ST5*) 106 (90–115), width (distance between bases of setae *ST3*) 60 (57–65). Ventrianal shield poorly sclerotized, triangular with distinct waist at level of *JV1* setae, smooth; with three pairs of pre-anal setae, *JV1* 17 (16–18), *JV2* 18 (16–19) and *ZV2* 17 (15–18), pair of para-anal seta (*PA*), post-anal seta (*PST*), and a pair of crescentic pre-anal pores (*gv3*) mesad *JV2*, distance between pores 24 (23–25). Length of ventrianal shield (from anterior to posterior margins) 120 (117–123), width at level of anterior corners 163 (144–172). Seta *JV5* 74 (67–80) on soft cuticle surrounding ventrianal shield.



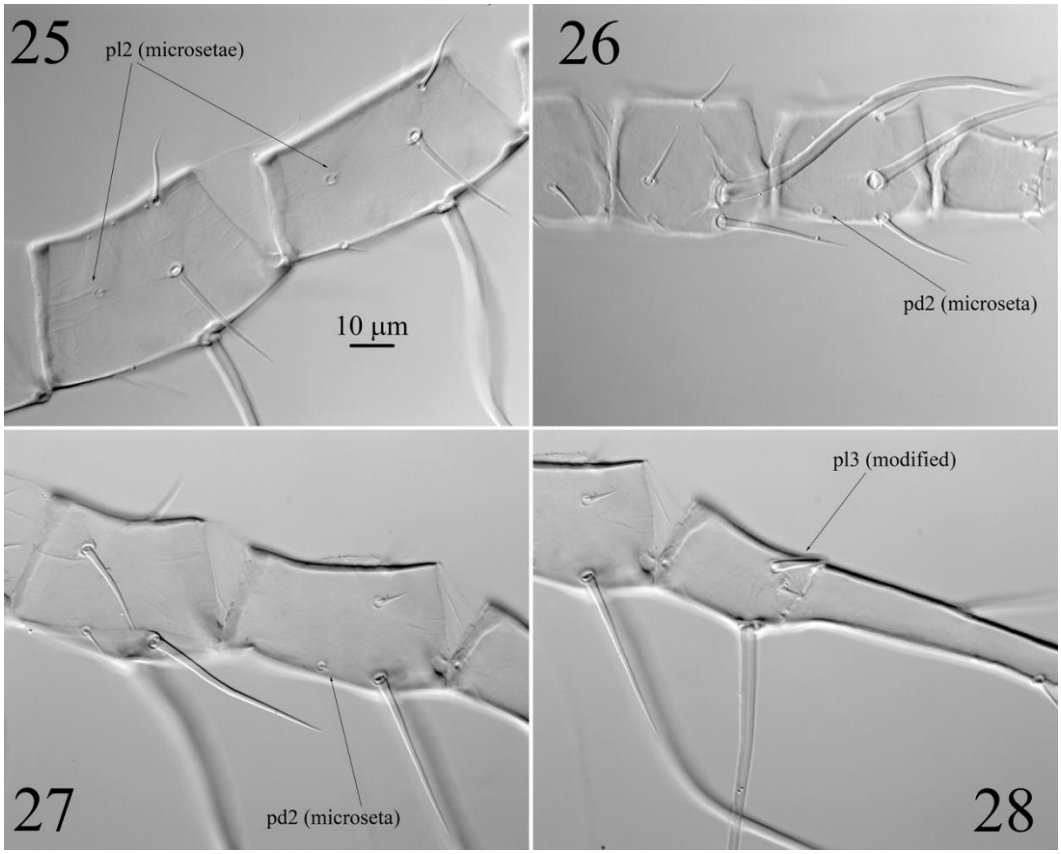

**Figures 17–20.** DIC micrographs of *Flagroseius euflagellatus* (Karg, 1983) (female) – **17.** Subcapitulum; **18.** Sternal shield; **19.** Ventrianal shield; **20.** Spermatheca.




**Figures 21–24.** DIC micrographs of *Flagroseius euflagellatus* (Karg, 1983) – **21.** Chelicerae of female; **22.** Chelicera of male; **23.** Ventrianal shield of male; **24.** Genu, tibia and tarsus of leg IV with macrosetae (female).

**Chelicera (Figs 16, 22) –** Fixed digit 21 (20–22) long, with seven teeth and pilus dentilis; movable

digit 20 (20–21) long with one tooth. Spermatodactyl foot L-shaped.




**Figures 25–28.** DIC micrographs of *Flagroseius euflagellatus* (Karg, 1983) (female) – **25.** Genu and tibia of leg I (ventral view); **26.** Genu and tibia of leg III (dorsal view); **27.** Genu and tibia of leg IV (ventral view); **28.** Basitarsus of leg IV (ventral view).

**Legs (Fig. 15) –** Leg I 350 (334–367), II 287 (275–297), III 290 (270–303), IV 366 (358–384) in length. Leg chaetotaxy as in female. Measurements of macrosetae as follows: *SgeI* 65 (64–68), *StiI* 102 (98–106), *StIa* 118 (117–120), *StIb* 102 (98–104), *SgeII* 34 (29–36), *StiII* 27 (25–30), *StII* 30 (29–30), *SgeIII* 102 (97–108), *StiIII* 65 (61–70), *SgeIV* 166 (149–175), *StiIV* 113 (107–120), *StIV* 96 (92–102). All macrosetae pointed apically, except on leg IV with small knob in some specimens.

***Remarks***

The species *F. euflagellatus* was first described by Karg in 1983, based on specimens collected from tea leaves in Ganbung, Indonesia. This unusual species was initially classified within the genus *Proprioseiopsis* and a new subgenus, *Flagroseius* (Karg, 1983). Subsequently, the species was repeatedly reported and redescribed from Indonesia (Ehara 2005) and Malaysia (Ehara 2006). Chant and McMurtry (2005), in their revision of the subfamily Amblyseiinae, assigned this species to a separate genus, *Flagroseius*, which included two species: *F. euflagellatus* (Karg) and *F. mahabaeus* (Schicha & Corpuz-Raros, 1992). After examination of holotypes of both species, authors assigned *F. mahabaeus* as junior synonym of *F. euflagellatus*.

Despite the original description by Karg (1983) and subsequent redescriptions by Chant and McMurtry (2005) and Ehara (2005), certain morphological characters were either omitted or inaccurately described, and the male was described only fragmentarily. Specifically, the original description lacks a precise account of the number of solenostomes on the dorsal shield, illustrations of the female sternal shield, and comprehensive depictions of the male (except for the chelicera). The redescription by Chant and McMurtry (2005) may contain some inaccuracies regarding cheliceral dentition, possibly due to the condition of the slide examined. Furthermore, Ehara's (2005) most recent detailed redescription includes illustrations of leg segments. However, errors are present in the number of setae on genu I (9 setae), tibia

I (9 setae), tibia III (6 setae), tibia IV (5 setae) vs. 10, 10, 7, 6 in current study. Most probably microsetae on these segments were overlooked because of their extremely short length (2–3 µm).

***Material examined***

Eight females and six males on *Citrus maxima* (Burm.) Merr., Southern Vietnam, Dong Nai province, Cat Tien National Park, 30 November 2022, 10° 27' 35.9" N, 106° 54' 10.9" E, 118 m a.s.l. All material collected by Salavatulin, V.M.

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**Author contributions:** All authors contributed equally on all counts. All authors have read and agreed to the published version of the manuscript.

**Availability of data and materials:** Data are available upon request from the authors.

**Ethics approval and consent to participate:** This study only included arthropod material, and all required ethical guidelines for the treatment and use of animals were strictly adhered to in accordance with international, national, and institutional regulations. No human participants were involved in any studies conducted by the authors for this article.

**Consent for publication:** NA.

**Competing interests:** All study participants, or their legal guardian, provided informed written consent prior to study enrollment.

**Generative AI statement:** The authors declare that AI was not used at any stage of the manuscript development.

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# توصیف تکمیلی گونه *Flagroseius euflagellatus* (Karg) (Mesostigmata: Phytoseiidae) از پارک ملی کَت تِین، جنوب ویتنام

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**دریافت**
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**انتشار**
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**دبیر تخصصی**
/. جوهرچی

## چکیده

هرنای فیتوزئید *Flagroseius euflagellatus* (Karg) بر اساس نمونه‌های ماده و نر جمع‌آوری‌شده از *Citrus maxima* (Burm.) Merr. در پارک ملی کَت تِین، جنوب ویتنام، بازتوصیف می‌شود که نشان‌دهنده نخستین گزارش از این گونه از این کشور است. توصیف‌های پیشین ناقص و نادرستی‌هایی در کتوتاکسی پا و دندانه‌های سَرونی داشتند. بازتوصیف جامع با تصاویر و اندازه‌گیری‌های دقیق از هر دو جنس و مستندسازی ساختارهای ریخت‌شناختی که پیش‌تر نادیده گرفته شده بودند، از جمله الگوهای کامل قرارگیری موهای تمام بندهای پا، ارایه می‌شود.

**واژگان کلیدی:** مهار زیستی، ریخت‌شناسی، هرناهای شکارگر، آسیای جنوب شرقی، آرایه‌شناسی

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