

## Article

### Study of nine paratypes of *Paraphytoseius santurcensis* De Leon, 1965 (Acari: Phytoseiidae) after 50 years: comments and voucher photos

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#### Abstract

To resolve the controversy of its synonymy, 7 paratype females and 2 paratype males of *Paraphytoseius santurcensis*, borrowed from Florida State Collection of Arthropods, Gainesville, FL, USA, were studied after 50 years from its original publication. Numerous voucher photos of these were taken and studied along with specimens of *Paraphytoseius orientalis*. No significant differences were observed between *P. santurcensis* and *P. orientalis*. Therefore, the former is considered to be a junior synonym of the latter, confirming the synonymy established by Matthyse and Denmark in 1981.

**Key words:** *Paraphytoseius santurcensis*; *P. orientalis*; Puerto Rico; synonym; Trinidad.

#### Introduction

*Paraphytoseius santurcensis* De Leon, 1965, was described based upon the holotype female, 6 paratype females, and 3 paratype males, collected by De Leon in Santurce, Puerto Rico, on 5 September 1963, on *Hibiscus tiliacea* (Malvaceae) and 1 paratype female collected from the same area on *Hura crepitans* (Euphorbiaceae). Thus, there were 8 females and 3 males in De Leon's collection at the time of his publication. Subsequently, during 13 September and 19 October 1963, De Leon collected other specimens of this species in St. Augustine, Trinidad, West Indies, from *Lantana trifoliata* (Verbenaceae), *Piper aduncum* (Piperaceae) and *Solanum stromoniifolium* (Solanaceae). De Leon (1967) published this collection record and illustrated the idiosoma, spermatheca, chelicera, and leg IV of the species. In his original publication (De Leon, 1965), he stated his new species *Paraphytoseius santurcensis* as being similar to *Paraphytoseius multidentatus* Swirski and Shechter 1961, but different from the latter in having: (1) a notch (or invagination) on dorsal shield lateral to L4 (= s4) [absent in original published figure of *P. multidentatus*]; (2) large setae on dorsal shield being longer than in *multidentatus*; (3) 10 pairs of pores on dorsal shield [only 4 pairs in original published figure of *multidentatus*]; (4) 2 short, rod-shaped setae on genu of leg IV (= MgeIV-1 and MgeIV-2) [only 1 such seta on genu IV (= MgeIV) of *multidentatus*]; and (5) no macrosetae (= modified setae) on legs I-III [not mentioned in original publication of *multidentatus*]. He illustrated several features of his new species very well that included the idiosomal setae and pores on the dorsal shield of the female, its venter showing the sternal shield, genital shield, ventrianal shield and their setae, the pores and setae on the integument around the ventrianal shield, the spermatheca, chelicera showing the dentition on the fixed and movable digits, leg IV with 2 kinds of macrosetae (= spatulate macrosetae and rod-shaped

modified setae) and the male spermatodactyl. Although he did not mention it in text, he illustrated leg IV as having 1 heavy macroseta on femur (= modified seta MfeIV) [not mentioned nor illustrated in original publication of *multidentatus*]. In addition, he also illustrated tibia and basitarsus of leg IV each having a heavy and rod shaped seta (= modified seta MtiIV and MbtIV) [also present in *Paraphytoseius multidentatus*]. Thus, the major difference on leg IV of these 2 species is that *P. santurcensis* has 2 rod-shaped setae on the genu (= MgeIV-1 and MgeIV-2), whereas in *P. multidentatus* has only 1 such seta on the genu (= MgeIV).

Denmark and Muma (1975) studied 1 female and 1 nymph specimens of *Paraphytoseius santurcensis* collected in San Sebastian, Puerto Rico, on 15 May 1969 from "higuillo" leaves of *Piper* sp. (Piperaceae). They did not state who the collector was. Without giving any detail, Matthyse and Denmark (1981) synonymized *Paraphytoseius santurcensis* with *Paraphytoseius multidentatus*.

Seeing controversy, Schicha and Corpuz-Raros (1985) studied 2 female and 1 male paratypes of *Paraphytoseius santurcensis* borrowed from Dr. Harold A. Denmark and reported it to be very similar to *Paraphytoseius multidentatus*. In addition, they stated that the female of *P. santurcensis* had an additional knobbed seta on genu of leg III (= MgeIII), as opposed to De Leon (1965) who had stated that there were "no macroseta on legs I-III (i.e. no modified setae on legs I-III). For this reason, Schicha and Corpuz-Raros (1985) considered the synonymy of *P. santurcensis* with *Paraphytoseius multidentatus* as doubtful. Thus, it is evident that Schicha and Corpuz-Raros (1985) had made their decision on the presence of just 1 heavy and rod shaped seta on genu III (= MgeIII) which De Leon (1965) had stated absent.

Chant and McMurtry (2003) reported *Paraphytoseius multidentatus* Swirski and Shechter, 1961, as a junior synonym of *Paraphytoseius orientalis* (Narayanan, Kaur and Ghai, 1960). They also reported examining the type of *Paraphytoseius santurcensis* and stated the presence of 5 distinct macrosetae on leg IV which included 4 spatulate macrosetae on genu, tibia, basitarsus, and distitarsus and 1 rod shaped macroseta (= MgeIV) on genu IV.

Since its original reports mentioned above, *P. santurcensis* has not been recollected and has been reported only from Puerto Rico and Trinidad. De Leon (1965) did not state if there was a nymph in his collection and where his types were deposited. After his death on 8 June 1966, his collection of *P. santurcensis* ended up in the Entomology Section, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, FL, where they were remounted in 1985. Finally, these were deposited in the Florida State Collection of Arthropods (FSCA), Gainesville, FL, USA. Collection of 1 female and 1 nymph of *P. santurcensis* mentioned by Denmark and Muma (1975) ended up also in the above collection.

Noting that there were several unresolved questions regarding *P. santurcensis* even till 2014 and noting that the above authors had studied only 1–2 paratype females, the author borrowed all 10 paratypes of this species from the Florida State Collection of Arthropods (FSCA), Gainesville, FL, USA, which included 7 females, 2 males, and 1 nymph. The results of this study, except for the nymph, comparing with study of the 10 non-type females of *P. orientalis* collected in India by the author are reported in this paper which indicate that *P. santurcensis* is junior synonym of *P. orientalis*.

While this work was nearing completion, Prasad (2015a) published on the solenostomes and the lyrifissures of 9 paratype females and males of *P. santurcensis* mentioned above and indicated that these were very similar to those as in *P. orientalis*.

But, he did not declare the synonymy of the 2 species. Prasad (2015b) also published on the sigilla of *P. santurcensis* comparing with 3 other species of this genus. Thus, the solenostomes, the lyrifissures, and the sigilla of *P. santurcensis* are only mentioned briefly in this work.

A detailed revision of different species of *Paraphytoseius*, except for *P. santurcensis* but including *P. orientalis* and *P. multidentatus*, is completed and is in review (and is in review process). As the types of *P. santurcensis* were not available when the revision work was completed, the study of this species was prepared separately and presented here.

In the present work, short, variable, rod-shaped, or clavate setae on legs I-IV have been called as "modified setae" while long and spatulate setae of leg IV on genu, tibia, basitarsus, and distitarsus have been called as "macrosetae" for comparison purposes of these 2 kinds of setae for the species of *Paraphytoseius*.

### Material and methods

Ten paratype slides of *Paraphytoseius santurcensis* were borrowed by the author from the Florida State Collection of Arthropods (FSCA), Gainesville, Florida, in December 2014 (Figs. 1–2). These included 7 females, 2 males, and 1 nymph that had typed identification data on the left labels and collection data on the right labels. The details of these 10 slides were as given below. No numbers on these slides were written which were added on left label by this author after permission from Dr. Welbourn so that reference of a particular specimen or slide could be made in the result and discussion sections of this work and by the future researchers willing to study these paratypes.

Slides #1, 2 and 3 (1 Female on each, marked as female #1, 2, 3, respectively) - Left label: Phytoseiidae, *Paraphytoseius santurcensis* De Leon, ♀, PARATYPE. Right label: Santurce, Puerto Rico, 5 IX 1963, D. De Leon, on *Hibiscus tiliacea* (*sic* for *Hibiscus tilliaceous*), #2151, Hoyer.

Slides #4, 5 and 6 (1 Female on each, marked as female #4, 5, 6, respectively) - Left label: Phytoseiidae, *Paraphytoseius santurcensis* De Leon, ♀, PARATYPE. Right label: Santurce, Puerto Rico, 5 IX 1963, D. De Leon, on *Hibiscus tiliacea* (*sic* for *Hibiscus tilliaceous*), #2151a, Hoyer.

Slide #7 (1 Female, marked as female #7) - Left label: Phytoseiidae, *Paraphytoseius santurcensis* De Leon, ♀, PARATYPE. Right label: Santurce, Puerto Rico, 5 IX 1963, D. De Leon, on *Hibiscus tiliacea* (*sic* for *Hibiscus tilliaceous*), #2152, Hoyer.

Slides #8 and 9 (1 Male on each, male #1 on slide #8 and male #2 on slide #9) - Left label: Phytoseiidae, *Paraphytoseius santurcensis* De Leon, ♂, PARATYPE. Right label: Santurce, Puerto Rico, 5 IX 1963, D. De Leon, on *Hibiscus tiliacea* (*sic* for *Hibiscus tilliaceous*), #2151a, Hoyer.

Slide #10 (1 Nymph) - Left label: Phytoseiidae, *Paraphytoseius santurcensis* De Leon, ♀, PARATYPE. Right label: Santurce, Puerto Rico, 5 IX 1963, D. De Leon, on *Hibiscus tiliacea* (*sic* for *Hibiscus tilliaceous*), #2152, Hoyer.

Thus, there were 7 paratype females, 2 paratype (allotype) males, and 1 paratype nymph\* (\*not mentioned in publication of De Leon, 1965, if he had a nymph; assumed being present in his collection as paratype mentioned on the borrowed slide; not included in the present study) on the basis of which observations were made on the paratype females and the males, voucher photos taken and this paper completed. As could be seen from Figs. 1–2, all the slides were mounted in Hoyer's medium under small, round coverslips without ringing material around the edges except for slide # 4 (female) and # 8 (male) that did have clear ringing material. All the slides were returned to Dr. W. Call

Welbourn in April 2015 after the study. Dr. Harold Denmark (pers. comm., February 2015), informed the author that the paratype mites of De Leon were remounted in 1985 by Ms. Ladonia Fields of Gainesville, Florida, who retired from his department and died a few months before this communication.

The paratype females and males were examined in the laboratory of the author in West Bloomfield, Michigan, USA. They were examined using a trinocular Acc-Scope 3000 phase-contrast microscope (Acc-Scope, New York, NY, USA) under 200–400x equipped with a Canon EOS550D camera for taking voucher photos at 100–400x. These photos were saved in Adobe Photoshop CS5™ and setal signatures added in Adobe InDesign™ program. Different characters were measured in above magnification using mounted Micrometrics™ camera. The lengths of different shields were measured in middle and width at the widest point. The setae were measured from middle of setal base to the tip. All measurements are given in micrometers (µm). Part of the data on the measurements of *P. orientalis* are taken from another study of 10 females collected in India by the author (unpublished) to compare with the present data of *P. santurcensis*.

The setal nomenclature is based on the system proposed by Lindquist and Evans (1965) as adapted for the family Phytoseiidae by Rowell *et al.* (1978); the dorsal and caudoventral setal patterns of Chant and Yoshida-Shaul (1989, 1991); and the idiosomal setal patterns of Chant and Yoshida-Shaul (1992), who also provided the designations for these setae.

The voucher photos of the type specimens will be deposited in FSCA, Gainesville, Florida, USA. These will also be placed on the site of Indira Publishing House ([www.indirapublishinghouse.com](http://www.indirapublishinghouse.com)) or a link provided for online use of other acarologists.

## Results

### *Paraphytoseius santurcensis* De Leon, 1965\*

(Figs. 1–58, Tables 1–6, S5 absent, *orientalis* species group)

*Paraphytoseius santurcensis* De Leon, 1965: 130, Fig. 12.

*Paraphytoseius santurcensis*; De Leon (1967): 17, Fig. 23.

*Paraphytoseius santurcensis*; Denmark and Muma (1975): 283.

*Paraphytoseius santurcensis*; junior synonym of *Paraphytoseius multidentatus* Swirski and Shechter (1961): 114; per Matthyse and Denmark (1981): 342.

*Paraphytoseius santurcensis*; doubtful synonymy with *Paraphytoseius multidentatus* Swirski and Shechter (1961): 114; per Schicha and Corpuz-Raros (1985): 69.

*Paraphytoseius santurcensis*; Moraes *et al.* (1986): 106.

*Paraphytoseius santurcensis*; Denmark *et al.* (1999): 11.

*Paraphytoseius santurcensis*; Chant and McMurtry (2003): 220.

*Paraphytoseius santurcensis*; Moraes *et al.* (2004): 163.

*Paraphytoseius santurcensis*; Chant and McMurtry (2007): 53.

*Paraphytoseius santurcensis*; Prasad (2012): 853.

*Paraphytoseius santurcensis*; Demite *et al.* (2014): accessed September 2014.

*Paraphytoseius santurcensis*; Prasad (2015a): 163; Prasad (2015b): 249–276.

*Paraphytoseius santurcensis*\*; junior synonym of *Paraphytoseius orientalis* (Narayanan, Kaur and Ghai, 1960); per Matthyse and Denmark (1981): 342; **synonymy accepted.**

*World distribution* – Puerto Rico and Trinidad.

*Type data*

HOLOTYPE: Female, collected in Santurce, Puerto Rico, on 5 September 1963, from *Hibiscus tiliaceus* (Malvaceae), coll. D. De Leon. PARATYPES: 6 females and 3 males collected with holotype; 1 female, from *Hura crepitans* (Euphorbiaceae), other data same as for holotype. Deposition of types not mentioned in original publication (but paratypes in Florida State Collection of Arthropods, Gainesville, Florida).

**Description, Female (based on original description and illustrations of De Leon, 1965)**

*Dorsum* – Anterior end of peritreme reaching in vertical line with base of j1. Idiosoma with 13 pairs of setae on dorsal shield and 2 pairs of setae on integument; total = 15 pairs of setae. Dorsal shield incised lateral to base of s4, length and width = not given; measurements of setae on dorsal shield: j1 (D1) = 36, j3 (L1) = 98, j4 (D2) = 7, j5 (D3) = 5, j6 (D4) = 9, J5 (D6) = 5; z2 (L2) = 9, z4 (L3) = 11, z5 (M1) = not given, Z1 (L5) = 9, Z4 (M2) = 81, Z5 (L6) = 109; s4 (L4) = 132; r3 (S1) = 52, and R1 (S2) = 36. Thus, longest seta being s4 = 132, followed by Z5 = 109, j3 = 98, Z4 = 81, r3 = 52, j1 = 36, and R1 = 36.

*Solenostomes and lyrifissures on dorsal shield* – Total of 10 pairs of pores present on the dorsal shield. These were illustrated as follow (anterior to posterior in central and lateral rows and on lateral margin of dorsal shield, 1 pair each): (1) anteromedial to z4, (2) posteromedial to z5, (3) posterolateral to j6, (4) posteromedial to Z1, (5) in area of absent J2, (6) in area of absent J4, (7) posteromedial to Z4, (8) posterior to Z4, (9) posteromedial to r3 on lateral margin of dorsal shield, and (10) posteromedial to R1 on lateral margin of dorsal shield.

*Venter* – Sternal shield illustrated, crenate posteriorly, with 3 pairs of setae (ST1, ST2, ST3). Two, roughly oval to triangular metasternal shields each with 1 seta (ST4). Genital shield truncate posteriorly, indented posterolaterally in each corner and with a thin fold, with paired setae (ST5). Single, thin, metagenital shield or fold in between genital and ventrianal shield not discussed and not illustrated. Ventrianal shield elongate, length = 105, width = 58 near anterior margin, with 3 pairs of preanal setae (JV1, JV2, ZV2) but only 2 pairs of preanal setae in 1 paratype; 1 pair of slender (primary) metapodal shields, length = 27, illustrated; secondary or accessory metapodal shields not seen; endopodal shield not discussed and not illustrated. Seta JV5 (VL1) = 85.

*Lyrifissures on ventral integument around genital and ventrianal shield* – Total 5 pairs of poroids on ventral integument in between and lateral to genital and ventrianal shields.

*Spermatheca* – Calyx resembling shallow cup-shape, length = 7; atrium and major duct distinct; all without vesicle, illustrated.

*Chelicera* – Length of fixed digit of chelicera = 22; fixed digit multidentate and movable digit with 2 teeth, illustrated.

*Leg* – Length of legs: I = 339, II = 287, III = 284, and IV = 490; leg formula on basis of length = IV, I, II–III. Thus, leg IV being longest (= 490), followed by leg I (= 339), and III (= 287)–II (= 284) being almost same. Leg IV with total of 4 spatulate macrosetae on each genu (SgeIV = 31), tibia (StiIV = 40), basitarsus (SbtaIV = 49), and distitarsus (SdtaIV = 36). Thus, macroseta on basitarsus IV being longest (= 49) followed by tibia IV (= 40), distitarsus IV (= 36), and genu IV (= 31). Modified clavate or rod-shaped setae reported absent on legs I–III but illustrated short, thick, and blunt-tipped setae on leg IV

as follow: femur = 1 [MfeIV], genu = 2 [MgeIV-1 and MgeIV-2], tibia = 1 [MtiIV], and basitarsus = 1 [MbtIV]. Chaetotaxy of genu II, genu III, tibia II, and tibia III not given.

**Description, Male (based on original description and illustrations of De Leon, 1965)**

*Dorsum* – Similar to female but with r3 and R1 on dorsal shield. Dorsal shield length = 204–230 and width = 136.

*Chelicera* – Spermatodactyl foot length = 6 and shank length = 11. Tip L-shaped.

**Description, Female (based on examination of 7 paratype specimens)**

*Dorsum* [Table 1; Figs. 3–4 (female #1); 8–9 (female #2); 13–16 (female #3); 19–20 (female #4); 27–29 (female #5); 36–38 (female #6) and 39–40 (female #7)] – All 7 paratype females indicated presence of cleavage on dorsal shield lateral to seta s4. Dorsal shield in these was mostly smooth and peritremes extended anteriorly to base of j1 except in 1 female in which it was short of j1 base on one side. Idiosoma with 13 pairs of setae on dorsal shield and 2 pairs of setae on integument; total = 15 pairs of setae. Different measurements in these females were (average with range in parentheses): Dorsal shield length = 301 (292–317), width (on podonotum) = 178 (152–264); setae j1 = 34 (30–40), j3 = 94 (90–104), j4 = 4 (4–5), j5 = 4 (4–5), j6 = 5 (4–6), J5 = 4 (4–5); z2 = 9 (8–10), z4 = 10 (9–10), z5 = 4 (4–5), Z1 = 9 (8–11), Z4 = 81 (79–85), Z5 = 107 (102–111); s4 = 125 (116–136); r3 = 51 (48–55), and R1 = 29 (26–32). Thus, of all 7 landmark setae, the longest seta being s4 = 125 (116–136), followed by Z5 = 107 (102–111), j3 = 94 (90–104), Z4 = 81 (79–85), r3 = 51 (48–55), j1 = 34 (30–40), and R1 = 29 (26–32).

**Variation** – It is evident from the above measurements that significant variation is present not only in the measurements of the dorsal shield but also in the length of the dorsal idiosomal setae.

*Folds on dorsal shield* – Females of *Paraphytoseius* species are egg-shaped having length, width, and depth. When they are mounted on the glass slides in Hoyer's medium, they become flattened showing, depending if the female is young and with or without an egg, usually, showing 2 kinds of straight to semicircular folds: (1) Central folds (CF) – These start prominently in the central areas of the dorsal shield and extend less prominently curving laterally. These have been called as anterior folds (AF) on the podonotum which are present just anterior to setae j1 (called AF1), j3 (called AF2), and s4 (called AF3) (Figs. 4, 14, 20, 28, 48, 54). (2) Lateral folds (LF) – These are less prominent and shorter than central folds and present on lateral side of the podonotum, lateral to j3 (LF1) or lateral to s4 (LF2) (Figs. 4, 14, 28 - not labeled) and the opisthonotum (LF3, lateral to Z4 or Z5, Figs. 10 and 15). The significance of these folds is that they cause distortion to solenostomes, lyrifissures, and nearby setae. The tip of some setae, like z2 and z4, get lodged giving their inaccurate measurements.

*Solenostomes and lyrifissures on dorsal shield* [Figs. 4 (female #1); 8–9 (female #2); 14–16 (female #3); 19–20 (female #4); 27–29 (female #5); 36–38 (female #6) and 39 (female #7)] – These have been discussed in detail in Prasad (2015a). Thus, not discussed here.

*Venter* [Figs. 5 (female #1); 9, 10 (female #2); 15 (female #3); 21 (female #4); 29 (female #5); 37 (female #6) and 40 (female #7)] – Sternal and metasternal shields not clear but thinly pointed and long setae ST1, ST2, ST3 and ST4 present. Genital shield almost truncate posteriorly, much wider than anterior margin of ventrianal shield. Elongate and thinly pointed pair of setae ST5 present on lateral margin of genital shield.

Ventrianal shield elongate, pentagonal, widest anteriorly than near anal area. Female #1 - In place of having normal 3 pairs of preanal setae on ventrianal shield, having no JV1 and having only ZV2 on left and only JV2 and ZV2 on right side of ventrianal shield (Fig. 5). Female #2 - Ventrianal shield is slightly wider in anal area than in anterior area. All 3 pairs of preanal setae are located on lateral edge of ventrianal shield (Fig. 10). Female #4 - It has pair of setae ZV2 on integument lateral to ventrianal shield (Fig. 21). Female #5 - Similar to female #4, but this female has seta ZV2 on right located on the integument lateral to ventrianal shield but it is on this shield on the left (Fig. 30). Female #6 - Setae JV1, JV2, and ZV2 are marginally located on the ventrianal shield (Fig. 37). Female #7 - Seta JV2 on right side of ventrianal shield is blunt-tipped and rod-shaped than thinly pointed seta on left (Fig. 41).

**Variation** – As reported above some variation in the width of the ventrianal shield, anterior near JV1-JV1 versus near anal area, is seen. But, significant variation is seen in the placement of ZV2 which is usually located on this shield but then is displaced on the integument beside this shield (Figs. 5, 21, 30). Also, seta JV2 on right side of ventrianal shield becomes blunt-tipped and rod-shaped than thinly pointed seta on left (Fig. 41).

*Lyrifissures on ventral integument around genital and ventrianal shield* [Figs. 21 (female #4) and 30 (female #5)] – These are discussed in Prasad (2015a) showing lyrifissures iST5 located on integument posterolateral to ST5; iZV1 located on integument lateral to ZV1; iZV2 located on integument lateral to ZV2 and iZV3 on integument anterolateral to ZV3.

*Spermatheca* [Figs. 6 (female #1); 16 (female #3); 22 (female #4); 30 (female #5) and 41 (female #7)] – Calyx or cervix of spermatheca dish or disc-shaped, with atrium and major duct as illustrated by De Leon (1965). Intact vesicle and minor duct also evident in some females.

**Variation** – Depending how the specimen is mounted, calyx or atrium of spermatheca may get distorted giving different shape as shown in Fig. 41.

*Gnathosoma, ventral* [Figs. 22 (female #4) and 42 (female #7)] – It is typical of order Mesostigmata (Gamasida) and family Phytoseiidae. The followings are seen clearly on ventral gnathosoma: (1) A pair of well sclerotized horn-like corniculi (CO) located anterolateral to the hypostome (HY); (2) Three pairs of hypostomal setae arranged in a triangle (HY1-HY3); (3) Pair of palpcoxal or capitular setae (CS); and (4) Deutosternal or capitular groove (CGR) with at least 6 transverse rows of deutosternal denticles (DD1-DD6) and each row mostly having about 3–4 anteriorly pointed denticles.

*Chelicera* [Figs. 6 (female #1); 16 (female #3); 22 (female #4); 27 (female #5); 36 (female #6) and 42 (female #7)] – Fixed digit with at least 6 teeth and a pilus dentilis and movable digit with at least 2 teeth located in distal half of tooth (appear to have 1–2 additional tiny teeth in middle of tooth).

*Macrosetae on leg IV* [Table 2; Figs. 3, 7 (female #1); 12 (female #2); 18 (female #3); 24, 26 (female #4); 33–35 (female #5); and 45–46 (female #7)] – Measurements of 4 spatulate macrosetae on leg IV in 6 paratype females, Sge = 28 (24–31), Sti = 38 (34–41), Sbta = 49 (48–51), and Sdta = 35 (30–40).

*Modified setae on legs I-IV* [Table 3; Figs. 2, 6–7 (female #1); 8, 11–12 (female #2); 13, 17–18 (female #3); 19, 23–26 (female #4); 27, 31–35 (female #5) and 39, 43–46 (female #7)] – Leg I - Genu usually with 1 (MgeI) but occasionally with 2 (MgeI-1, MgeI-2) modified rod-shaped dorsal setae. Each tibia and basitarsus usually without but occasionally with 1 rod-shaped modified dorsal seta (MtiI, Mbtal). Leg II - Genu commonly with 1 short, heavy and clavate modified dorsal seta (MgeII on mid segment) but

occasionally with additional 1–2 rod-like modified dorsal setae (MgeII-1, proximal, and MgeII-3, distal). Each tibia and basitarsus usually without but occasionally with 1 rod-shaped modified dorsal seta (MtiII, MbtaII). Leg III - Genu usually without but occasionally with 1 modified rod-shaped dorsal seta (MgeIII). Each tibia and basitarsus without any modified seta. Leg IV - Femur with 1 moderately long and clavate modified anterolateral seta (MfeIV). Each genu, tibia, and basitarsus with 1 modified dorsal seta (MgeIV, MtiIV, MbtaIV) but genu, occasionally, with 2 such setae (MgeIV-1, MgeIV-3). Also, this kind of seta (MbtaIV), occasionally, absent on basitarsus. Lengths of legs I-IV not measured and chaetotaxy of genu and tibia of legs I-IV not studied.

#### *Remarks*

Femur of legs I-III have none but femur of leg IV always has 1 moderately long and elongate rod-shaped to clavate dorsal modified seta (MfeIV). Each genu, tibia, and basitarsus of leg IV also has 1 short rod-shaped modified seta (2 on genu in occasional cases). Genu of leg II always has 1 short, heavy, and clavate dorsal seta (MgeII-2) which is absent on genu I, III, IV. But 1–2 rod-shaped modified setae may be present on genu I-IV. Leg III usually does not have any modified seta. These modified setae have been reported differently in *Paraphytoseius* species by different authors, including 1–2 type specimens examined by them.

#### **Description, Male (based on examination of 2 paratype specimens)**

*Dorsum* [Table 4; Figs. 47–48 (slide # 8, male #1) and 53–55 (slide # 9, male #2)] – Smaller than female, with setae r3 and R1 on dorsal shield, and peritremes reaching anteriorly much short to base of j1. Dorsal shield smooth, without incision lateral to s4, and with 15 pairs of setae. Different measurements in 2 males were as follow (average with range in parentheses): Dorsal shield length = 236 (235–236), width (on podonotum) = 149 (145–152); setae j1 = 27 (26–28), j3 = 67 (65–68), j4 = 4 (3–4), j5 = 4 (3–4), j6 = 4 (3–4), J5 = 5 (4–5); z2 = 8 (7–9), z4 = 9 (8–9), z5 = 4 (3–4), Z1 = 8 (7–8), Z4 = 54 (51–56), Z5 = 69 (67–71); s4 = 87 (85–88); r3 = 39 (36–42), and R1 = 17 (14–20). Thus, of all 7 landmark setae, the longest seta (based on average) being s4 = 87 (85–88), followed by Z5 = 69 (67–71), j3 = 67 (65–68), Z4 = 54 (51–56), r3 = 39 (36–42), j1 = 27 (26–28), and R1 = 17 (14–20).

*Solenostomes and lyrifissures on dorsal shield* [Figs. 47–48 (male #1) and 53–55 (male #2)] – Only some seen clearly [gd5, gd8, id4, is1, idl2, idl3, idl4, idm4, idm5] but not others.

*Venter* [Figs. 49 (male #1) and 55–56 (male #2)] – Sternogenital shield large, elongate, with normal 5 pairs of sternal setae ST1–ST5 in between coxae I–IV. Ventrianal shield large, wider than long, with 3 pairs of preanal setae JV1, JV2, ZV2; pair of paraanal setae (PA), and single postanal seta (PO). Seta JV5 on integument posterolateral to ventrianal shield.

*Lyrifissures on ventral integument around genital and ventrianal shield* [Figs. 49 (male #1) and 56 (male #2)] – Lyrifissures iZV1 and iZV2 appear to be present on ventrianal shield and iZV3 appear to be on integument anterolateral to JV5 and iJV5 appear to be on integument medial to JV5.

*Gnathosoma, ventral* [Figs. 50 (male #1) and 57 (male #2)] – Similar to female.

*Chelicera* [Figs. 50 (male #1) and 57 (male #2)] – Fixed digit with 5 visible teeth and a pilus dentilus. Movable digit with 1 distally located tooth. Spermatodactyl on movable

digit with elongate shaft (shank), short distal T-shaped foot having pointed toe, heel and lateral process.

*Macrosetae on leg IV* [Table 5; Figs. 52 (male #1) and 59 (male #2)] – Measurements of 4 spatulate macrosetae on leg IV in 2 paratype males, Sge = 22 (21–22), Sti = 30 (29–30), Sbta = 38 (37–38), and Sdta = 27 (26–27).

*Modified setae on legs I-IV* [Table 6; Figs. 51-52 (male #1) and 53, 58-59 (male #2)] – Short, heavy, and clavate modified seta MgeII on genu of leg II present. In addition, slightly longer than MgeII and elongate rod-shaped modified seta present on each genu I (MgeI), moderately long and rod-shaped modified seta on femur IV (MfeIV) and basitarsus IV (MbtIV).

Based on the present study, including numerous voucher photos and several tables, it is declared that *P. santurcensis* is a junior synonym of *P. orientalis*. Thus, this finding supports the synonymy proposed by Matthyse and Denmark (1981).

### Discussion

As stated before in the Introduction, De Leon (1965) stated his new species *Paraphytoseius santurcensis* being similar to *Paraphytoseius multidentatus* Swirski and Shechter 1961, but different from the latter in having: (1) a notch (or invagination) on dorsal shield lateral to L4 (= s4) [absent in original published figure of *P. multidentatus*]; (2) large setae on dorsal shield being longer than in *multidentatus*; (3) 10 pairs of pores on dorsal shield [only 4 pairs in original published figure of *multidentatus*]; (4) 2 short, rod-shaped setae on genu of leg IV (= MgeIV-1 and MgeIV-2) [only 1 such seta on genu IV (= MgeIV) of *multidentatus*]; and (5) no macrosetae (= modified setae) on legs I-III [not mentioned in the original publication of *multidentatus*].

Both *multidentatus* and *santurcensis* have disc - or dish-shaped spermatheca and movable digit has 2 teeth and fixed digit has 7 teeth in *multidentatus* and is multidentate in *santurcensis*. De Leon (1965) also illustrated (but did not mention in text) 1 modified seta on each femur, tibia, and basitarsus of leg IV which were similar to as in *Paraphytoseius multidentatus*. However, he mentioned and illustrated 2 short, rod-shaped setae on genu of leg IV when Swirski and Shechter (1961) had mentioned and illustrated only 1 such seta on genu of leg IV.

Matthyse and Denmark (1981) had synonymized *P. santurcensis* with *P. multidentatus* Swirski and Shechter 1961, which Schicha and Corpuz-Raros (1985) had considered doubtful. Chant and McMurtry (2003) reported *P. multidentatus* as a junior synonym of *P. orientalis* (Narayanan, Kaur and Ghai, 1960), and stated the female of *P. santurcensis* having additional knobbed seta on genu of leg III (= MgeIII) when De Leon had stated "no macroseta on legs I-III."

Thus, keeping above controversies in mind, the present study of 7 paratype females and 2 males of *P. santurcensis* and 10 non-type females of *P. orientalis* from India could be summarized as given below (Tables 1-6, Figs. 1-60).

*Notch or invagination on dorsal shield* (Fig. 14) – De Leon (1965) reported the presence of a notch on the dorsal shield in *P. santurcensis* when it was reported absent or present in *P. orientalis* (Syn.: *P. multidentatus*). Report of the absence of a notch in the genus *Paraphytoseius* was considered an error by Chant and McMurtry (2003, 2007). It was found in the present study that it was always present but sometimes it had collapsed or was covered under the large tubercle and thick seta s4 giving the impression that it was absent. This collapsed tubercle created a lateral depression near the base of this seta in which the distal end of seta z4 got trapped giving its inaccurate length measurement if not

seen clearly. The notch or invagination was found present lateral and slightly anterior to the base of seta s4 in all 7 paratype females included in the present study (Table 1, Fig. 14).

*Peritreme* (Fig. 14) – Similar to the illustration of the peritreme given by De Leon (1965), the anterior end of peritreme on each side in 7 paratype females extended in vertical line to base of j1. Similar to above, in *P. orientalis*, it extended anteriorly to base of j1 too.

*Length and width of dorsal shield* – As indicated in Table 1, De Leon (1965) gave these as follow: Length = 288 and width = 170. His measurements were of a holotype female which could not be obtained for the present study. The whereabouts of this holotype female is unknown. The average measurements (range in parentheses) of 7 paratype females were: Length = 301 (292–317) and width = 178 (152–264). These indicate slightly larger measurements of length and width in the paratype females than in the holotype female. However, measurements of De Leon (1965) fall within the range or are very close to measurements of *P. orientalis* being: Length = 309 (290–336) and width = 160 (142–182) (Table 1).

*Length of dorsal setae* – Table 1 gives measurements of 15 pairs of dorsal idiosomal setae in 7 paratype females which includes also the measurements of these as given by De Leon (1965). All of his measurements fall within the range of or are very close to the present study except for R1 = 36 against the present study of 29 (26–32). But, all of his measurements are very close to or fall within the range of *P. orientalis* [except for his R1 = 36; *orientalis* = 30 (25–33)]. As stated before, his measurements are from a holotype female only.

*Large setae on dorsal shield* (Table 1; Figs. 3–5, 8–10, 13–16, 19–20, 27–29, 36–37, 39–40, 47–48, and 53–55) – De Leon (1965) stated large setae on the dorsal shield being longer in *P. santurcensis* than in *P. multidentatus*. His measurements of 7 landmark setae in the holotype female were (Table 1): j1 (D1) = 36, j3 (L1) = 98, Z4 (M2) = 81, Z5 (L6) = 109; s4 (L4) = 132; r3 (S1) = 52, and R1 (S2) = 36. As given above, all of his measurements, except for R1 (= 36), were similar to the present study of *P. santurcensis* and *P. orientalis* (Table 1). He had compared his measurements of single holotype female with the measurements of 7 type females of Swirski and Shechter (1961) [given in bracket] that were as follows: j1 (D1) = 36 [30–38], j3 (L1) = 98 [76–81], Z4 (M2) = 81 [69–81], Z5 (L6) = 109 [76–91]; s4 (L4) = 132 [107–124]; r3 (S1) = 52 [41–46], and R1 (S2) = 36 [20–33].

*Pores on dorsal shield* (Figs. 14–16 and 27–29) – Solenostomes and lyrifissures in *P. santurcensis* have been discussed and illustrated by Prasad (2015a) giving many voucher photos. Many of these are included in the present showing clearly. In brief, Prasad (2015a), out of 8 pairs on the dorsal shield and the peritremal shield, saw only 7 pairs of solenostomes [gd1, gd2, gd3 - not seen on peritremal shield, gd4, gd5, gd6, gd8, gd9]. Of these, large gd5 and punctiform gd8 were seen consistently in all females and males. In addition to these, a total of 19 pairs of lyrifissures [16 pairs on the dorsal shield (id1, id2, id4, id6, idx1, is1; idl2, idl3, idl4, idm1, idm2, idm3, idm4, idm5, idm6, idx2) and 3 pairs on the peritremal shield (id3, id7, id8)] of *P. santurcensis* were seen when De Leon (1965) had stated having only 10 pairs of pores-poroids on the dorsal shield of this species. This kind of disagreement between different authors in the species of *Paraphytoseius* is not uncommon as most of these are tiny structures, often difficult to see, and several specimens are required to identify all these 26–28 pairs of pores and poroids on the dorsal shield and the peritremal shield.

*Macrosetae on leg IV* (Table 2, female; Table 5, male; Figs. 7, 12, 18, 24, 26, 33, 35, 52, and 59) – These are very stable, large, and spatulate setae on leg IV in the female and male of *P. santurcensis*. De Leon (1965) gave measurements of 4 spatulate macrosetae on leg IV of his holotype female as (Table 2): Sge = 31, Sti = 40, Sbta = 49, and Sdta = 36. Thus, the longest macroseta being on basitarsus and the shortest being on genu. The measurements of these setae in 6 female paratypes of this species in the present study (Table 2) indicates as follows (range in parentheses, and of De Leon in bracket): Sge = 28 (24–31) [31], Sti = 38 (34–41) [40], Sbta = 49 (48–51) [49], and Sdta = 35 (30–40) [36]. It can be seen that all the measurements of De Leon (1965) fall in the range of the 6 paratype females measured. Table 2 also indicates that measurements of these 4 macrosetae given by De Leon (1965) and of the present study fall in the range of the measurements of *P. orientalis*.

*Modified setae on legs I-IV* (Table 3; Figs. 6–7, 11–12, 17–18, 23–26, 31–35, 43–46, 51–52, and 58–59) – There are 3 kinds of setae on legs I-IV of *Paraphytoseius* species, including *P. orientalis* and *P. santurcensis*. One kind are finely or thinly pointed setae commonly called as "setose, setaceous, or pointed setae, or just as setae" present on all leg segments. The second kind are thick and spatulate-tipped setae called as "macrosetae" that are present dorsally only on genu, tibia, basitarsus, and distitarsus of leg IV called as SgeIV or sgeIV (on genu), StiIV or stiIV (on tibia), SbtaIV or sbtaIV or stbIV (on basitarsus), and SdtaIV or staIV (on distitarsus). The third kind are "rod-, club-shaped, or clavate setae" that are present on femur of leg IV and genu, tibia, basitarsus, and distitarsus of legs I-IV (usually absent on leg III and distitarsus of legs I-IV). Similar to macrosetae of leg IV (SgeIV, StiIV, SbtaIV, and SdtaIV), these third kind of setae have been called also as "small blunt setae" (Swirski and Shechter 1961); "short, rod-shaped setae" (De Leon 1965); "rod-like setae" (Ehara 1967); "knobbed macrosetae" (Schicha & Corpuz-Raros 1985; Ho & Lo 1989); "blunt-tipped macrosetae" (Beard & Walter 1996; Ehara, Gotoh & Amano 2000); "macrosetae" (Ehara & Amano 2004); and "stout, spatulate, short, knobbed or blunt setae" (Moraes, Zannou, Ueckermann, Oliveira, Yaninek & Hanna 2007). These differentiated setae tend to be the pd1 setae on genu I and genu II, and the ad1 setae on genu III and genu IV, though some species have additional such setae (Denmark & Evans 2011; e.g., as in *P. hilli*). Several species in *Paraphytoseius* have been described that have these differentiated or modified setae but named differently, and lumping together with spatulate macrosetae, by different authors even in the same species causing confusion in the published works.

Prasad and Karmakar (2015) called the spatulate setae on leg IV as "Primary macrosetae" and the modified setae on legs I-IV as "Secondary macrosetae" in *Paraphytoseius* species. Beard and Walter (1996) described their new species *Paraphytoseius hilli* Beard and Walter, 1996, unusually having large number of such "knobbed or blunt-tipped setae" on legs I-IV [I-II-III-IV: genua = 6, 5, 5, 5 (including 1 SgeIV) and tibiae = 4, 4, 5, 4 (including 1 StiIV)] and leg IV having additional thick, knobbed or blunt-tipped setae on trochanter (= 1), femur (= 4), and basitarsus (= 1). Seeing variation of such setae in the present study of *P. santurcensis*, all these short, clavate or rod-shaped setae of legs I-IV have been called "Modified setae" and labeled as "MfeIV = on femur IV, MgeI = on genu I, MgeII = on genu II" etc. If found 2 or 3 on same segment (e.g. on genu II), they have been called (from proximal to distal) as "MgeII-1, MgeII-2, and MgeII-3" for comparison purposes.

From the above and as given in Table 3 and several figures (Figs. 6–7, 11–12, 17–18, 23–26, 31–35, 43–46, 51–52, and 58–59), it is apparent that the rod-shaped or clavate

setae on legs I-IV: (1) are modified setae, (2) not seen alike by all researchers even in the same species, (3) most species of *Paraphytoseius* (excluding *P. hilli*) have these modified setae on all or some legs, and (4) have variable lengths and tips. However, this seta on genu II (MgeII) is, almost always, clavate (Figs. 7, 11, 17, 23, and 25) and longer than on genu I (MgeI) (Figs. 6, 11, 17, 23, and 25) in *P. santurcensis*. Modified seta on femur of leg IV (MfeIV) is very stable, clavate or rod-shaped, longer than MgeI or MgeII (Fig. 26), and easily seen even in low magnification (Figs. 3, 7, 12, 23, 26, 33, and 34). Also, these modified setae on leg III and IV are thin rod-shaped, slightly curved, and may have slight clavate tip (Figs. 7, 11–12, 18, 24–26, 35, and 45) but, often, do not have pointed tip. These on leg IV are very similar to those of *P. orientalis* as shown in Fig. 60 and several published line drawings of leg IV of this species mentioned before (also, see *P. multidentatus* and other synonymized species). These modified setae on legs of male (Table 6) are shorter and thinner than in the females and, often, are difficult to recognize if modified setae unless greatly enlarged.

Schicha and Corpuz-Raros (1985) and Chant and McMurtry (2003) examined only 1 or 2 paratype females of *P. santurcensis* and did not see same number of modified setae. In the present study, 7 paratype females and 2 paratype (allotype) males were examined giving more extensive data on measurements and information on the variation. It was noted that unless some of these setae were examined under very high magnification and or enlarged in Photoshop or other programs, some of these were hard to determine if they had clavate, rod-shaped, or pointed tips. Therefore, these setae must be examined under high magnification in case of uncertainty.

Macrosetae have been defined differently by different phytoseiid researchers. Muma *et al.* (1970) called macrosetae of legs I-IV if they were noticeably thicker than other setae of the segment, or their lengths were more than half the length of the segment on which present, and if facing distally (towards pretarsus). Other enlarged or modified setae were not considered macrosetae by them. Schicha (1987) called macrosetae of legs to those setae that were noticeably different than the "normal" setaceous setae and or if their lengths were more than half the length of the segment on which they were present. Beard (2001) called these as enlarged, differentiated setae, longer (sometimes not so) and thicker or knobbed than other setae on the same segment that were normally thin and setiform. She considered these differentiated setae as pd1 on genu I and II, and ad1 on genu III and IV, and some species having more such setae on the legs.

As stated before, these rod-shaped or clavate setae on legs I-IV in *P. santurcensis* and other species of *Paraphytoseius* have created confusion in published literature as these had been lumped together with traditionally called macrosetae (SgeIV, StiIV, SbtIV, and SdtaIV) in giving the total counts of macrosetae on legs I-IV in descriptions and discussions. The author of this work believes, as stated before, that these setae, even though they meet some of the above criteria of being called as macrosetae, are modified and variable setae, and should be named as "Modified setae" for comparison purposes with those of traditionally called "Macrosetae". It is believed also that these setae have evolved differently in different species for different ecological-physiological reasons for adaptive purposes.

*Ventral characteristics* (Figs. 5, 10, 21, 30, and 41) – These in *P. santurcensis*, including spermatheca and shape of ventrianal shield and setae, are very similar to those of *P. orientalis*. De Leon (1965) did state that, instead of the normal 3 pairs, 1 paratype female had only 2 pairs of preanal setae indicating the variation from norm. In the present study, female #1 (Fig. 5) and female #4 (Fig. 21) indicated only 2 pairs of preanal setae

(JV1 and JV2) on each side of the ventrianal shield and, unusually, ZV2 on the integument. But, female #5 (Fig. 30) indicated 3 setae on left (JV1, JV2, ZV2) and only 2 pairs (JV1, JV2) on right margin of the ventrianal shield and seta ZV2 on integument right of the ventrianal shield. It is possible that De Leon (1965) had examined one of these females but did not mention that 3 females had such major variations. He did not mention either that one of his paratype females (female # 7, slide #7, Fig. 41), unusually, had rod-shaped seta JV2 on right. Thus, among his 7 paratype females studied, 4 females or 57% type females had this kind of high variation in the preanal setae.

Usually, the ventrianal shield in *P. santurcensis* is widest anteriorly near JV1-JV1, constricted bilaterally posterior to JV2, and widens, but less than anterior, near mid anus just posterior to paired paraanal setae. Also, the 3 pairs of preanal setae (JV1, JV2, ZV2) are located on the lateral margin, but in about anterior one third, of the ventrianal shield. The transverse distance between bases of ZV2-ZV2 is more than JV1-JV1 and JV2-JV2. The vertical distance between JV1-ZV2 and ZV2-JV2 are small but almost the same. Occasionally, this is not the case and the ventrianal shield may be slightly wider posteriorly near the anal area than anteriorly near setae JV1-JV1 and, similar to variation in lengths of setae, the distance in between the bases of 3 pairs of preanal setae may vary. Occasionally, these 3 pairs of setae may appear in a vertical line. These kind of variable characteristics have been used to define some new species in *Paraphytoseius*. It is good to visualize the ventrianal shield, along with sternal shield and ventrianal shield, in 3 dimensional view understanding that these structures have not only length and width but depth as well to allow these structures to expand and retract. Thus, shape may change and vary in Hoyer's mounted specimens. Female #2 shows normal pentagonal ventrianal shield, with all preanal setae located normally on the shield, but shows being widest posteriorly near the anal area than anteriorly near JV1-JV1 area.

De Leon (1965) illustrated 5 pairs of lyrifissures (called as iST5, iZV1, iZV2, iZV3, and iJV5 in the present study) present ventrally lateral to posterior genital shield and lateral to ventrianal shield. In his later publication on same species from Trinidad, De Leon (1967) illustrated only 3 pairs of these lyrifissures (iST5, iZV1, and iZV2). These 3 kinds and iZV3 were clearly seen in Female #5 (Fig. 30).

*Gnathosomal characteristics* – The gnathosoma (Figs. 22, 42), although not illustrated in *P. santurcensis* (or any other species of *Paraphytoseius*) by any phytoseiid researcher, Figs. 22 and 42 in female and Figs. 50 and 57 in male, indicate that it represents Mesostigmata and Phytoseiidae. It has similar palps with 1 heavy and blunt tipped seta (al) on femur and 2 such setae (al1 and al2) on genu. In addition, it has bifurcated palpal apotele at ventral base of thumb-like tarsus and no claws. Dorsally, it has paired chelicerae, harpoon-shaped corniculi and ventrally has 3 pairs of hypostomal setae, 1 pair of capitular setae, and other structures around the oral opening and on the ventral gnathosoma.

De Leon (1965) illustrated 2 teeth on movable digit of chelicera in a paratype he collected in Puerto Rico but illustrated 3 teeth on movable digit (showed 3rd posteriormost tooth being very tiny) of chelicera in a female he collected in Trinidad (De Leon 1967). He illustrated fixed digit as multidentate having a pilus dentilus. It appears to have at least 6 teeth on it. In the present study, movable digit was observed to have 2 pronounced teeth located distally and 1-2 tiny and less pronounced teeth proximally and, thus, having 2-4 teeth on the movable digit (Figs. 6, 16, 22, 27, 36, 42). The fixed digit was found to have up to 7 teeth and a pilus dentilus.

**Males** (Figs. 47–59) – Measurements of 2 males in present study are given in the Results section and in Tables 4 and 5. Males are much smaller than the female. These males are compared with measurements of 3 males given by De Leon (1965). Measurements of length and width of the dorsal shield given by De Leon (1965) (L = 204-230 and W = 136) are slightly less than the present study (L = 235-236 and W = 145-152). He did not give the measurements of macrosetae on leg IV. De Leon (1965) stated male resembling female. He illustrated spermatodactyl stating shank = 11 long and foot = 6 long. In the present study of 2 males, the spermatodactyles were found to be L-shaped as shown in Figs. 50 and 57, similar to as illustrated by De Leon (1965).

**Host association** – *Hibiscus tiliacea* [*sic* for *tilliaceus*] (Malvaceae), *Hura crepitans* (Euphorbiaceae), *Lantana trifoliata* = *Lantana trifolia* (Verbenaceae), *Piper aduncum* (Piperaceae), and *Solanum stromoniifolium* [*sic* for *Solanum stramonifolium* (Solanaceae)] (De Leon 1967).

**Variation in *Paraphytoseius santurcensis*** – Variation occurs in *P. santurcensis* in relation to length and width of dorsal shield, length of setae, shape of the ventrianal shield, and presence of preanal setae on the ventrianal shield. In addition, variation in number of modified setae on legs I-IV is also present.

**Similarities between *Paraphytoseius santurcensis* and *Paraphytoseius orientalis*** – As discussed above, morphologically, *P. santurcensis* is identical to *P. orientalis*. Even the measurements of these 2 species given in different tables fall within the range of variation of each other. The macrosetae and the modified setae on legs I-IV are identical to those as in *P. orientalis*. It is believed that differences in the observations of Schicha and Corpuz-Raros (1985) [reporting additional knobbed (modified) seta on each genu of leg III and IV] and Chant and McMurtry (2003) [reporting 1 such knobbed (modified) seta on genu of leg IV] may have been as they had examined only 1 or 2 paratype females. As the present work included studies of 7 paratype females and 2 paratype (allotype) males of *P. santurcensis* and 10 non-type females of *P. orientalis* from India, it was possible to note the similarities between these 2 species and note the variations in *P. santurcensis*.

### Conclusion

Based on the above studies and seeing the similarities and the variations, *Paraphytoseius santurcensis* is considered as a junior synonym of *Paraphytoseius orientalis* as established by Denmark & Matthyse (1981). The latter species has wide geographic and large host associations. Thus, this species has adapted to different climatic and plant host associations. It is considered that the modified setae on legs I-IV are greatly variable in length, thickness, shape of tip, and number. These are going through significant mutational changes, possibly, due to adaptive changes of this species, and that seta ZV2 is moving away on the integument from its normal location on the ventrianal shield.

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**مطالعه ۹ پاراتیپ گونه (Acari: *Paraphytoseius santurcensis* De Leon, 1965)  
Phytoseiidae) پس از ۵۰ سال: تفسیرها و تصاویر مستند**

ویکرام پراساد

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### چکیده

برای حل جدال در مترادف گونه، ۷ پاراتیپ ماده و ۲ پاراتیپ نر *Paraphytoseius santurcensis* قرض گرفته شده از کلکسیون بندپایان ایالت فلوریدا، گینسویل، فلوریدا، ایالات متحده آمریکا پس از ۵۰ سال از چاپ نخستین توصیف آن مطالعه شدند. تصاویر مستند فراوانی از آنها تهیه و با گونه *Paraphytoseius orientalis* مقایسه شدند. اختلاف معنی دار و مهمی بین دو گونه دیده نشد. بنابراین گونه دومی به عنوان مترادف کم سابقه گونه نخست در تأیید مترادف ایجاد شده توسط ماتیسه و دنمارک در سال ۱۹۸۱ در نظر گرفته شد.

واژگان کلیدی: گونه *Paraphytoseius santurcensis*؛ گونه *P. orientalis*؛ پورتوریکو؛ مترادف؛ ترینیداد.

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**Table 1.** Measurements of dorsal idiosomal characteristics in 7 paratype females of *Paraphytoseius santurcensis* collected in Puerto Rico by De Leon (1965) [FSCA] (x = not measured) and compared with those of 10 non-type females of *Paraphytoseius orientalis* collected in India (\*\*\*)

Particulars	Female 1		Female 2		Female 3		Female 4		Female 5		Female 6		Female 7		De Leon (1965)		Average		Range		
	Slide #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Dorsal shield L	300	317	292	292	295	302	293	305	301	301	292-317	288	309	290-336							
Dorsal shield W	170	181	152	152	264	162	160	160	178	178	152-264	170	160	142-182							
Dorsal shield cleavage	present	present	present	present	present	present	present	present	present	present	present	present	present	present							
DS sculpturing pattern*	smooth	smooth	smooth	smooth	smooth	smooth	smooth	smooth	smooth	smooth	smooth	smooth	smooth	smooth							
Peritremes extending to	j1	j1	j1	j1	j1	j1**	j1	j1	j1	j1	j1	j1	j1	j1	j1	j1	j1	j1	j1	j1	j1
j1	36	40	34	34	35	34	30	30	34	34	30-40	36	39	35-44							
j3	91	104	90	90	93	94	94	91	94	94	90-104	98	92	85-102							
j4	5	4	5	5	4	5	4	4	4	4	4-5	7	5	4-6							
j5	5	4	5	5	4	5	4	4	4	4	4-5	5	4	4-5							
j6	5	6	5	5	4	5	4	4	5	5	4-6	9	5	4-6							
J5	5	5	4	4	5	5	4	4	5	5	4-5	5	5	4-6							
z2	9	8	8	8	9	10	9	9	9	9	8-10	9	11	8-13							
z4	10	10	9	9	9	10	10	9	10	10	9-10	11	11	9-15							
z5	5	4	5	5	4	5	4	4	4	4	4-5	x	4	4-5							
Z1	10	11	9	9	8	9	9	9	9	9	8-11	9	9	7-11							
Z4	83	85	80	80	80	79	79	80	81	81	79-85	81	83	79-95							
Z5	108	107	111	111	102	110	106	108	107	107	102-111	109	105	101-118							
s4	126	136	116	116	127	129	121	123	125	125	116-136	132	126	116-132							
r3	49	54	48	48	55	53	49	48	51	51	48-55	52	49	43-61							
R1	31	29	28	28	32	28	28	26	29	29	26-32	36	30	25-33							

\* = Mostly smooth with light reticulations on lateral side of the dorsal shield.

\*\* Peritreme much short of j1 on right

\*\*\* = *Paraphytoseius orientalis* - Part of data from unpublished work.

De Leon (1965) - Measured holotype female only.

FSCA = Florida State Collection of Arthropods, Gainesville, FL, USA.

**Table 2.** Measurements of macrosetae on leg IV in 6 paratype females of *Paraphytoseius santurcensis* collected in Puerto Rico by De Leon (1965) [FSCA, slide #6, female, legs not in good condition to measure] and compared with those of 10 non-type females of *Paraphytoseius orientalis* collected in India (x = not clear to measure).

Particulars	Female 1	Female 2	Female 3	Female 4	Female 5	Female 7	Average	Range	De Leon	Average	Range
Slide #	1	2	3	4	5	7			1965	<i>P. orientalis</i>	<i>P. orientalis</i>
Leg IV										*	*
SgeIV	28	31	24	29	28	29	28	24-31	31	28	25-31
StiIV	37	41	34	38	38	38	38	34-41	40	37	33-44
SbtaIV	49	48	48	51	50	49	49	48-51	49	46	41-50
SdtaIV	35	35	30	40	x	35	35	30-40	36	36	33-40

\* = *Paraphytoseius orientalis* - Part of data from unpublished work.

FSCA = Florida State Collection of Arthropods, Gainesville, FL, USA.

**Table 3.** Modified setae on legs I-IV in 6 paratype females of *Paraphytoseius santurcensis* collected in Puerto Rico by De Leon (1965) [FSCA, slide #6 (x), female, legs not in good condition to measure] and compared with those of Schicha and Corpuz-Raros (1985) and Chant and McMurtry (2003b) [x = absent, not seen, not reported].

Particulars	Female 1	Female 2	Female 3	Female 4	Female 5	Female 6	Female 7	De Leon	Schicha	Chant
Slide #	1	2	3	4	5	6 (x)	7		and C-R	and McM
Leg I										
MgeI	1, 2	1	2	1	1	x	1	x	x	x
MtiI	1	x	x	x	x	x	x	x	x	x
MbtiI	1	x	x	x	x	x	x	x	x	x
Leg II										
MgeII	1, 3	1, 2	1	1	1	x	1	x	x	x
MtiII	x	x	x	x	0, 1	x	x	x	x	x
MbtiII	1	x	x	x	x	x	x	x	x	x
Leg III										
MgeIII	1	1	x	0, 1	0	x	x	x	1	x
MtiIII	x	x	x	x	x	x	x	x	x	x
MbtiIII	x	x	x	x	x	x	x	x	x	x
Leg IV										
MfeIV	1	1	1	1	1	x	1	1	x	x
MgeIV	1	1	2	2	1, 2	x	1	2	1	1
MtiIV	1	1	1	1	1	x	1	1	x	x
MbtiIV	1	1	x	1	1	x	1	1	x	x

\*\*# of MfeIV, MgeIV, MtiIV, and MbtIV from figure of De Leon (1965a). He stated modified setae absent on legs I-III.  
FSCA = Florida State Collection of Arthropods, Gainesville, FL, USA.

**Table 4.** Measurements of dorsal idiosomal characteristics in 2 paratype males of *Paraphytoseius santurcensis* collected in Puerto Rico and compared with those of males of De Leon, 1965, and 10 females of *Paraphytoseius orientalis* collected in India (FSCA, x = not clear to measure).

Particulars	Male 1	Male 2	Average	Range	De Leon 1965****	F-Average <i>P. orientalis</i>	F-Range <i>P. orientalis</i>
Slide #	8	9					
Dorsal shield length	236	235	236	235-236	204-230	309	290-336
Dorsal shield width**	152	145	149	145-152	136	160	142-182
Dorsal shield cleavage	present	present	present		present		
DS sculpturing pattern*	smooth	smooth	smooth		smooth		
Peritremes to***	j1	j1	j1		j1		
j1	28	26	27	26-28	x	39	35-44
j3	65	68	67	65-68	x	92	85-102
j4	3	4	4	3-4	x	5	4-6
j5	3	4	4	3-4	x	4	4-5
j6	3	4	4	3-4	x	5	4-6
J5	4	5	5	4-5	x	5	4-6
z2	7	9	8	7-9	x	11	8-13
z4	8	9	9	8-9	x	11	9-15
z5	3	4	4	3-4	x	4	4-5
Z1	7	8	8	7-8	x	9	7-11
Z4	56	51	54	51-56	x	83	79-95
Z5	71	67	69	67-71	x	105	101-118
s4	85	88	87	85-88	x	126	116-132
r3	42	36	39	36-42	x	49	43-61
R1	20	14	17	14-20	x	30	25-33

\* = Mostly smooth with light reticulations on lateral side of the dorsal shield.

\*\* = Widest dorsal shield width measured near s4.

\*\*\* = Peritreme much short of reaching to j1.

\*\*\*\* = De Leon (1965) measured 3 males. Only 2 males measured here.

F-Average, F-Range, orientalis - Average and range of 10 non-type females.

FSCA = Florida State Collection of Arthropods, Gainesville, FL, USA.

**Table 5.** Measurements of macrosetae on leg IV in 2 paratype males of *Paraphytoseius santurcensis* collected in Puerto Rico by De Leon (1965) [FSCA]\* [\*\* not measured in *P. orientalis*].

Particulars	Male 1	Male 2	Average	Range	De Leon
Slide #	8	9			1965*
Leg IV					
SgeIV	21	22	22	21–22	x
StiIV	30	29	30	29–30	x
SbtaIV	38	37	38	37–38	x
SdtaIV	27	26	27	26–27	x

\*De Leon (1965) - Did not measure macrosetae of leg IV in males.

\*\* = *Paraphytoseius orientalis* - Not measured.

FSCA = Florida State Collection of Arthropods, Gainesville, FL, USA.

**Table 6.** Modified setae on legs I-IV in 2 paratype males of *Paraphytoseius santurcensis* collected in Puerto Rico by De Leon (1965) (FSCA, x = absent, not seen, not reported).

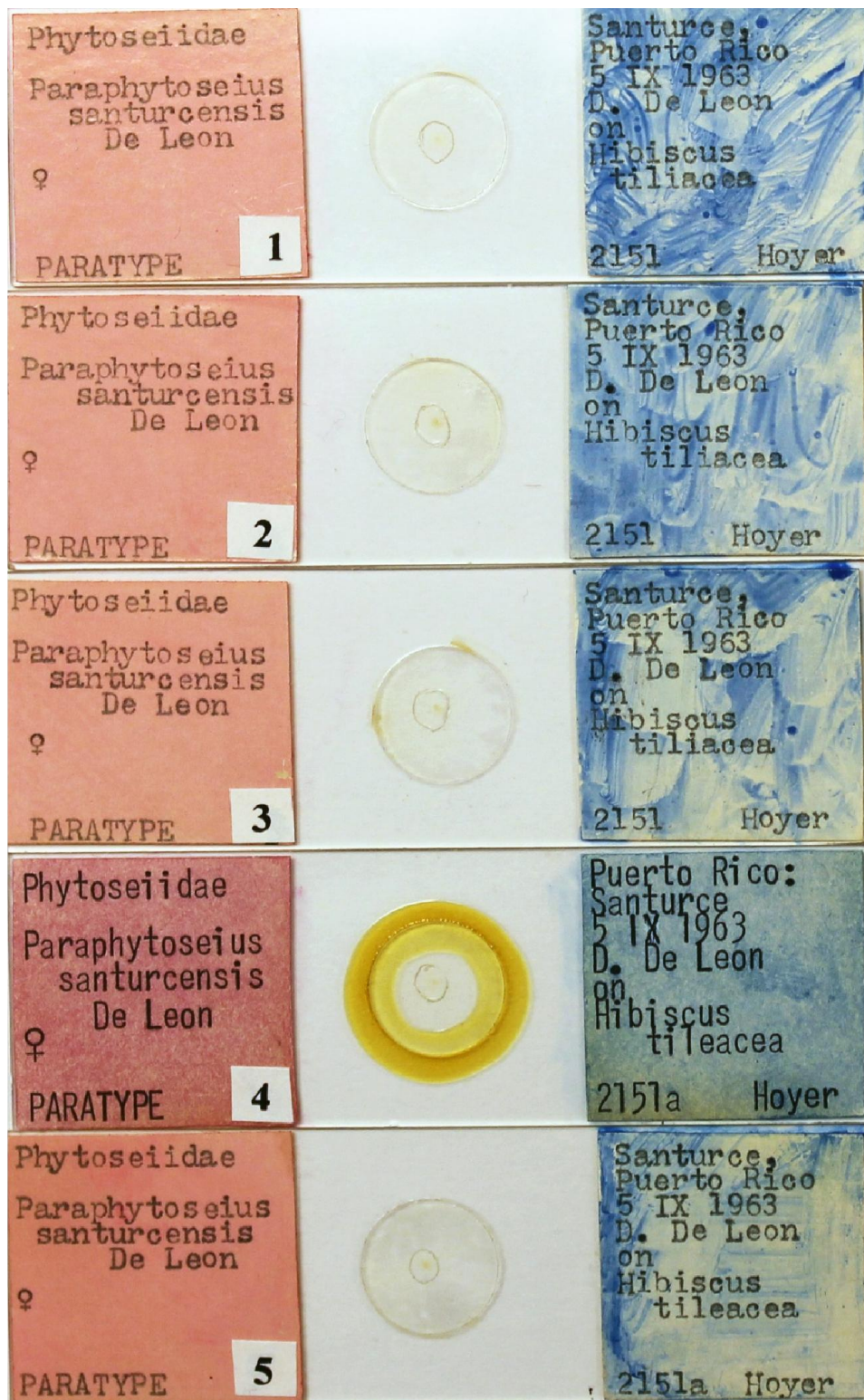
Particulars	Male 1	Male 2
Slide #	8	9
Leg I		
MgeI	1	x
MtiI	x	x
MbtaI	x	x
Leg II		
MgeII	1	1
MtiII	x	x
MbtaII	x	x
Leg III		
MgeIII	x	x
MtiIII	x	x
MbtaIII	x	x
Leg IV		
MfeIV	1	1
MgeIV	x	x
MtiIV	x	x
MbtaIV	x	1

De Leon (1965) did not study these in males.

Schicha and Corpuz-Raros (1985) and Chant and McMurtry (2003) - Did not study or report these in males.

*Paraphytoseius orientalis* - Not studied in males.

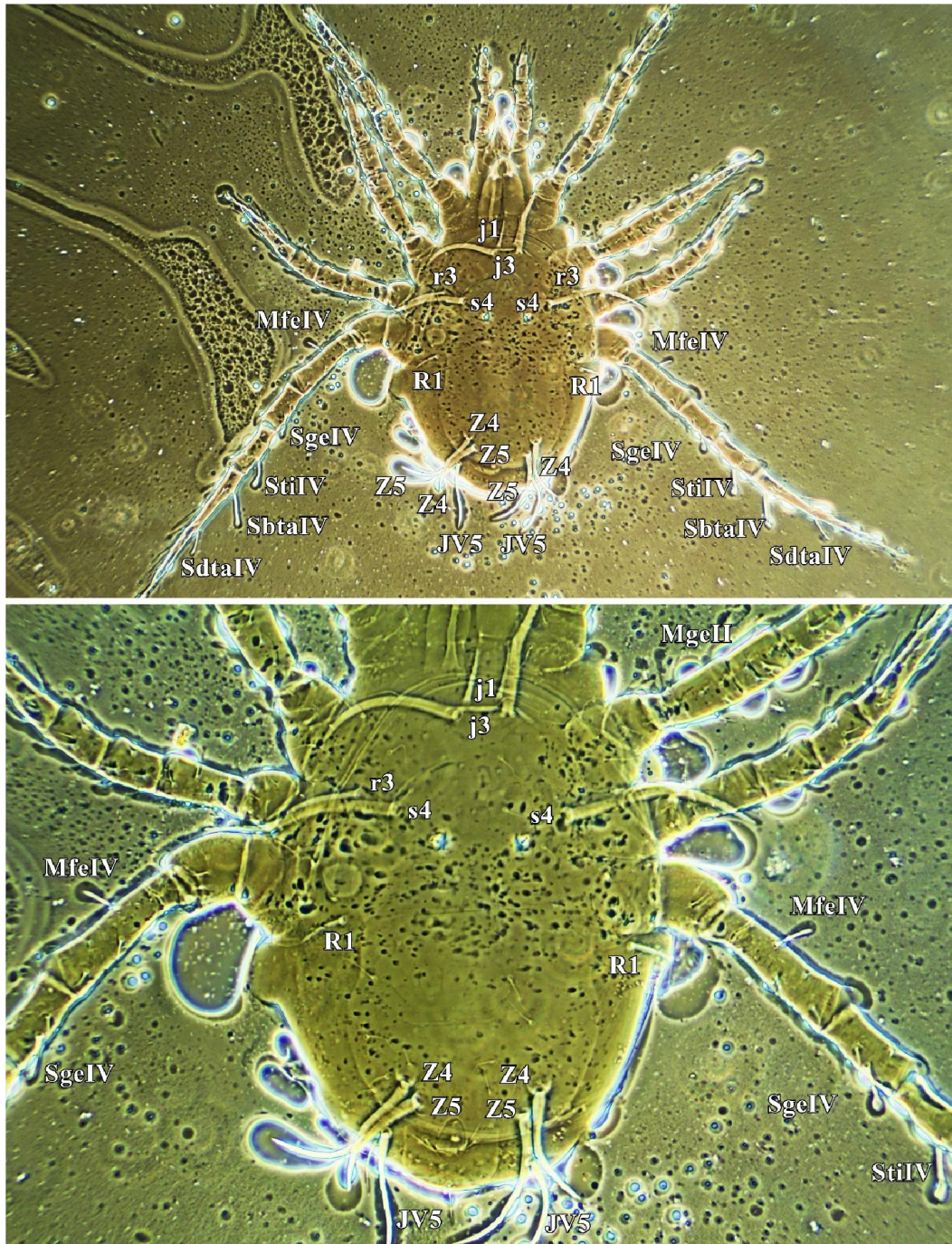
FSCA = Florida State Collection of Arthropods, Gainesville, FL, USA.



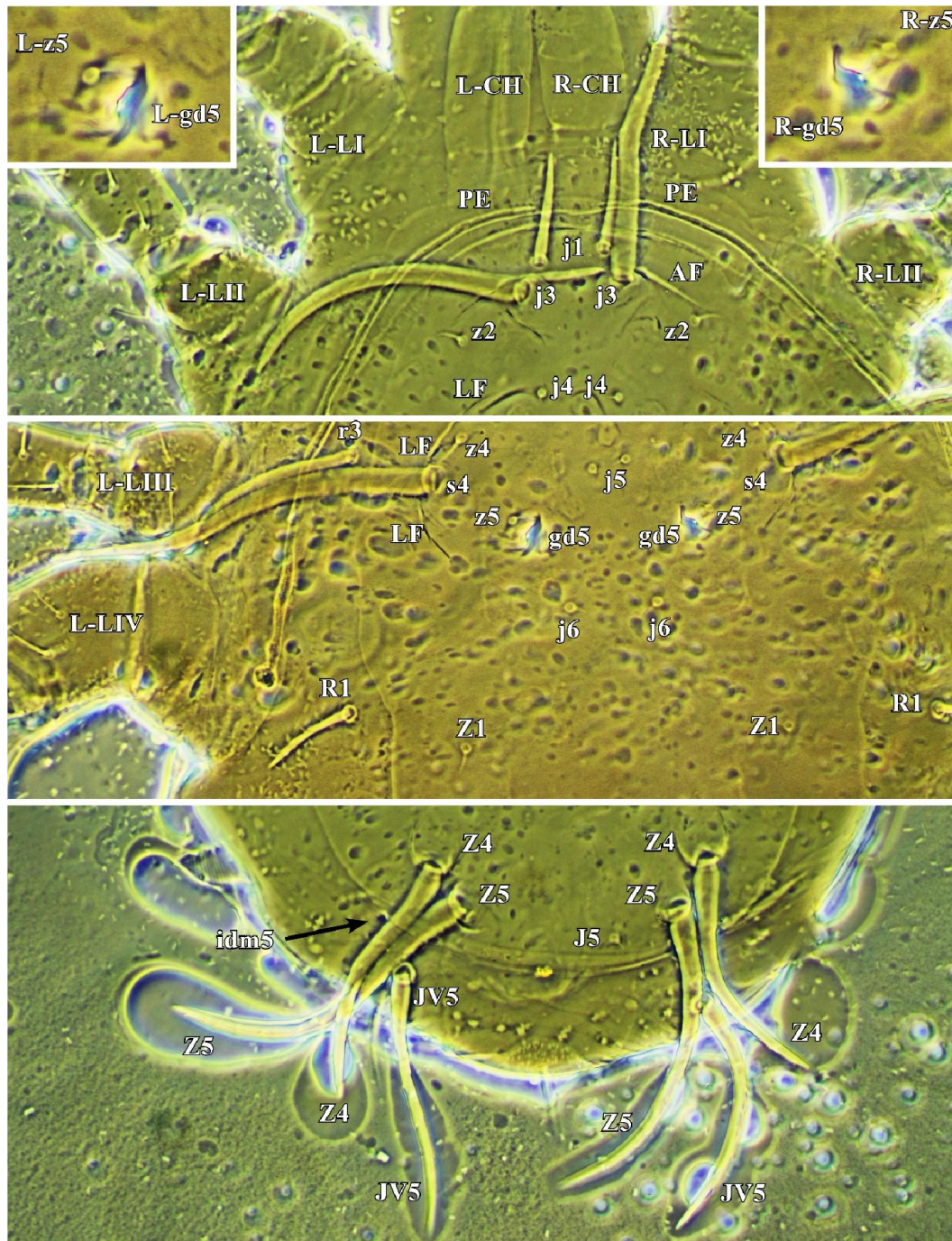
**Figure 1.** *Paraphytoseius santurcensis* De Leon: Slides #1–5, Paratype females (females #1–5 from *Hibiscus tiliacea*; all types in collection of Florida State Collection of Arthropods (FSCA), Gainesville, FL, USA).



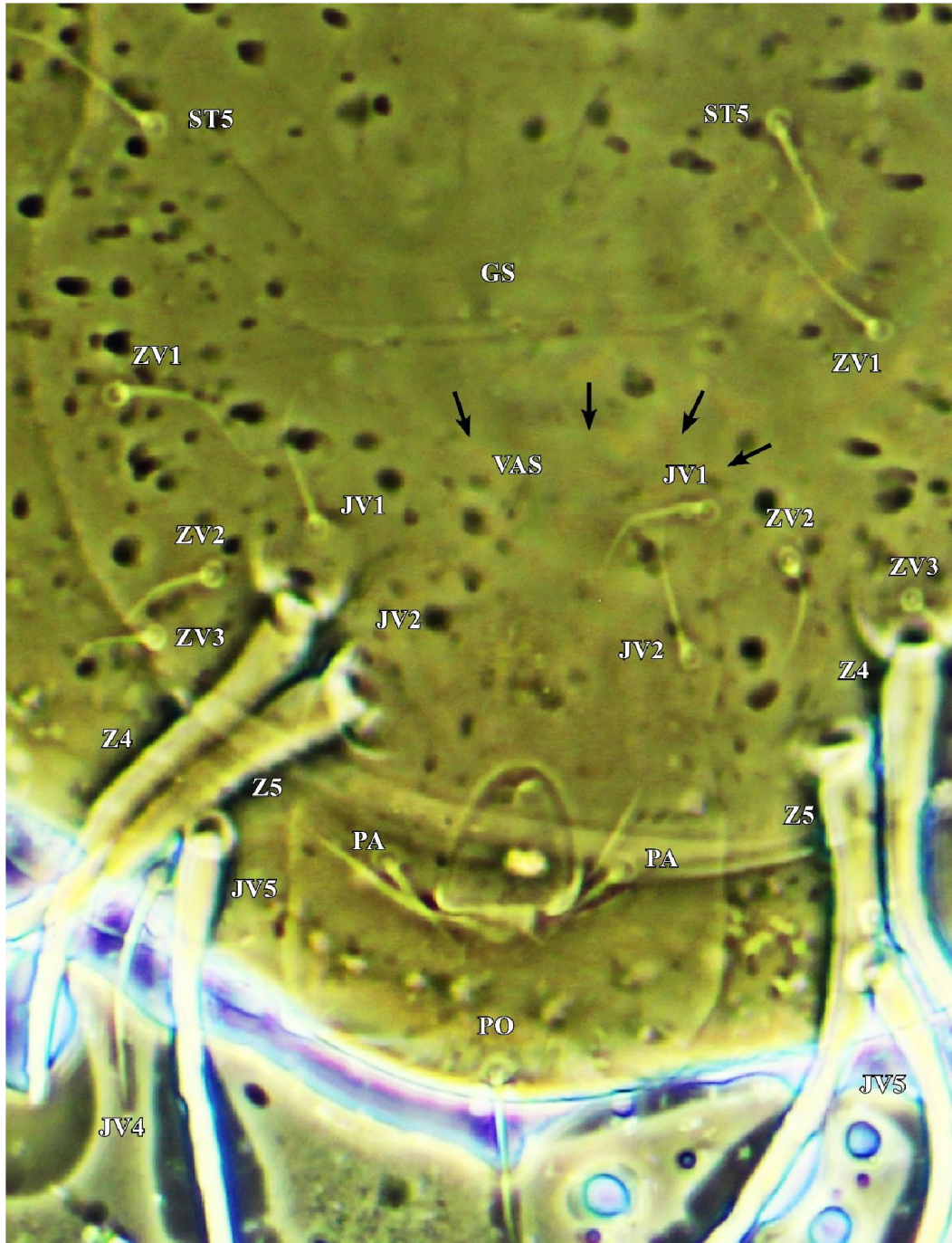
**Figure 2.** *Paraphytoseius santurcensis* De Leon: Slides # 6–7, Paratype females (females #6 from *Hibiscus tileacea* and female #7 from *Hura crepitans*), #8–9: Paratype (allotype) males (both from *Hibiscus tileacea*), and #10: Paratype nymph (from *Hura crepitans*); all types in collection of Florida State Collection of Arthropods (FSCA), Gainesville, FL, USA.



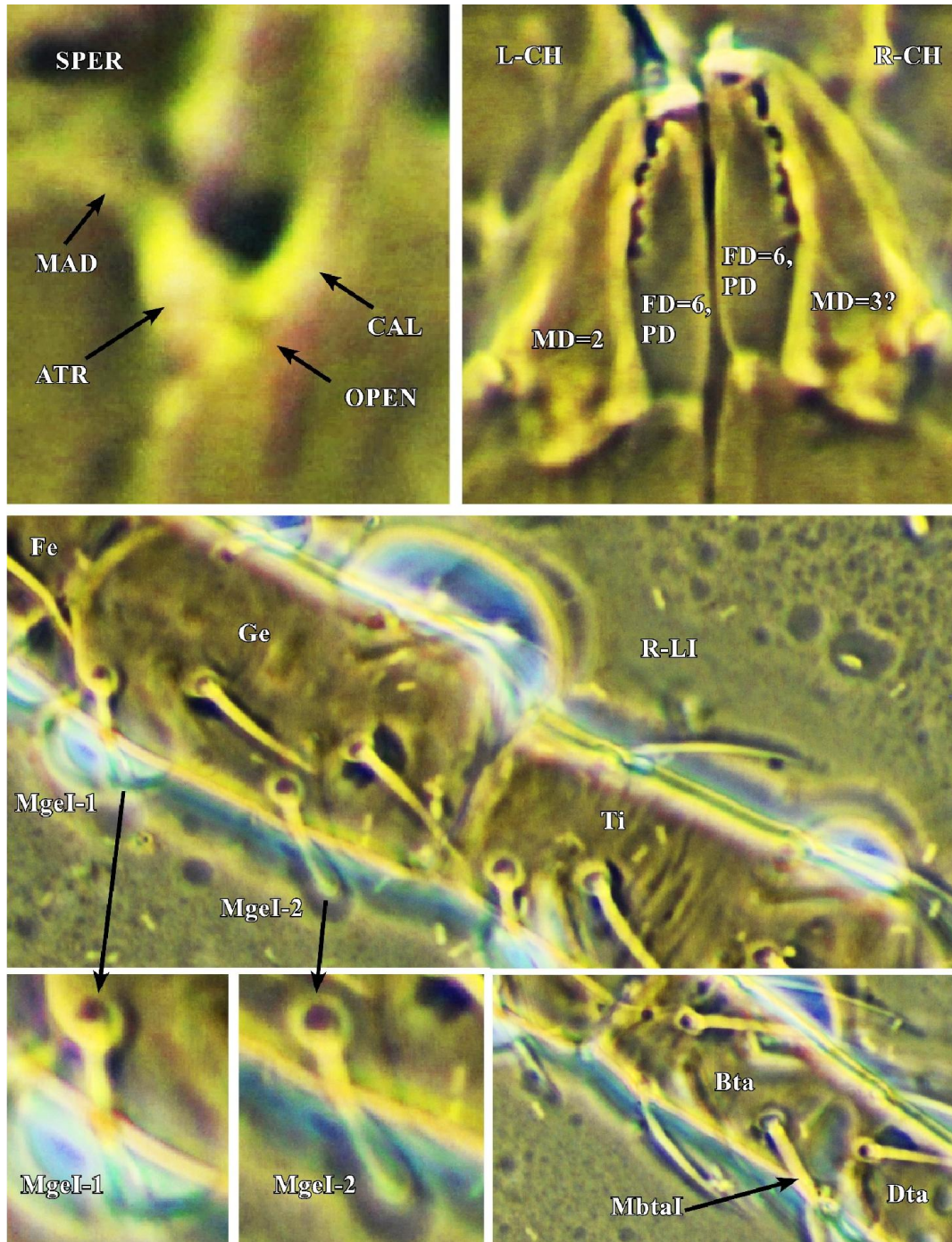
**Figure 3.** *Paraphytoseius santurcensis*: *Top* - Dorsal view of body and legs in low magnification; *Bottom*- Dorsal view of body and legs in high magnification showing landmark setae on idiosoma and legs [FSCA, paratype, slide #1, female #1, *top* - 100x, *bottom* - 200x].



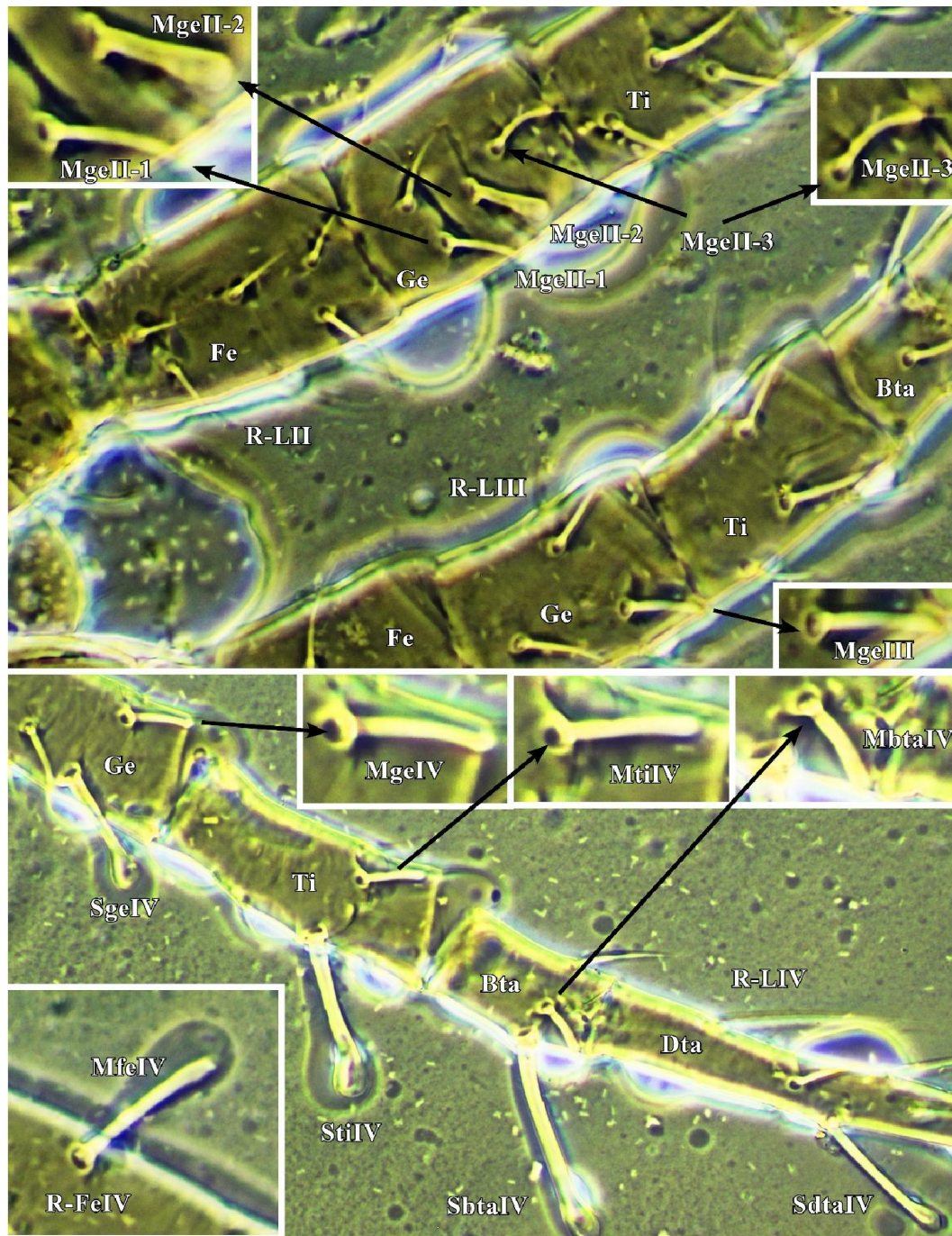
**Figure 4.** *Paraphytoseius santurcensis*: Dorsal view of idiosoma showing peritreme and dorsal setae in high magnification. Solenostome gd5 near z5 (also in inset) and lyrifissure idm5 posterolateral to Z4 seen (on arrow head) [FSCA, paratype, slide #1, female #1, 400x].



**Figure 5.** *Paraphytoseius santurcensis*: Ventral view of idiosoma showing posterior genital shield (GS) and ventrianal shield (VAS) in high magnification (anterior border faintly seen: arrow), unusually, with only 2 pairs of preanal setae (JV1 and JV2) and ZV2 on integument [FSCA, paratype, slide #1, female #1, 400x].



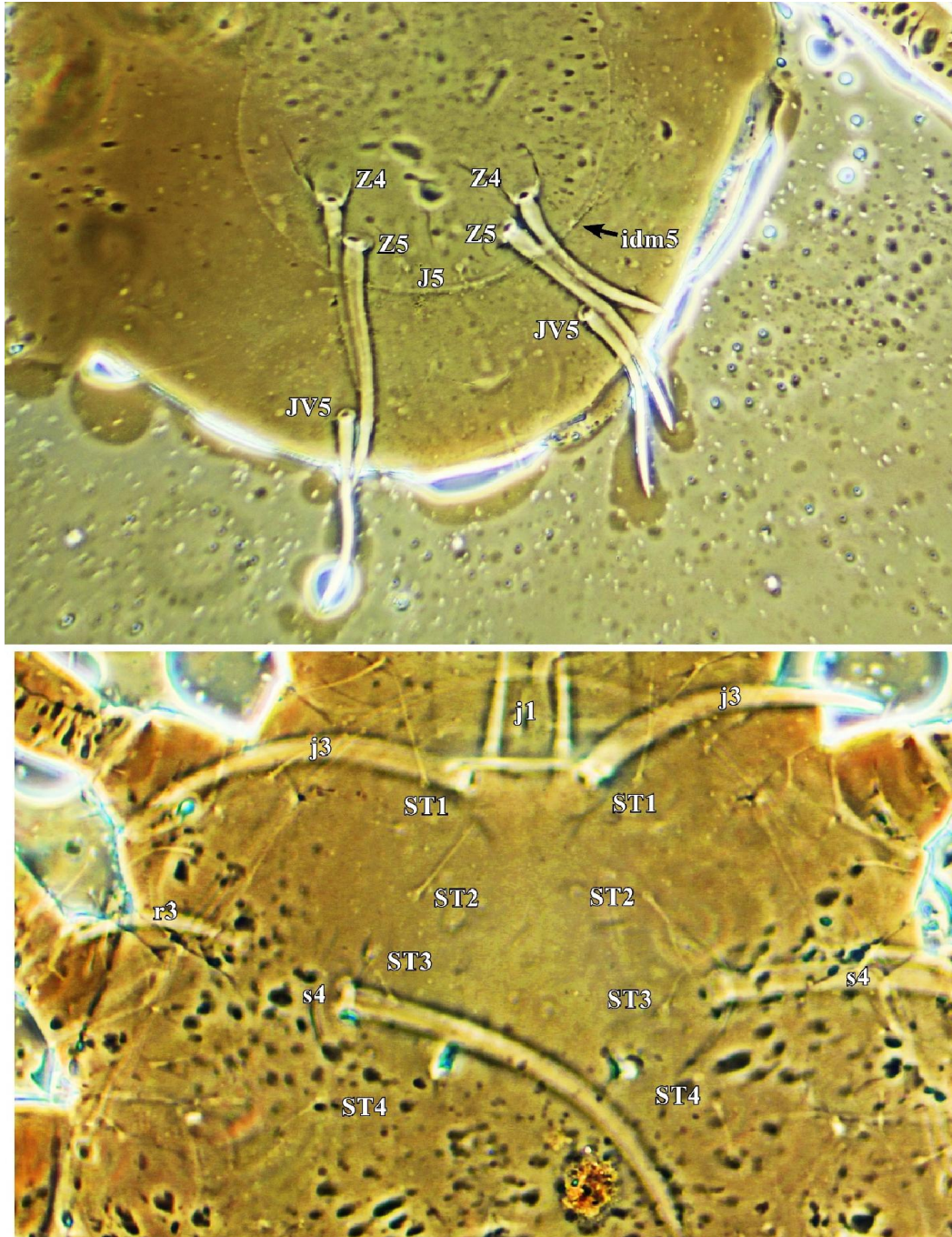
**Figure 6.** *Paraphytoseius santurcensis*: Top left - Spermatheca; Top right - Chelicerae; Bottom - Right leg I (R-LI) with modified setae MgeI-1, MgeI-2, and MbtaI [FSCA, paratype, slide #1, female #1, 200-400x].



**Figure 7.** *Paraphytoseius santurcensis*: *Top* - Right legs II and III (R-LII and R-LIII) with enlarged modified setae (MgeII and MgeIII); *Bottom* - Right leg IV (R-LIV) with macrosetae (SgeIV, StiIV, SbtiIV, and SdtaIV) and (enlarged) modified setae (MfeIV, MgeIV, MtiIV, and MbtaIV) [FSCA, paratype, slide #1, female #1, 400x].



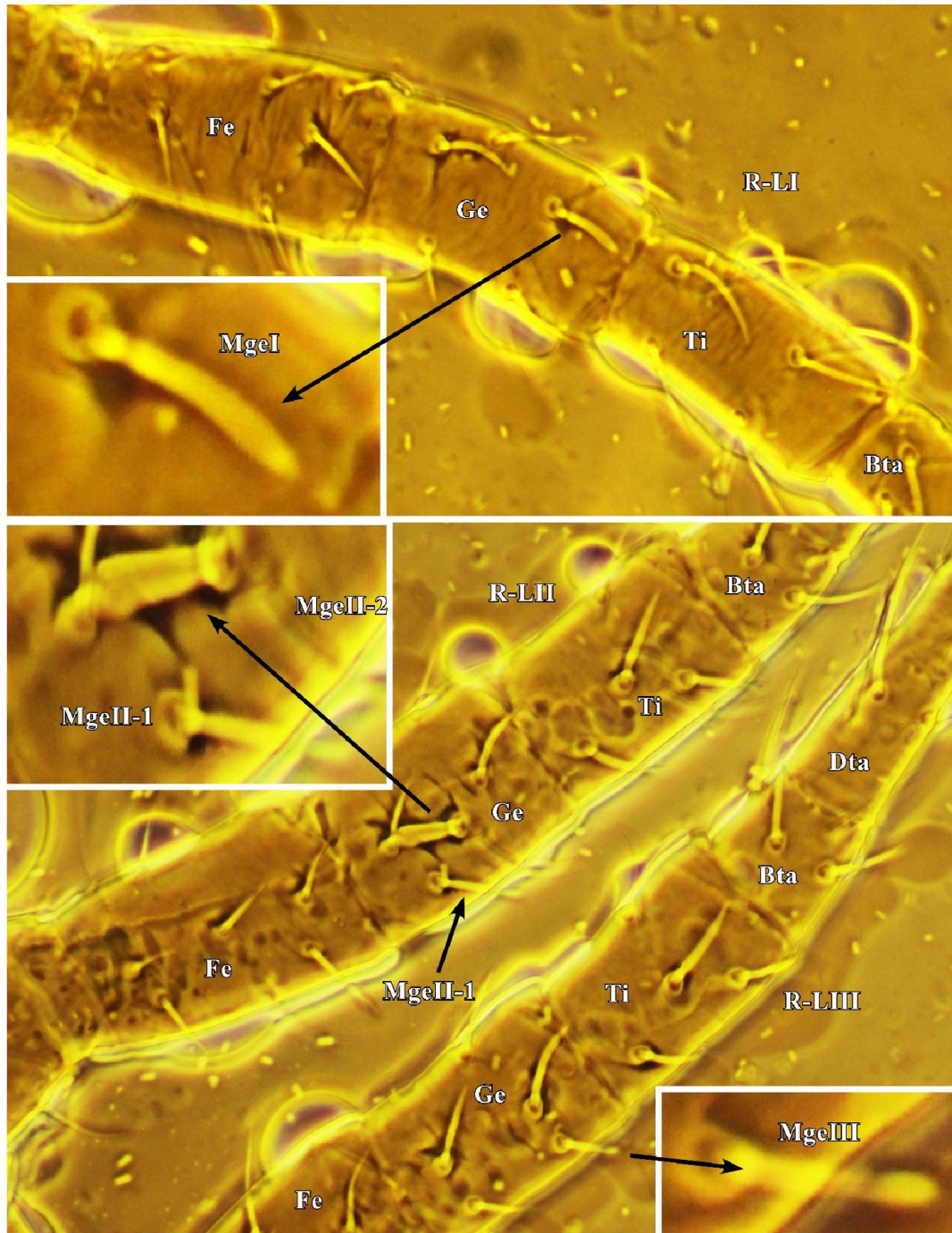
**Figure 8.** *Paraphytoseius santurcensis*: *Top* - Dorsal view of body and legs in low magnification (100x); *Bottom* - Dorsal view of body and legs in high magnification showing landmark setae on idiosoma and legs. Solenostome gd5 posteromedial to z5, setae ST5\* (\*ventral setae), and modified seta MgeII also seen [FSCA, paratype, slide #2, female #2, 200x].



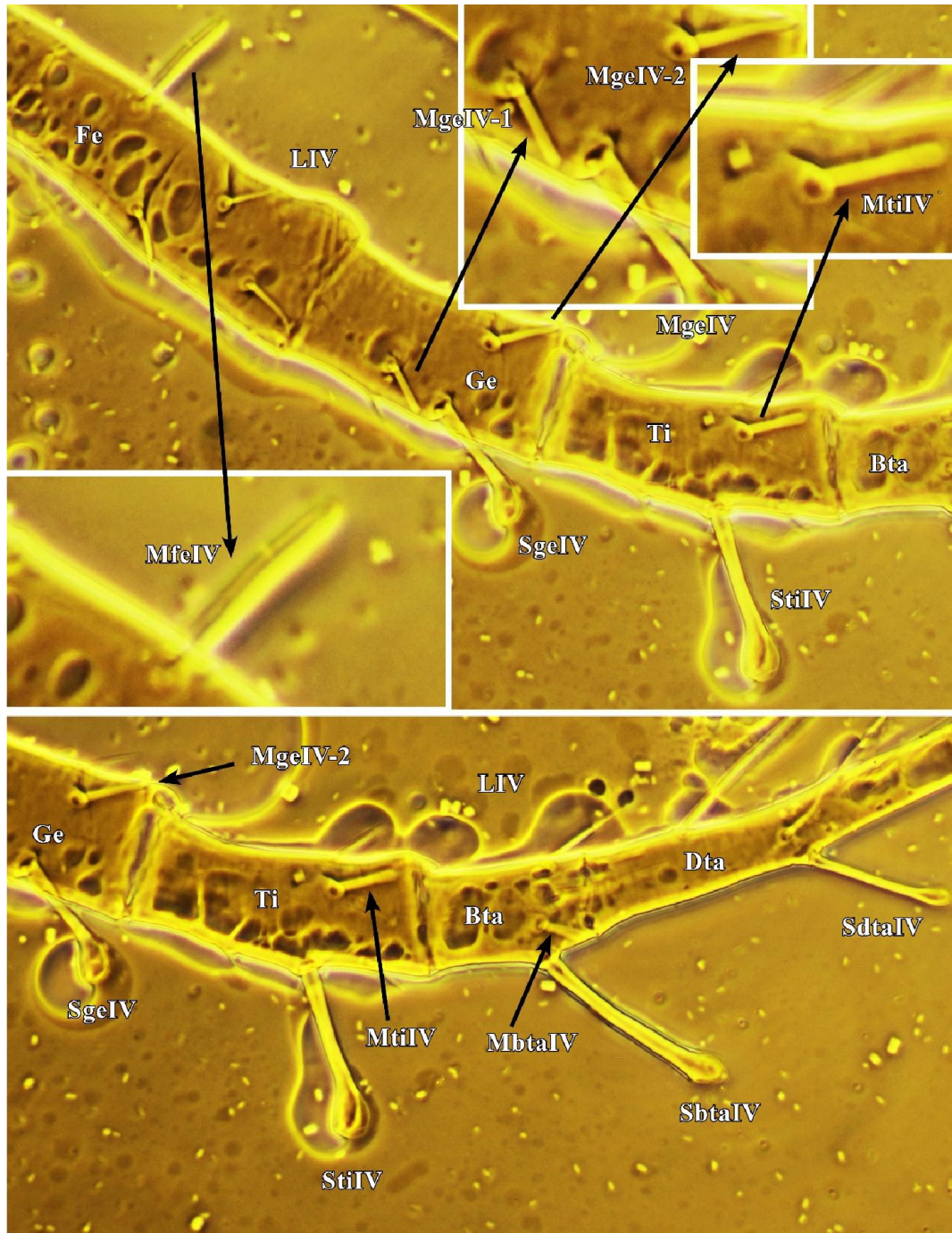
**Figure 9.** *Paraphytoseius santurcensis*: *Top* - Dorsum with setae J5, Z4, Z5, idm5 on dorsal shield and JV5\* (\*ventral seta) on integument; *Bottom* - Venter with setae ST1, ST2, ST3, and ST4 (Landmark dorsal setae j1, j3, s4, and r3 also seen) [FSCA, paratype, slide #2, female #2, 400x].



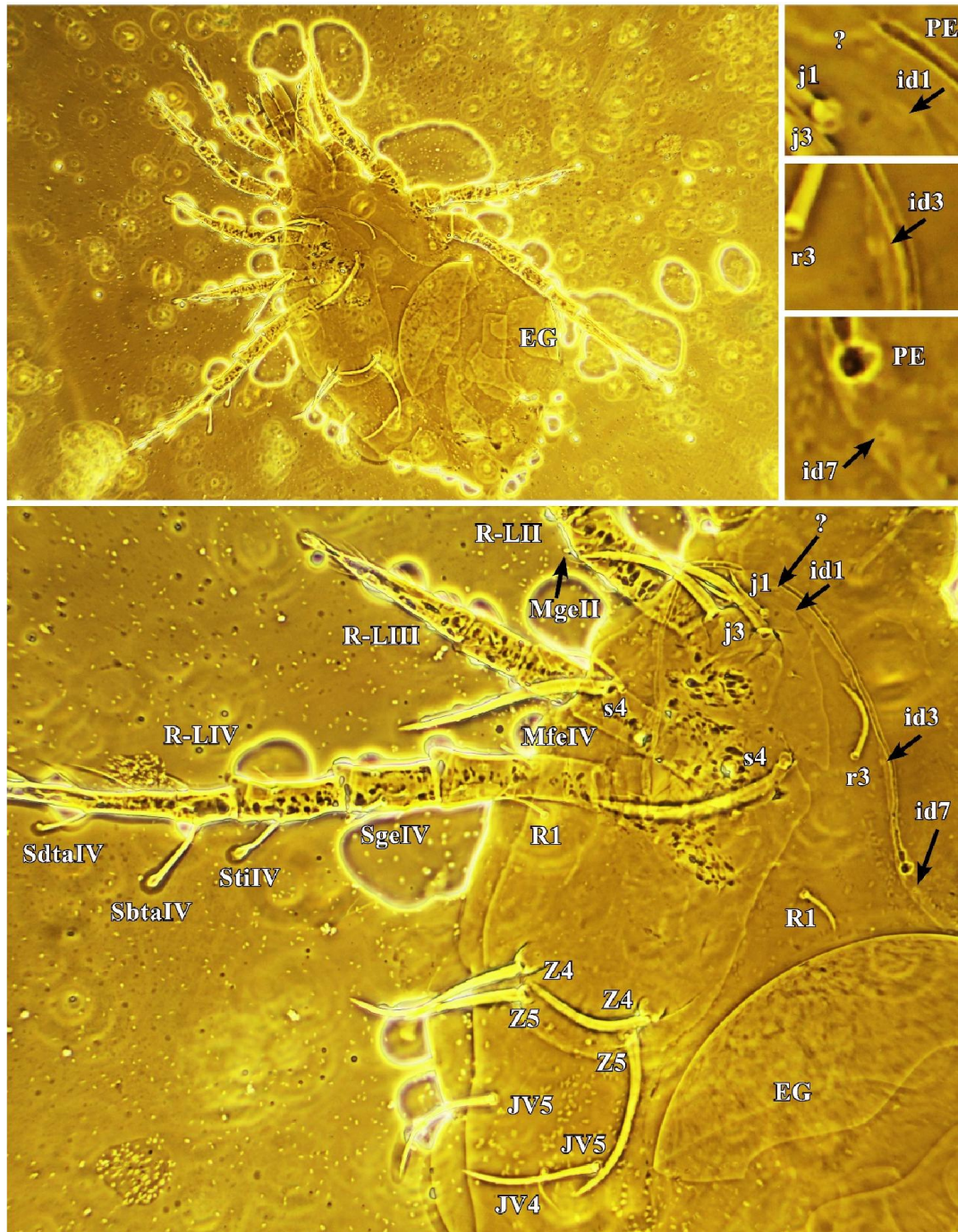
**Figure 10.** *Paraphytoseius santurcensis*: Ventrianal shield with 3 pairs of preanal setae (JV1, JV2, ZV2), pair of paraanal setae (PA), and single postanal seta (PO). Setae ST5, JV4, JV5, ZV1, and ZV3 on integument [FSCA, paratype, slide #2, female #2, 400x].



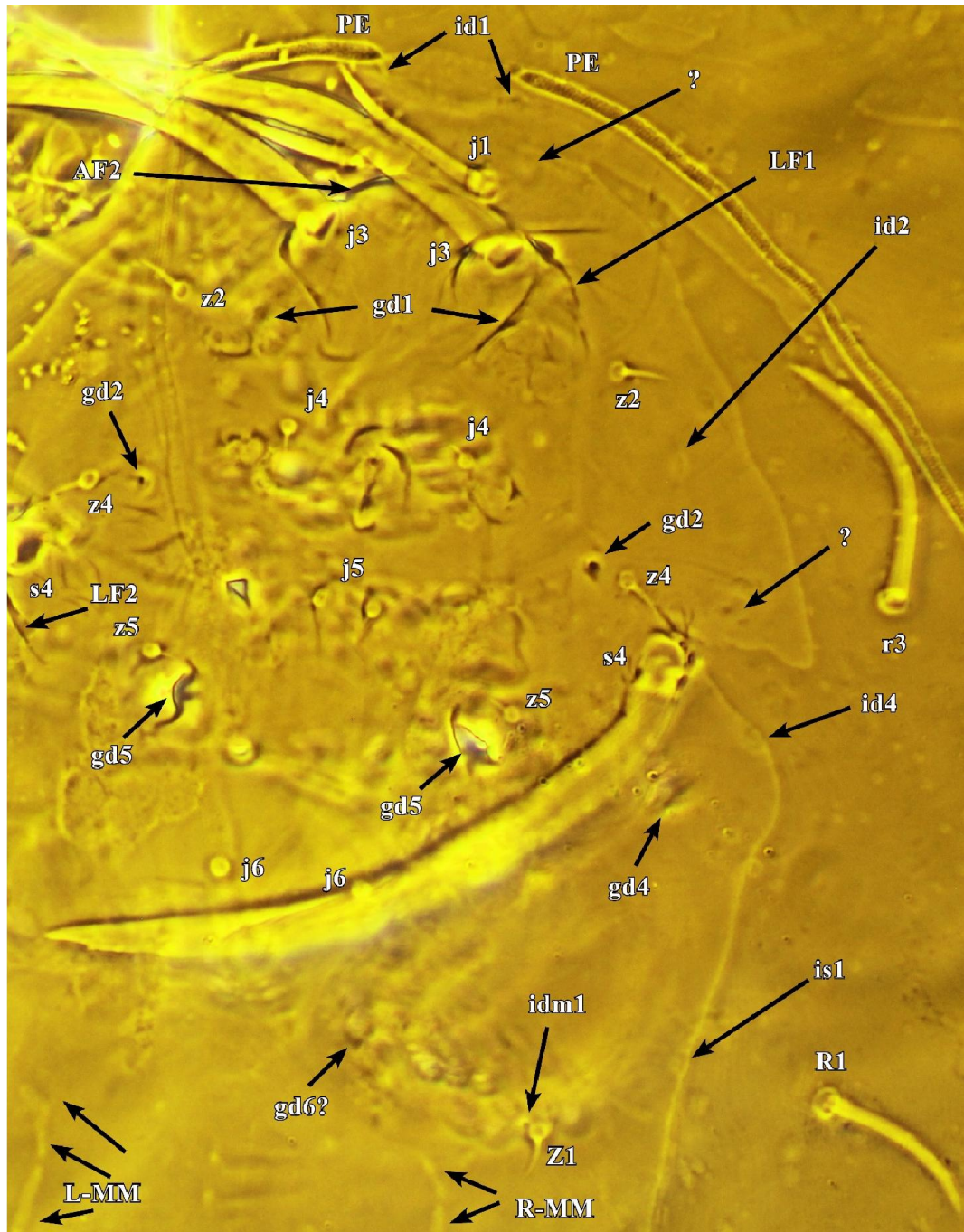
**Figure 11.** *Paraphytoseius santurcensis*: *Top* - Right leg I (R-LI) with modified seta MgeI; *Bottom* - Right leg II (R-LII) with modified setae MgeII-1 and MgeII-2; and Right leg III (R-LIII) with modified seta MgeIII (inset, setae much enlarged) [FSCA, paratype, slide #2, female #2, 400x].



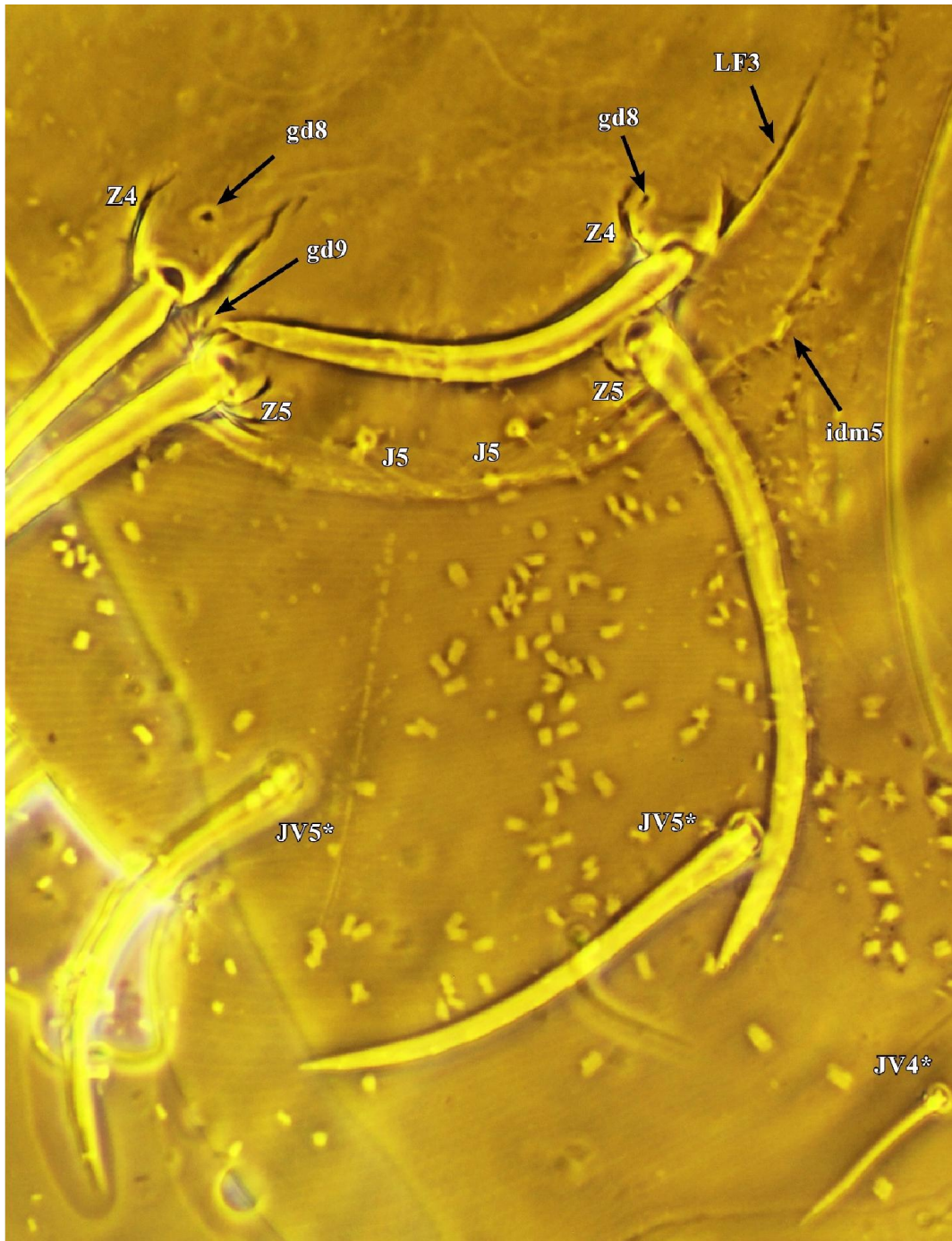
**Figure 12.** *Paraphytoseius santurcensis*: Top and bottom - Right leg IV (R-LIV) with macrosetae SgeIV, StiIV, SbtalIV, and SdtaIV, and modified setae MfeIV, MgeIV-1, MgeIV-2, MtiIV, and MbtaIV [FSCA, paratype, slide #2, female #2, 400x].



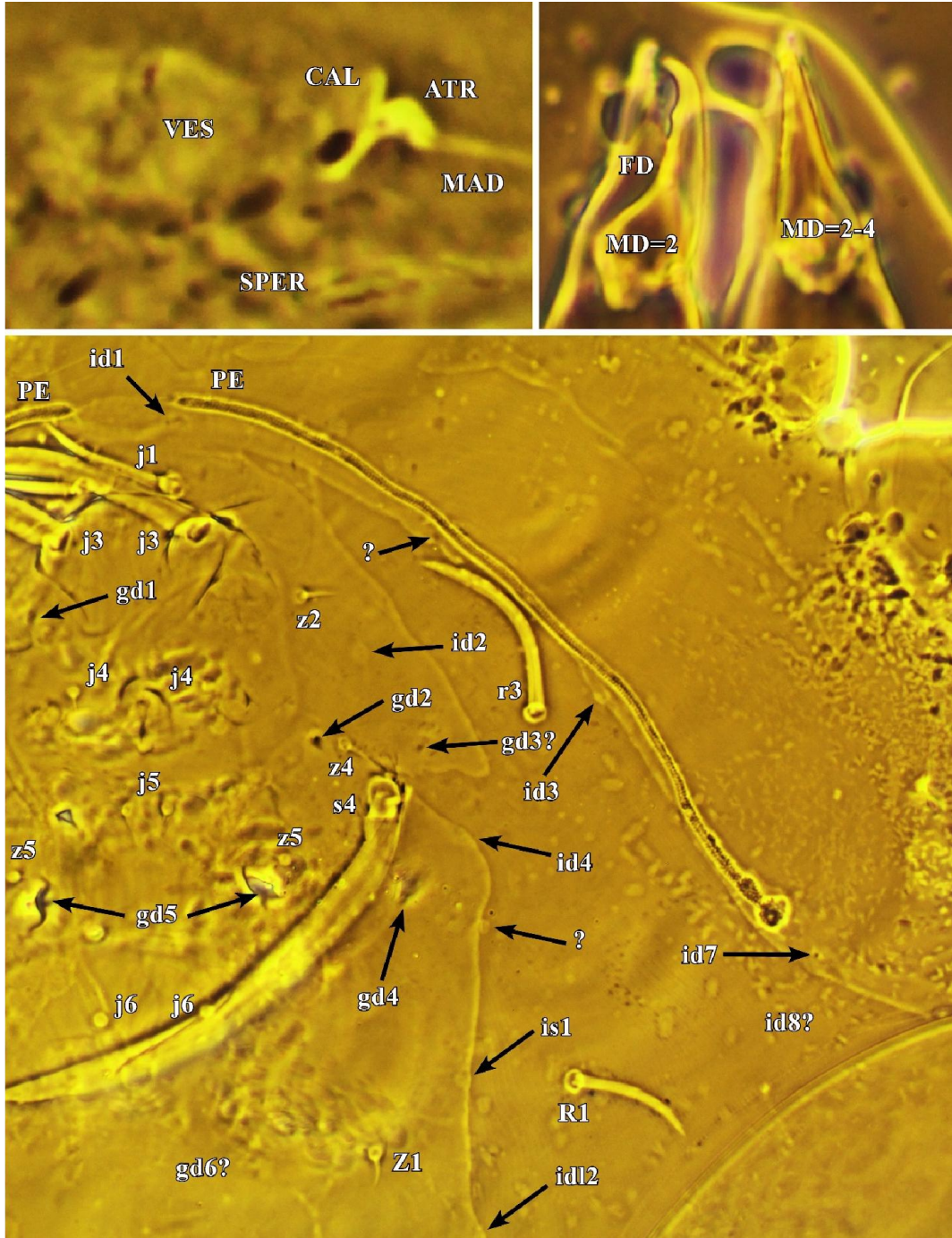
**Figure 13.** *Paraphytoseius santurcensis*: *Top* - Dorsal view of body and legs in low magnification; *Bottom* - Dorsal view of body and legs in high magnification showing landmark setae on idiosoma and legs. A broken egg (EG) also seen [FSCA, paratype, slide #3, female #3, *top* - 100x, *bottom* - 200x].



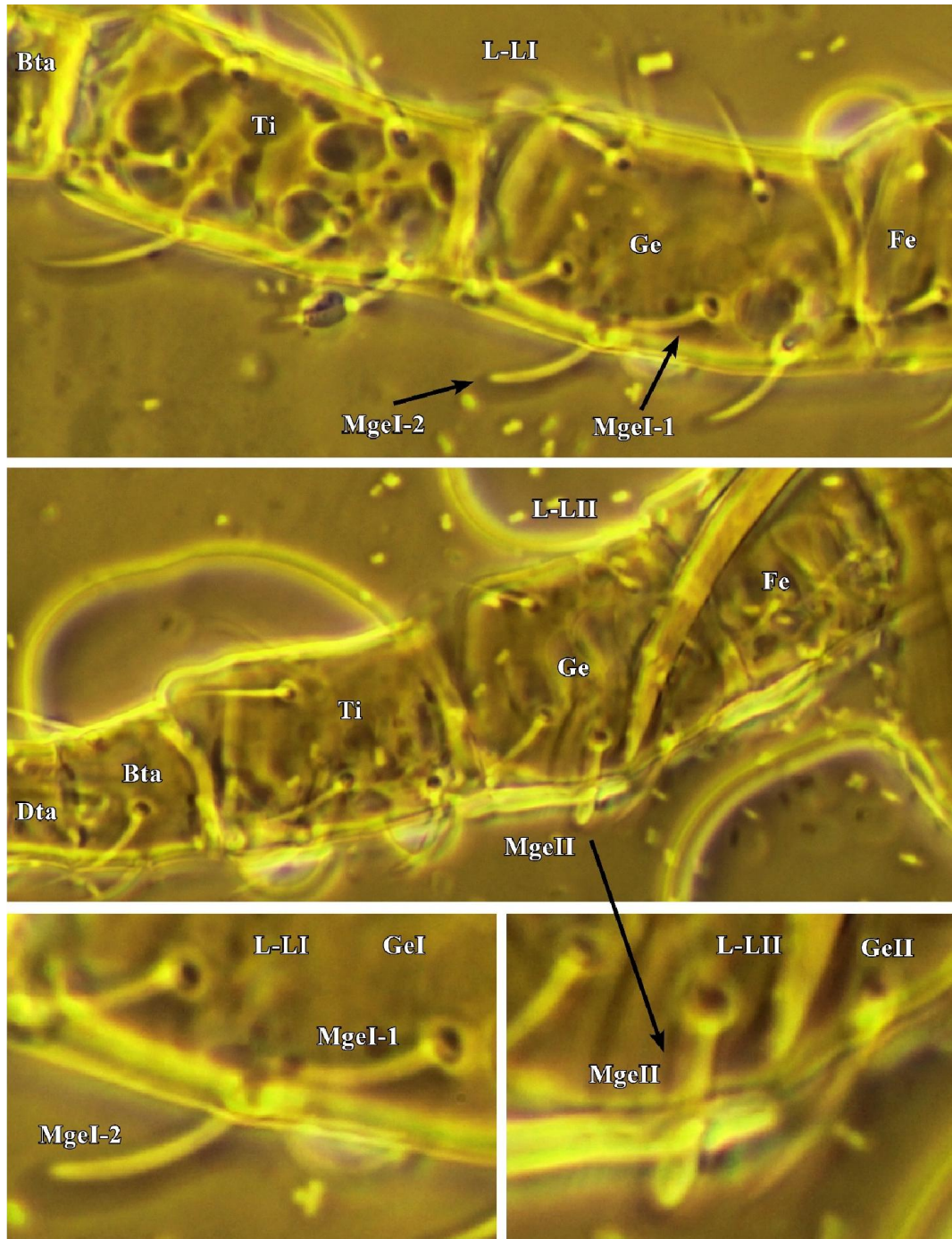
**Figure 14.** *Paraphytoseius santurcensis*: Dorsal view of idiosoma showing peritreme, dorsal setae, muscle marks (MM), solenostomes (gd1, gd2, gd4, gd5), and lyrifissures (id, is) in high magnification [FSCA, paratype, slide #3, female #3, 400x].



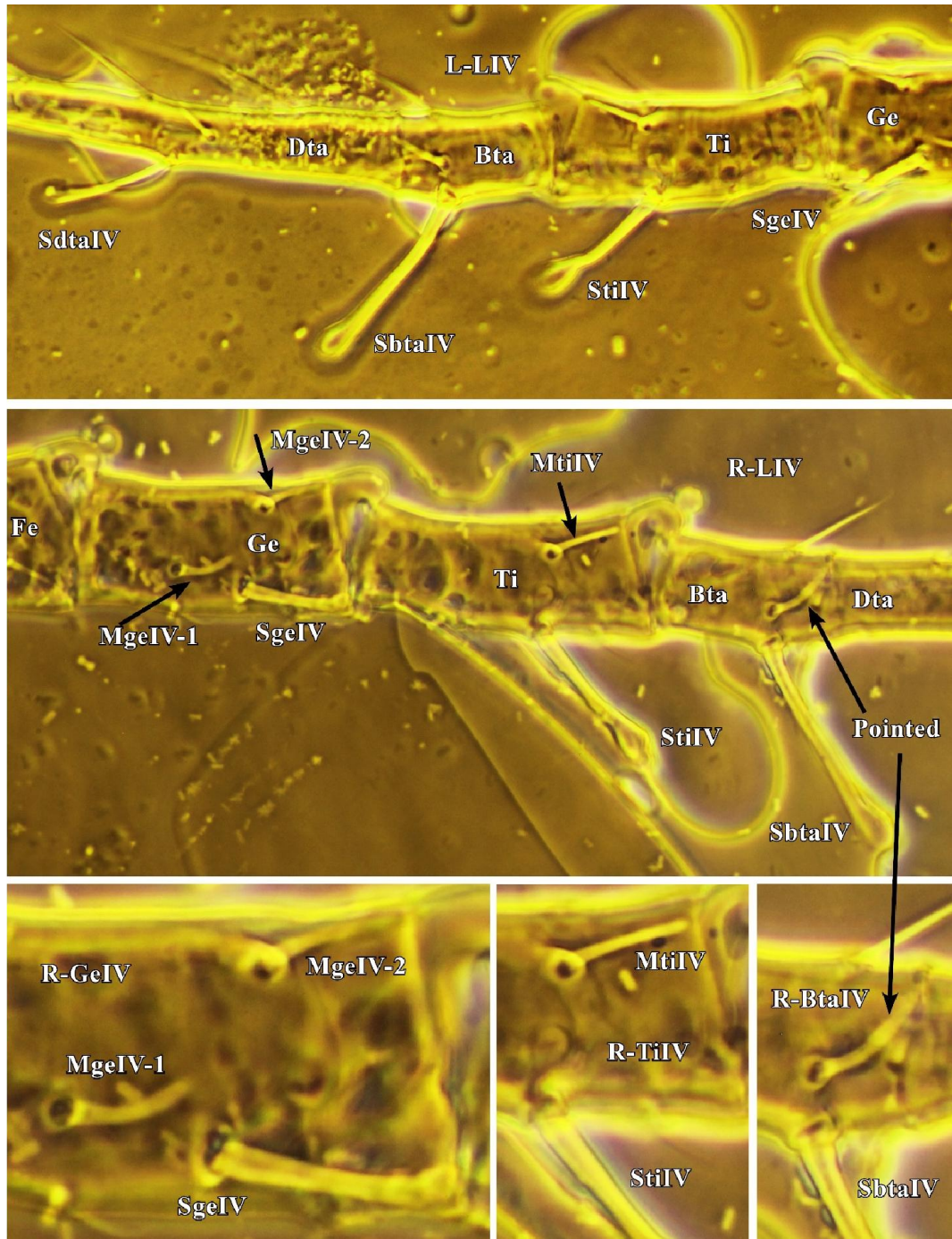
**Figure 15.** *Paraphytoseius santurcensis*: Dorsal view of posterior idiosoma showing dorsal setae, solenostomes (gd8 and gd9), lyrifissure idm5, and ventral setae (JV4\* and JV5\*) in high magnification [FSCA, paratype, slide #3, female #3, 400x].



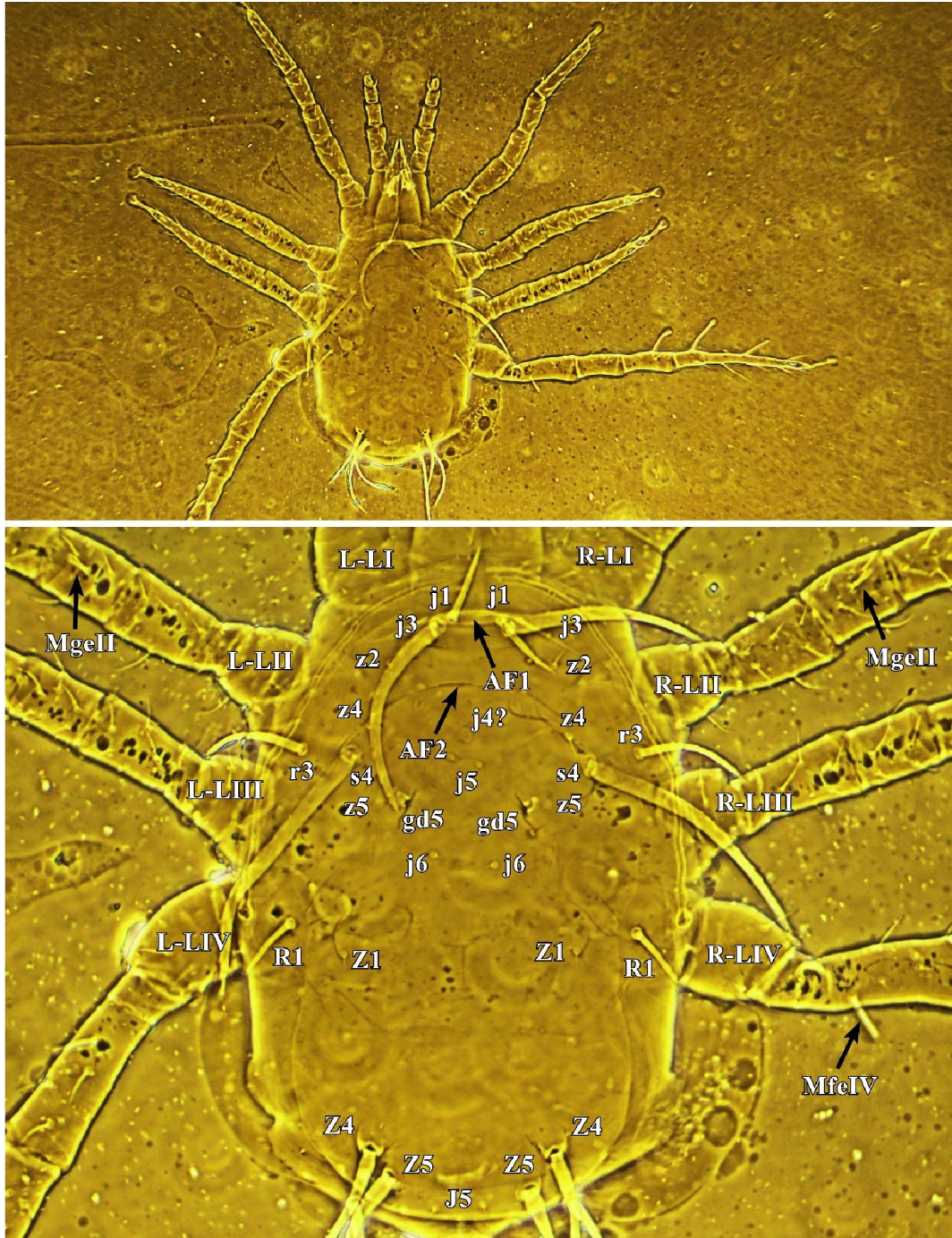
**Figure 16.** *Paraphytoseius santurcensis*: Top left - Spermatheca; Top right - Chelicerae; Bottom - Dorsal view of anterior idiosoma showing peritreme (PE), dorsal setae, solenostomes (gd1, gd2, gd4, gd5), and different lyrifissures in high magnification [FSCA, paratype, slide #3, female #3, 400x].



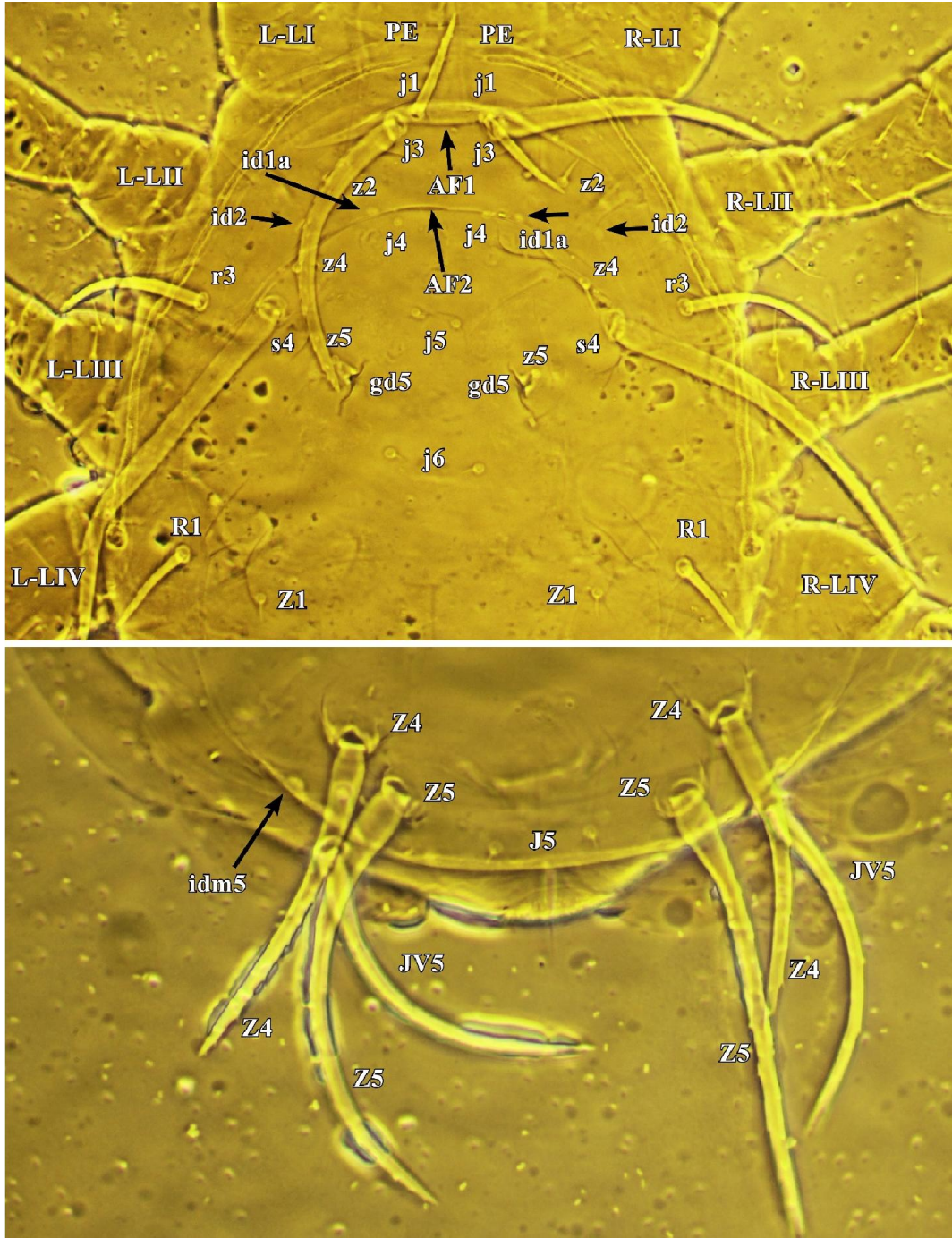
**Figure 17.** *Paraphytoseius santurcensis*: Top - Left leg I (L-LI); Middle - Left leg II (L-LII); Bottom left and right - Modified setae on genu of leg I (MgeI) and genu of leg II (MgeII) very much enlarged [FSCA, paratype, slide #3, female #3, 400x].



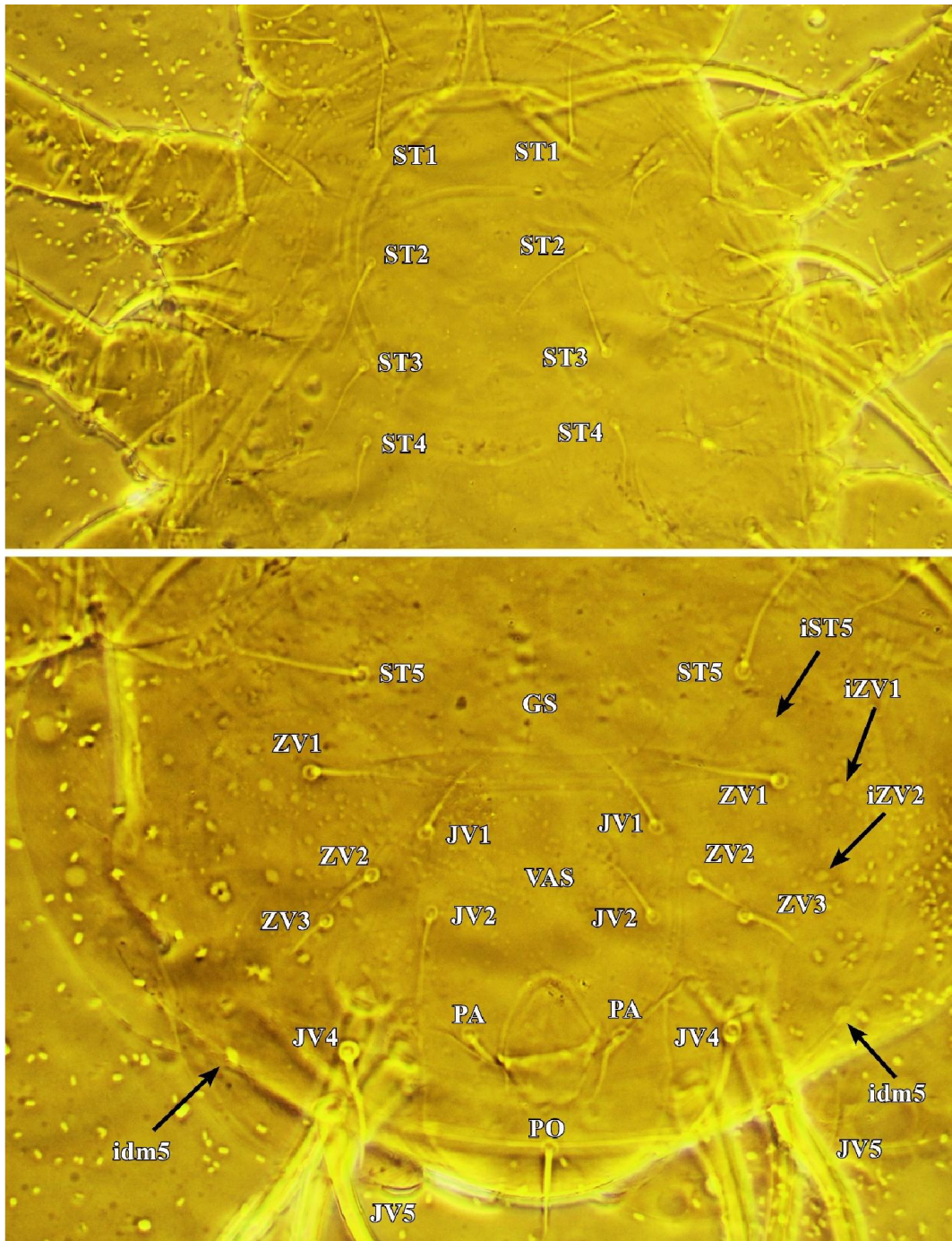
**Figure 18.** *Paraphytoseius santurcensis*: Top - Left leg IV (L-LIV); Middle - Right leg IV (R-LIV); Bottom left and right - Enlarged macrosetae on genu, tibia, and basitarsus of right leg IV. Modified setae MgeIV and MtiIV also seen [FSCA, paratype, slide #3, female #3, 400x].



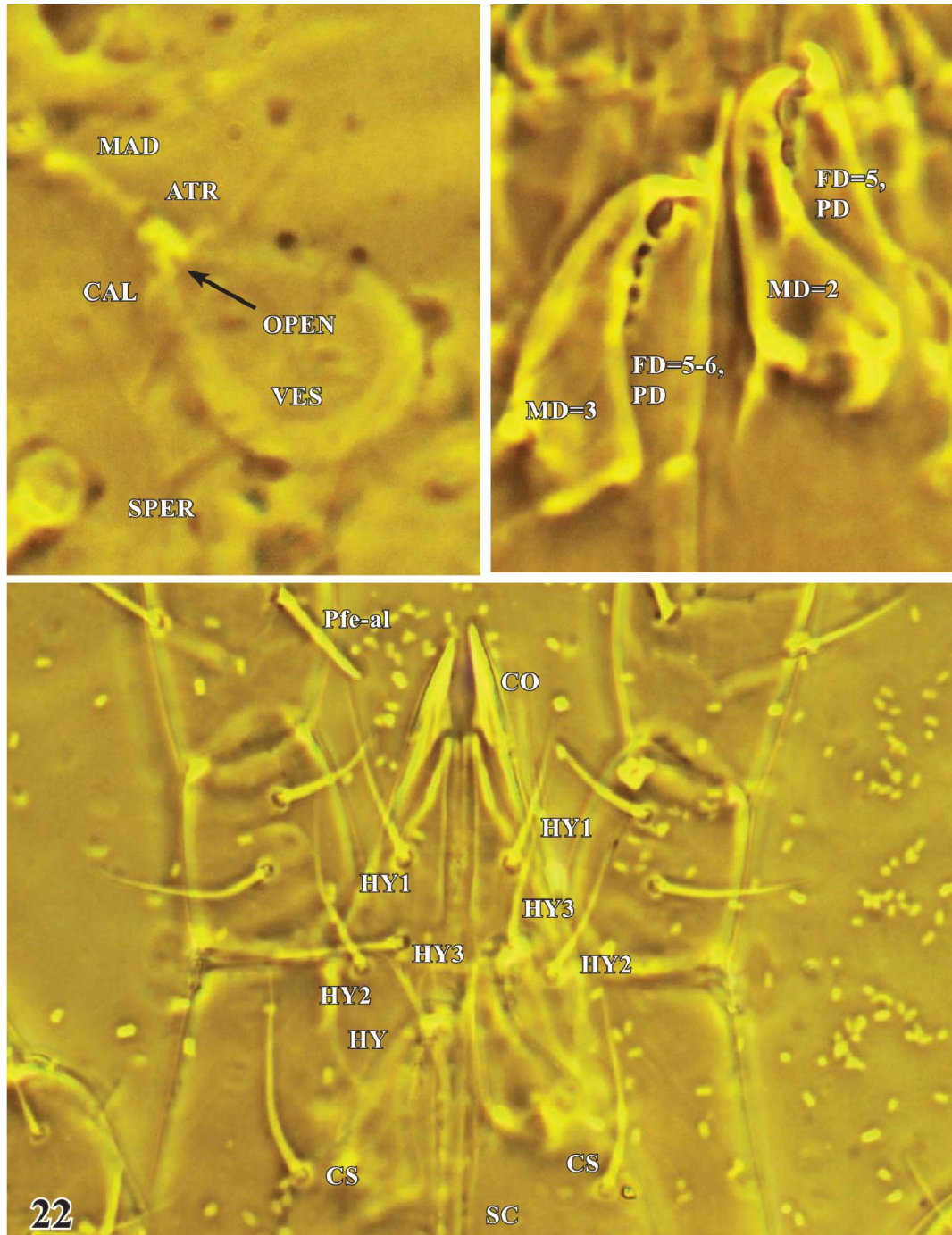
**Figure 19.** *Paraphytoseius santurcensis*: *Top* - Dorsal view of body and legs in low magnification (100x); *Bottom* - Dorsal view of body and left and right legs in high magnification (200x) showing 2 anterior folds (AF1, AF2), solenostome gd5, and landmark setae on idiosoma and legs [Paratype, slide #4, female #4, FSCA].



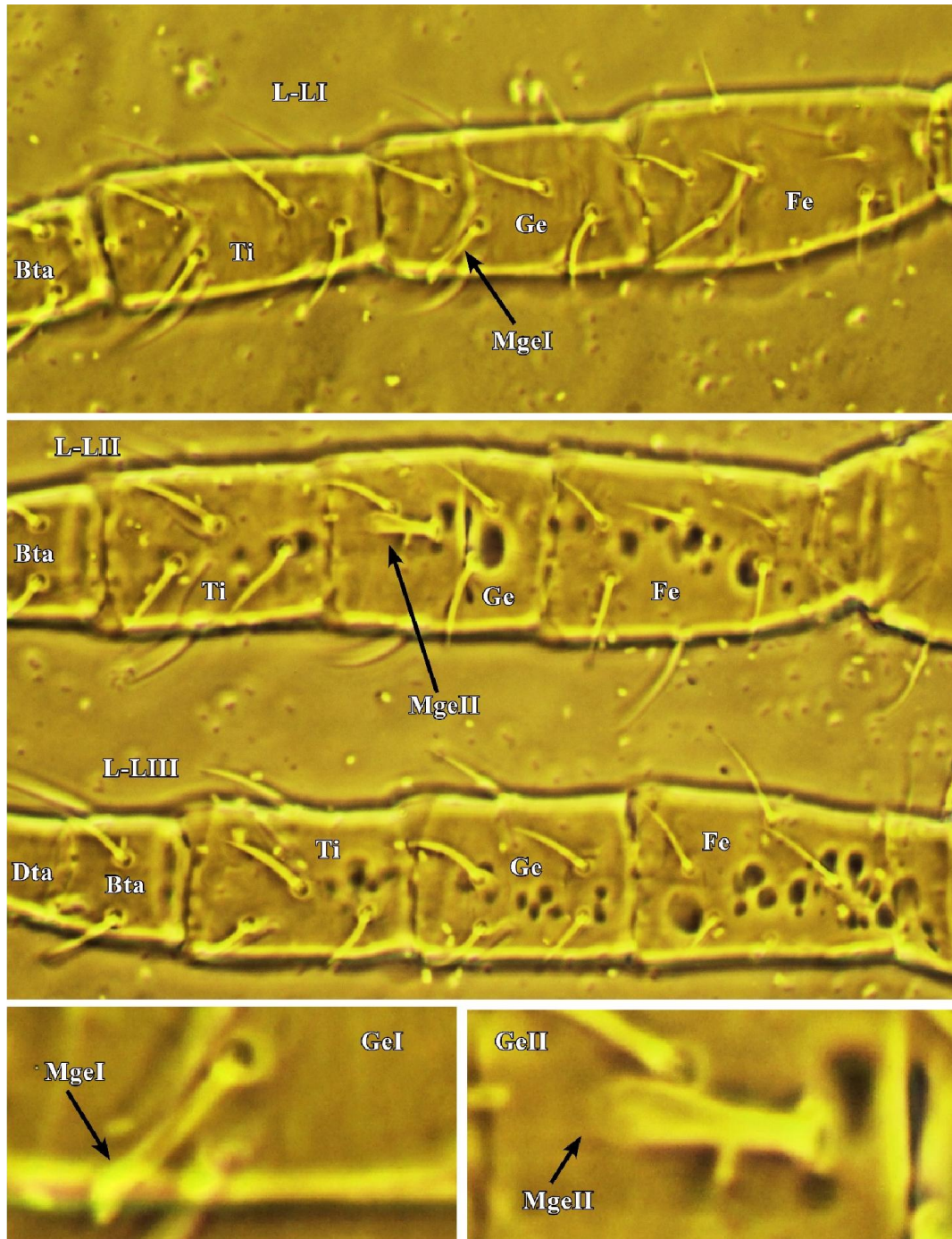
**Figure 20.** *Paraphytoseius santurcensis*: *Top* - Dorsal view of anterior idiosoma with 2 anterior folds (AF1 and AF2), solenostomes, lyrifissures, and part of legs I-IV; *Bottom* - Dorsal view of posterior idiosoma with large landmark setae (Z4, Z5, JV5), tiny J5, and lyrifissure idm5 [FSCA, paratype, slide #4, female #4, 400x].



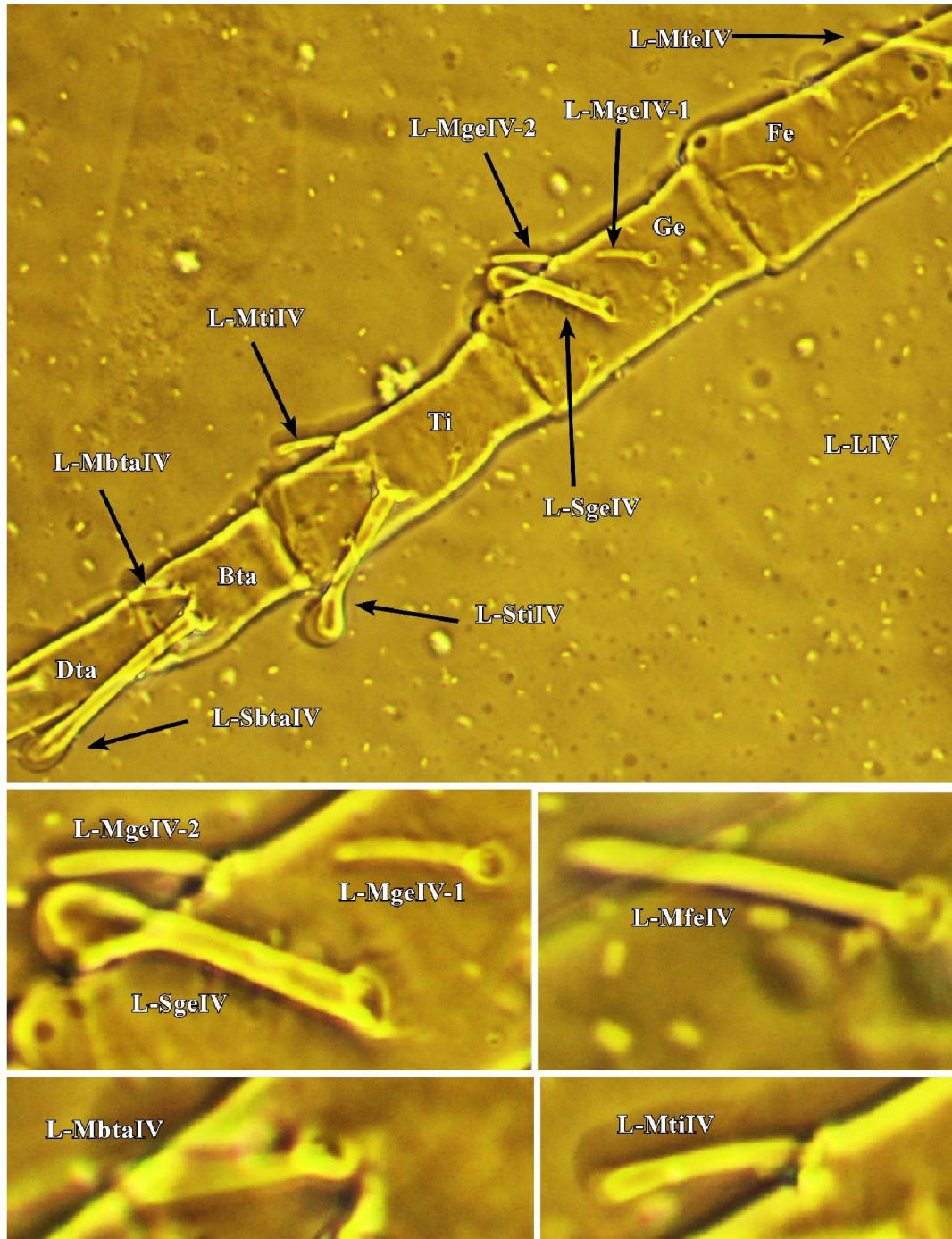
**Figure 21.** *Paraphytoseius santurcensis*: *Top* - Ventral view of anterior idiosoma with setae STI-STIV; *Bottom* - Ventral view of posterior idiosoma with ventrianal shield showing paired ZV2, unusually, on integument. Other setae and lyrifissures iST5, iZV1, iZV2 and idm5 as shown (arrow) [FSCA, paratype, slide #4, female #4, 400x].



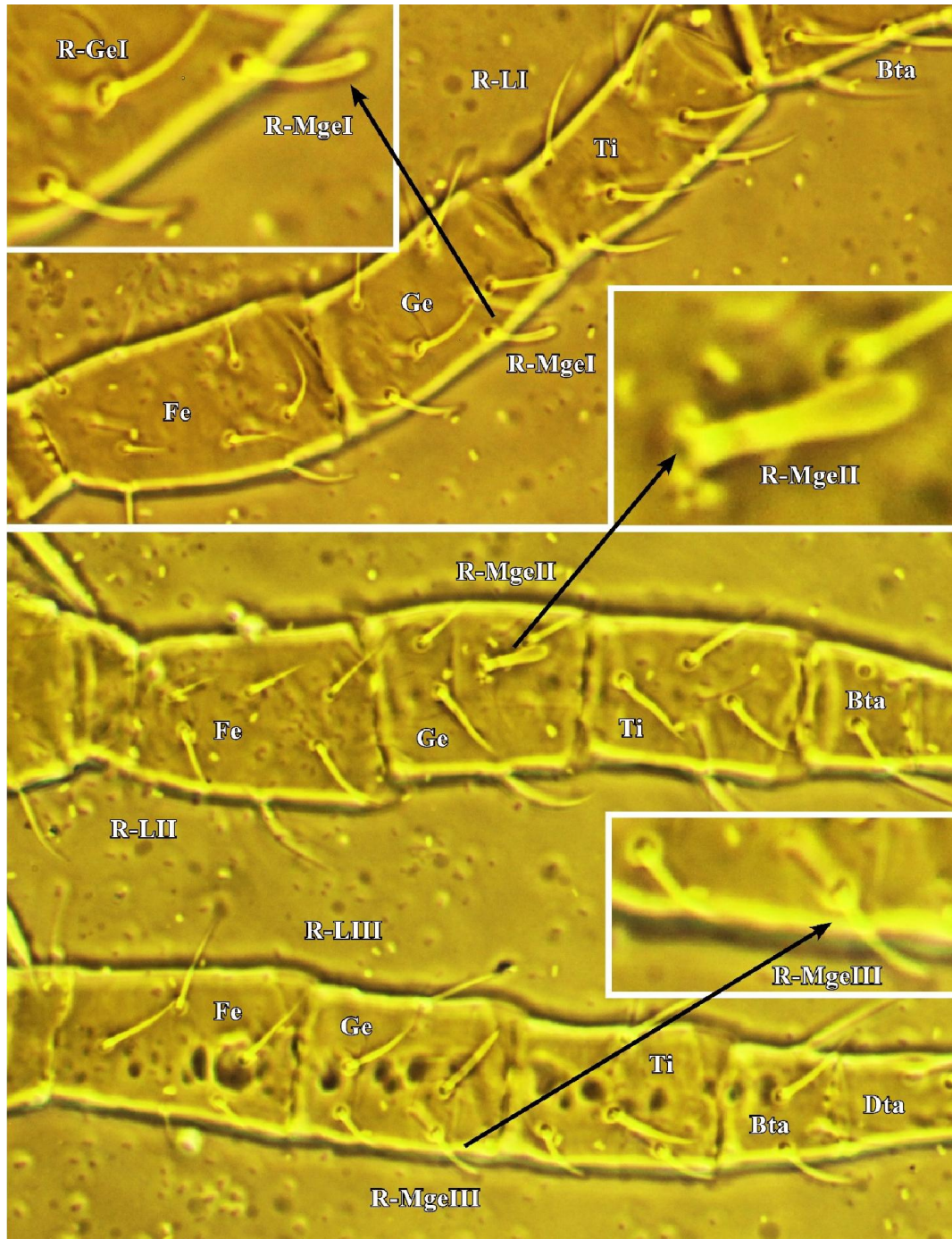
**Figure 22.** *Paraphytoseius santurcensis*: Top left - Spermatheca; Top right - Chelicerae; Bottom - Ventral view of gnathosoma showing corniculi (CO), hypostome (HY), 3 pairs of hypostomal setae (HY1-HY3), subcapitulum (SC), and 1 pair of subcapitular setae (CS) [FSCA, paratype, slide #4, female #4, 400x].



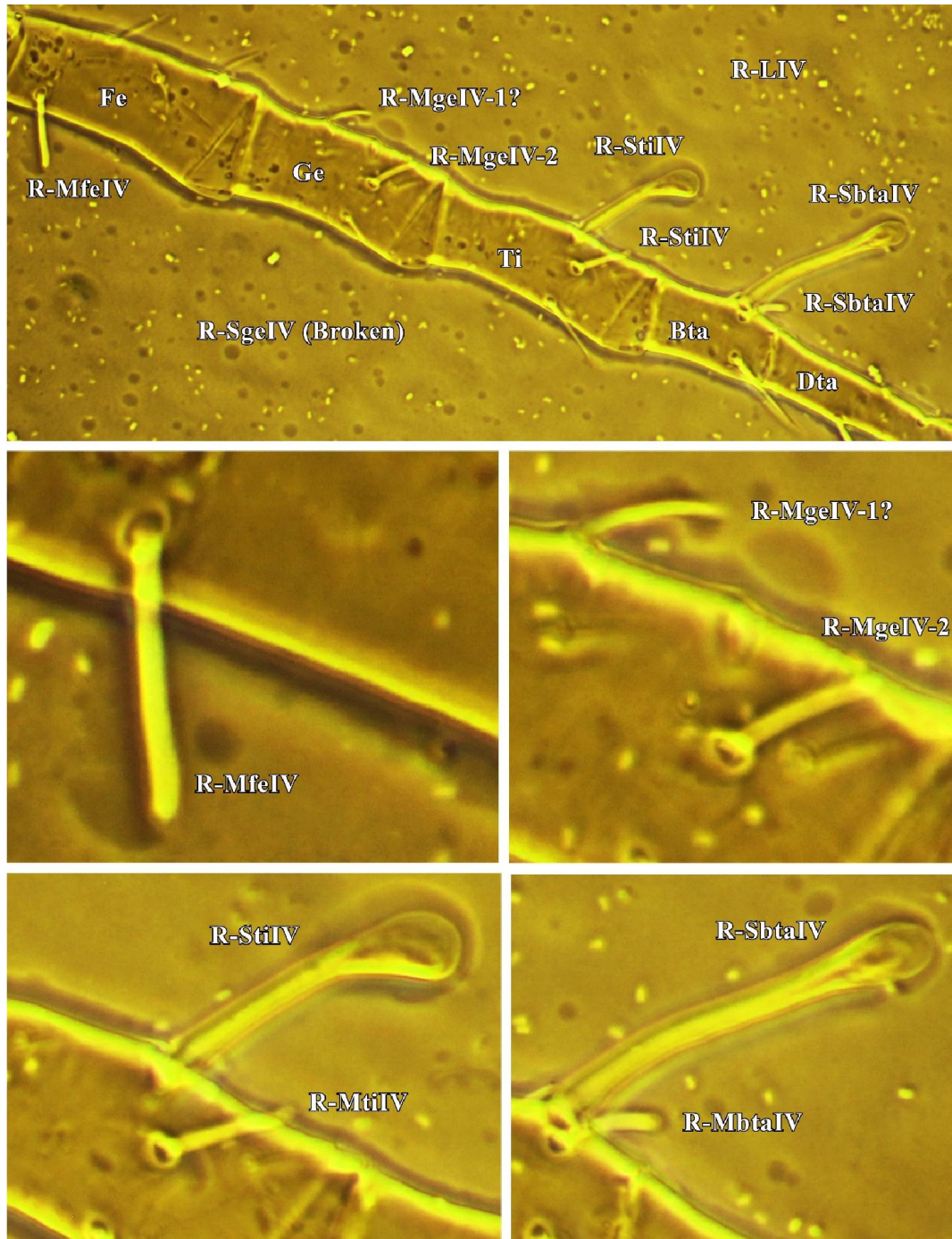
**Figure 23.** *Paraphytoseius santurcensis*: *Top* - Left leg I; *Middle* - Left legs II-III; *Bottom* - Enlarged view of modified setae MgeI (on left) and MgeII (on right) [FSCA, paratype, slide #4, female #4, female #4, 400x].



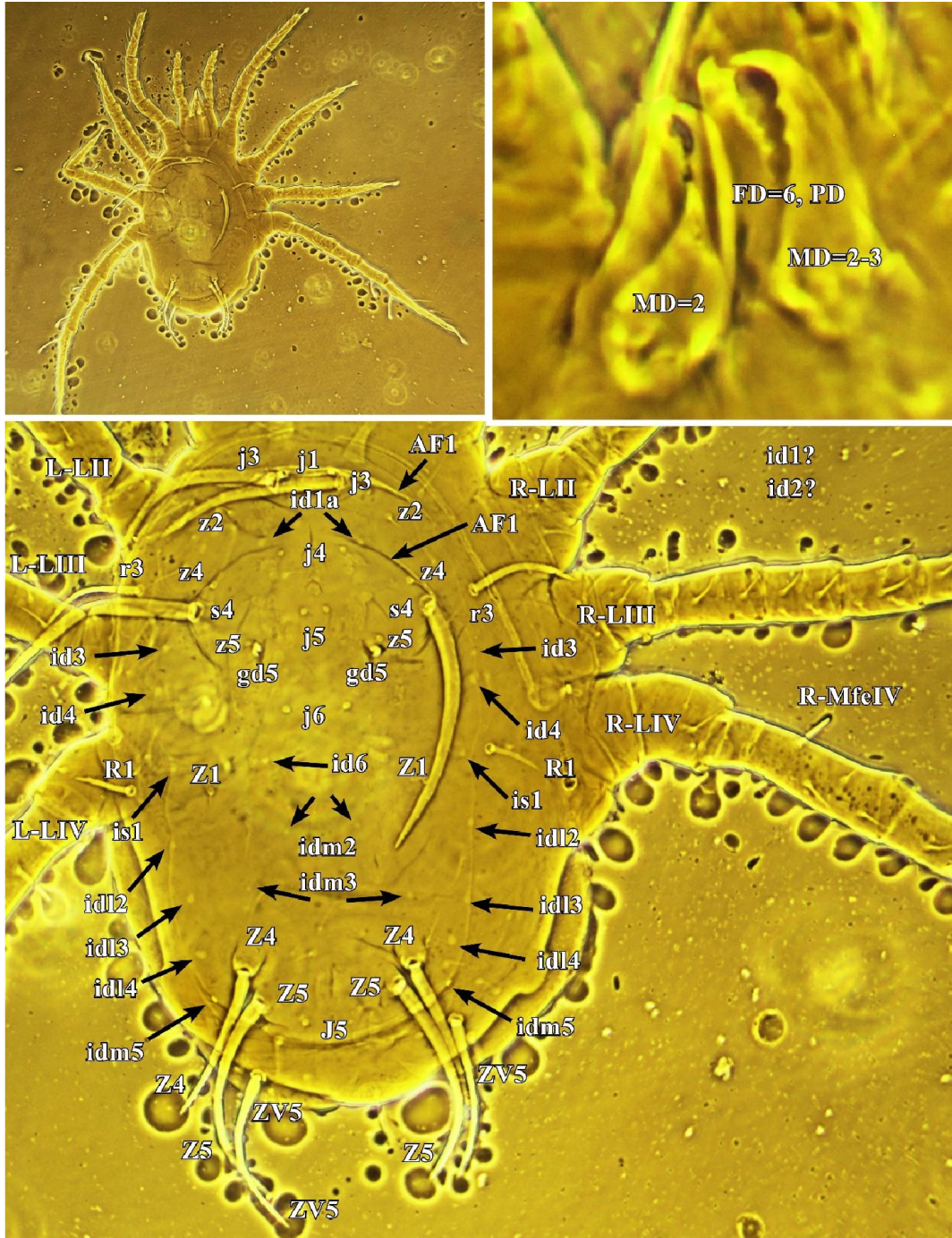
**Figure 24.** *Paraphytoseius santurcensis*: *Top* - Left leg IV with macrosetae and modified setae; *Middle* - Enlarged views of left MfeIV (right), left MgeIV-1, left MgeIV-2, and left MgeIV on leg IV (left); *Bottom* - Enlarged views of left MtiIV (right) and left MbtaIV (left) on leg IV [FSCA, paratype, slide #4, female #, 400x].



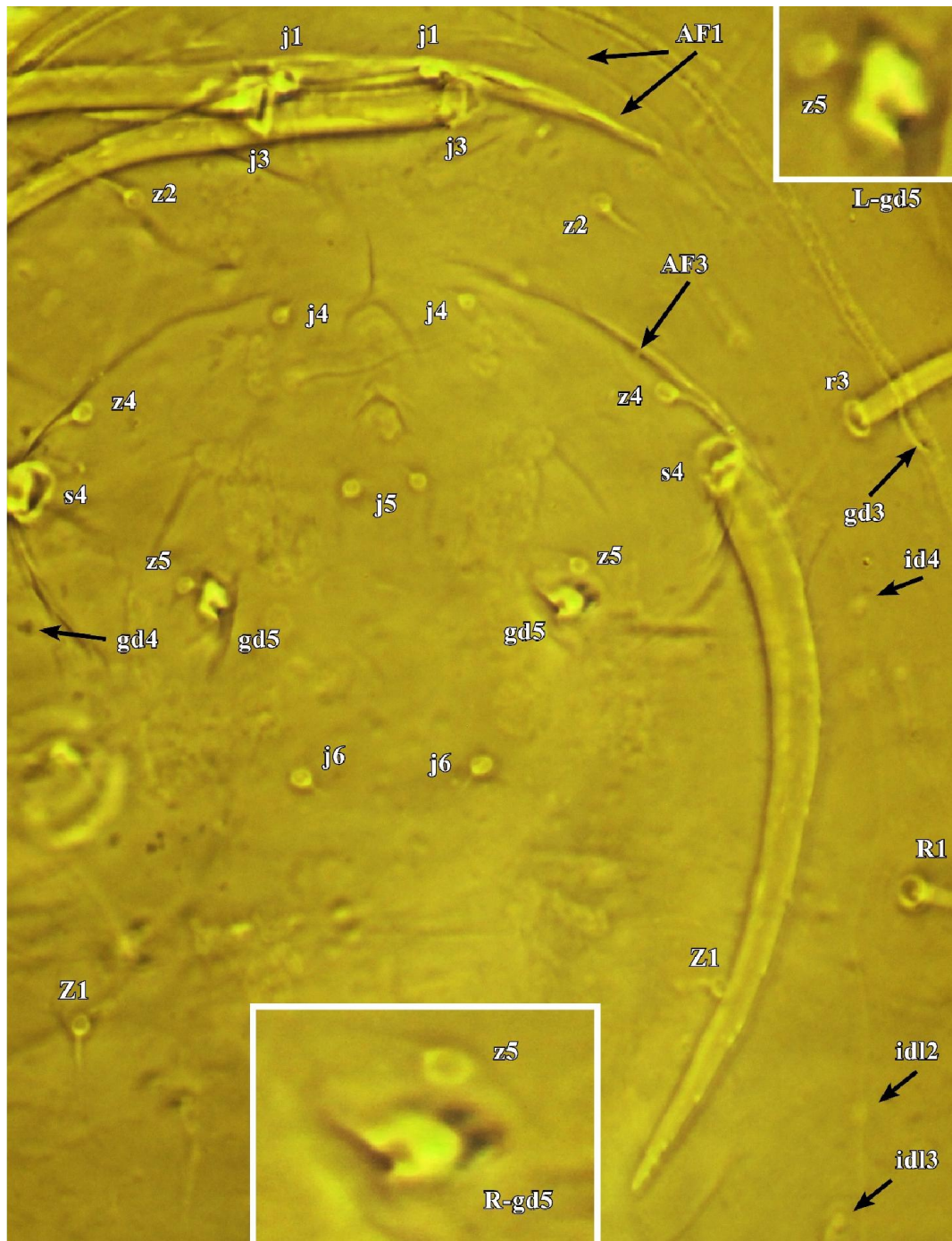
**Figure 25.** *Paraphytoseius santurcensis*: Top - Right leg I with MgeI; Bottom - Right legs II-III (Enlarged views of modified setae, arrows, MgeII and MgeIII) [FSCA, paratype, slide #4, female #4, 400x].



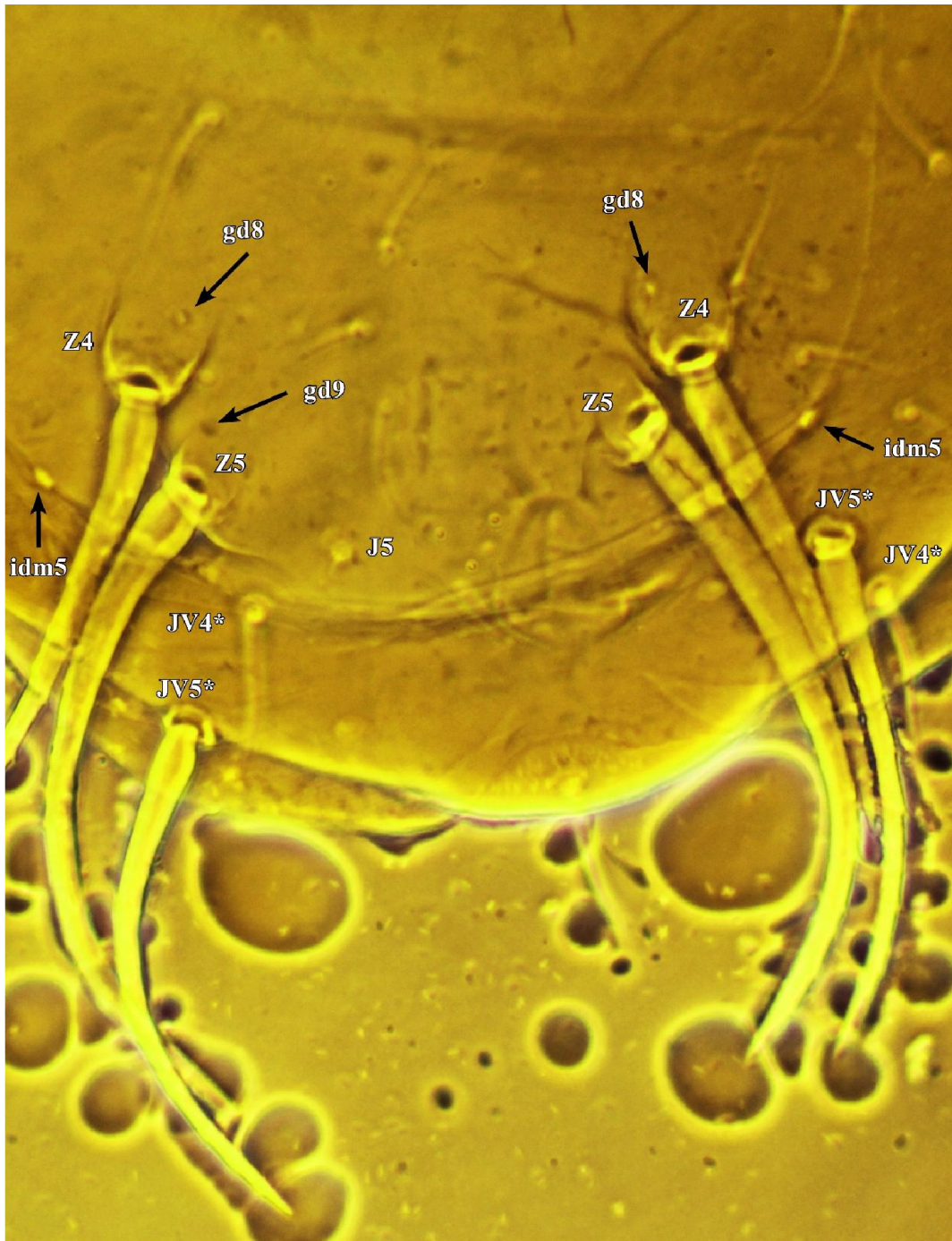
**Figure 26.** *Paraphytoseius santurcensis*: Top - Right leg IV with macrosetae and modified setae; Middle - Enlarged views of right MfeIV (left) and right MgeIV-1 and MgeIV-2 (right); Bottom - Enlarged views of right MtiIV (on left) and right MbtaIV (on right) [FSCA, paratype, slide #4, female #4, 400x].



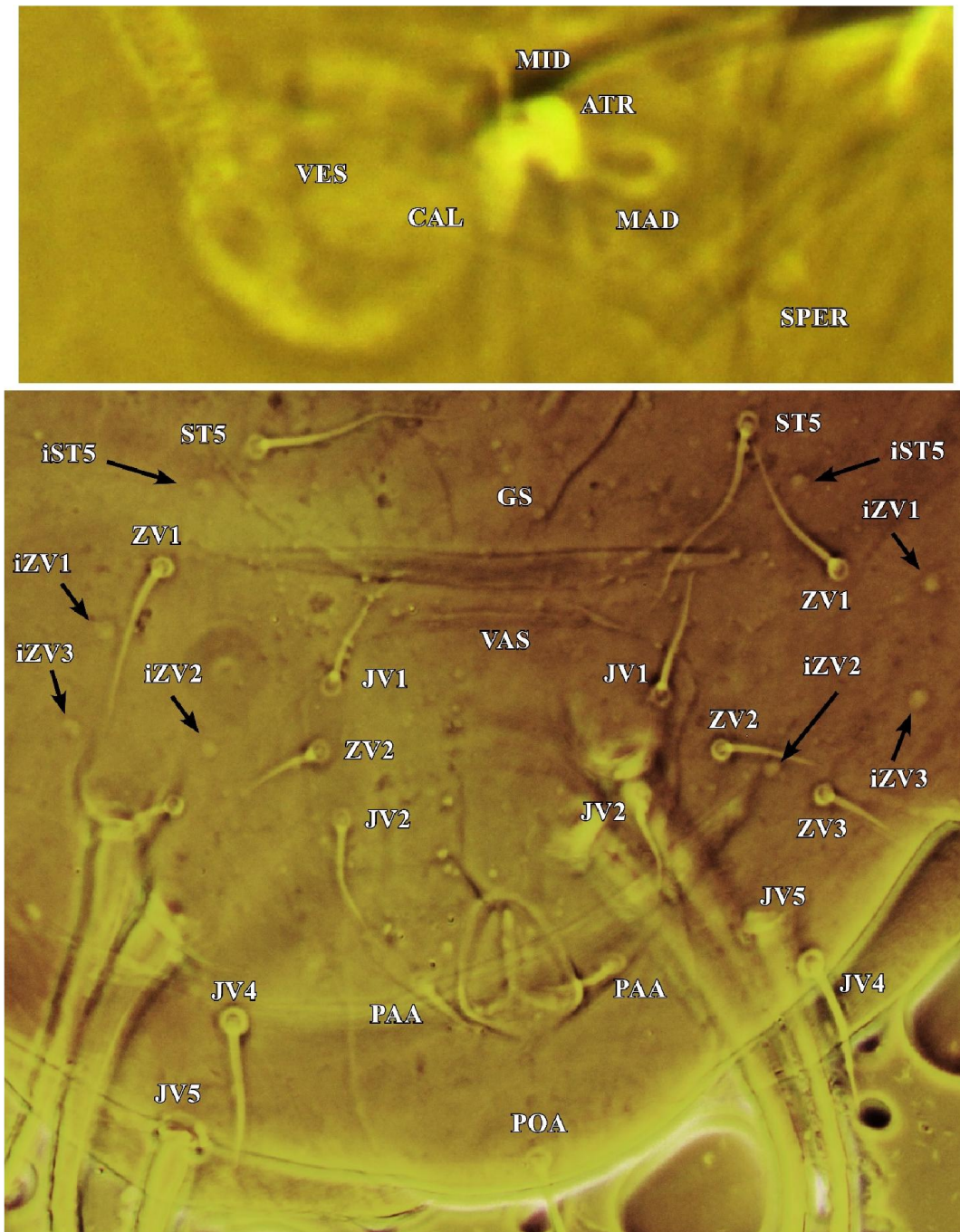
**Figure 27.** *Paraphytoseius santurcensis*: *Top left* - Dorsal view of body and legs in low magnification (100x); *Top right* - Chelicerae in high magnification (400x); *Bottom* - Dorsal view of body and legs in high magnification (200x) showing 2 anterior folds (AF1, AF2), solenostome gd5, and landmark setae on idiosoma and legs [FSCA, paratype, slide #5, female #5, 100-400x].



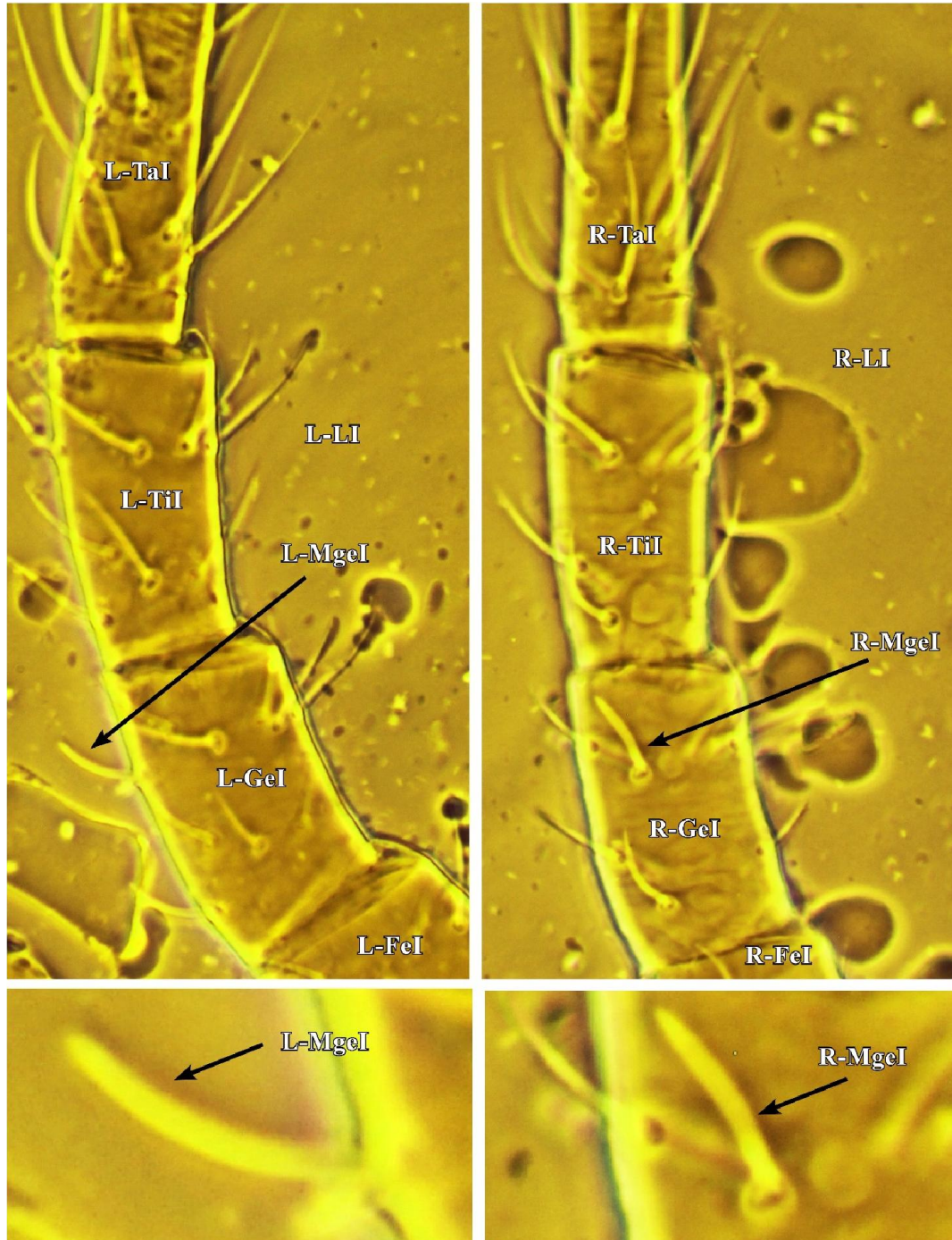
**Figure 28.** *Paraphytoseius santurcensis*: Dorsal view of anterior idiosoma in high magnification showing 2 anterior folds (AF1, AF2), solenostome gd5 (left in Top inset and right in Bottom inset), landmark setae, some lyrifissures and other solenostomes on idiosoma [FSCA, paratype, slide #5, female #5, 400x].



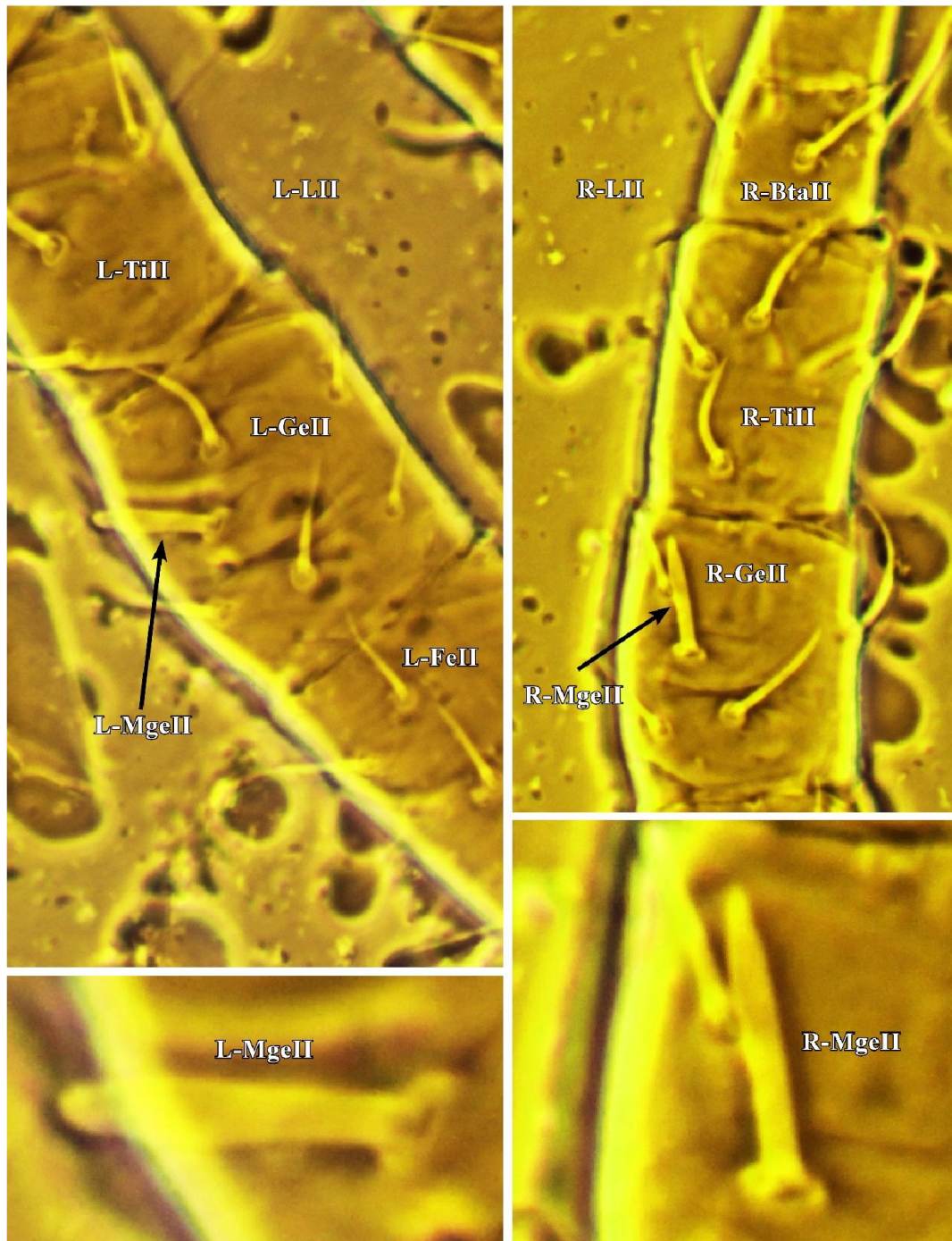
**Figure 29.** *Paraphytoseius santurcensis*: Dorsal shield in high magnification showing solenostomes gd8 and gd9, lyrifissure idm5, large landmark setae (Z4, Z5), and tiny seta J5. Ventral setae (\*) JV4\* and JV5\* also seen [FSCA, paratype, slide #5, female #5, 400x].



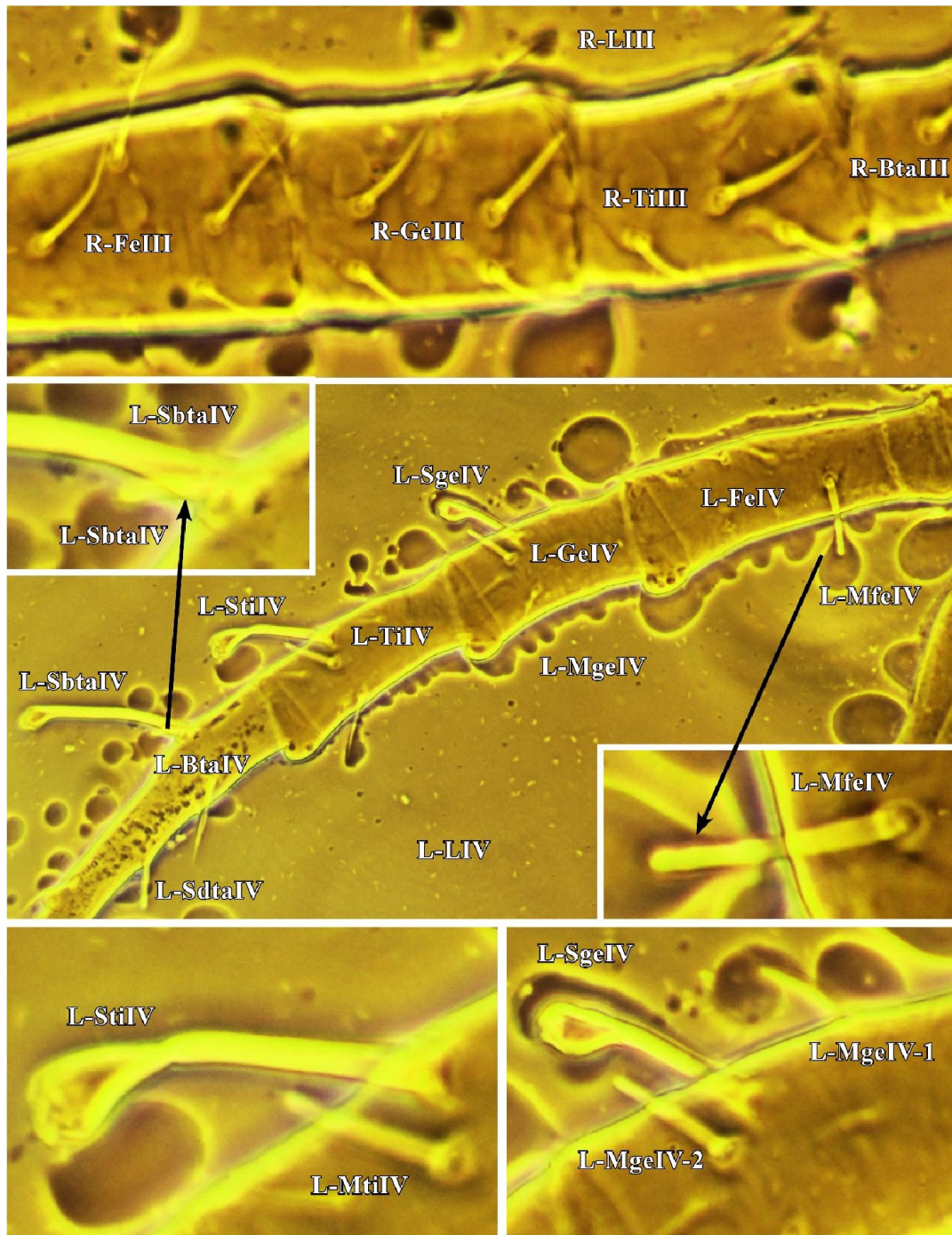
**Figure 30.** *Paraphytoseius santurcensis*: *Top* - Spermatheca (SPER); *Bottom* - Ventral view of posterior idiosoma showing posterior genital shield (GS) with ST5, ventrianal shield (VAS) with 3 pairs of preanal setae on left but, unusually, with only 2 pairs on right. Other ventral setae and lyrifissures also seen [FSCA, paratype, slide #5, female #5, 400x].



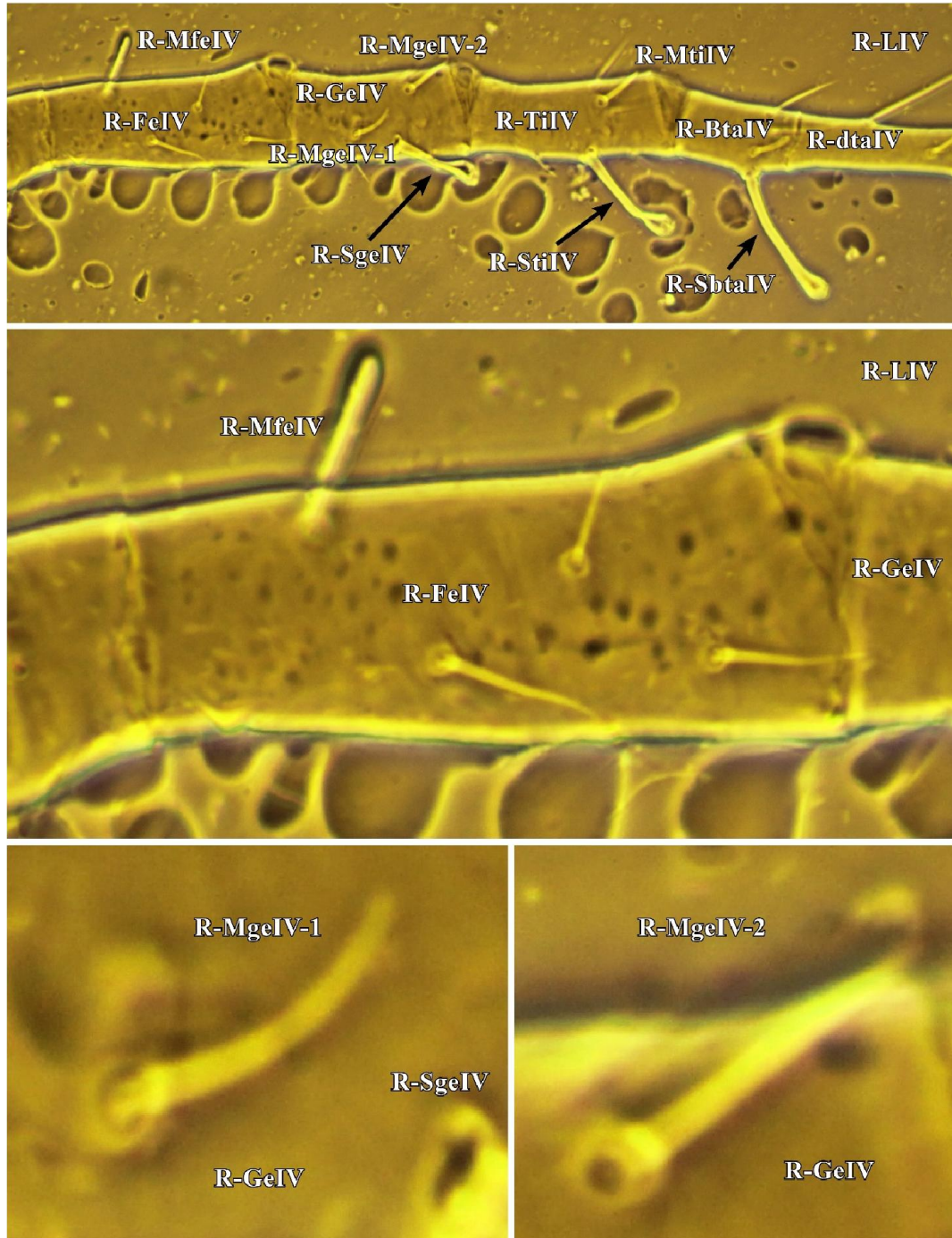
**Figure 31.** *Paraphytoseius santurcensis*: Top left - Left leg I with MgeI; Top right - Right leg I with MgeI; Bottom - Enlarged L-MgeI of left genu I (on left) and R-MgeI of right genu I [FSCA, paratype, slide #5, female #5, 400x].



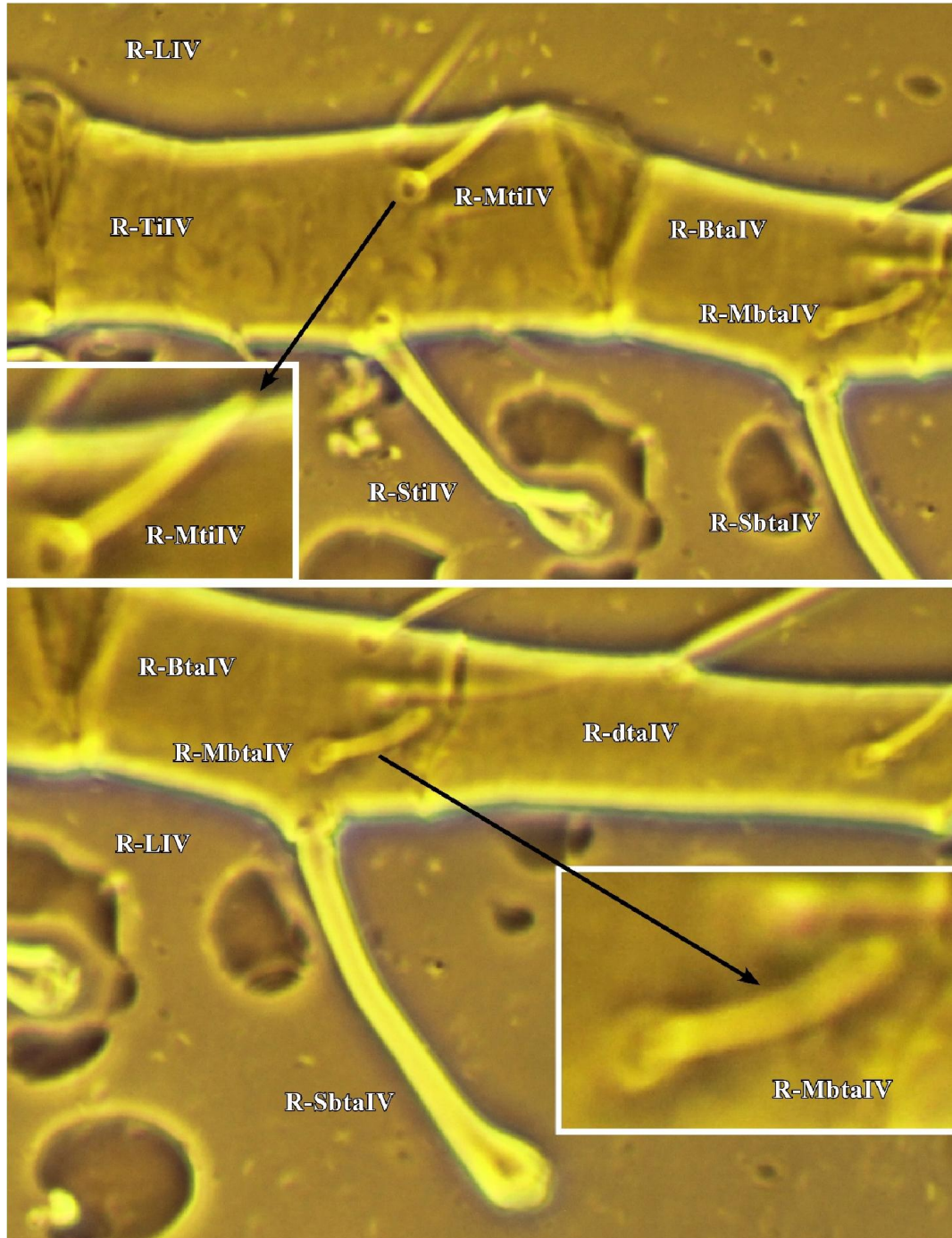
**Figure 32.** *Paraphytoseius santurcensis*: *Top left* - Left leg II with MgeII; *Top right* - Right leg II with MgeII; *Bottom* - Enlarged L-MgeII of left genu II (on left) and R-MgeII of right genu II - unusually (instead of clavate) with rod-shaped seta [FSCA, paratype, slide #5, female #5, 400x].



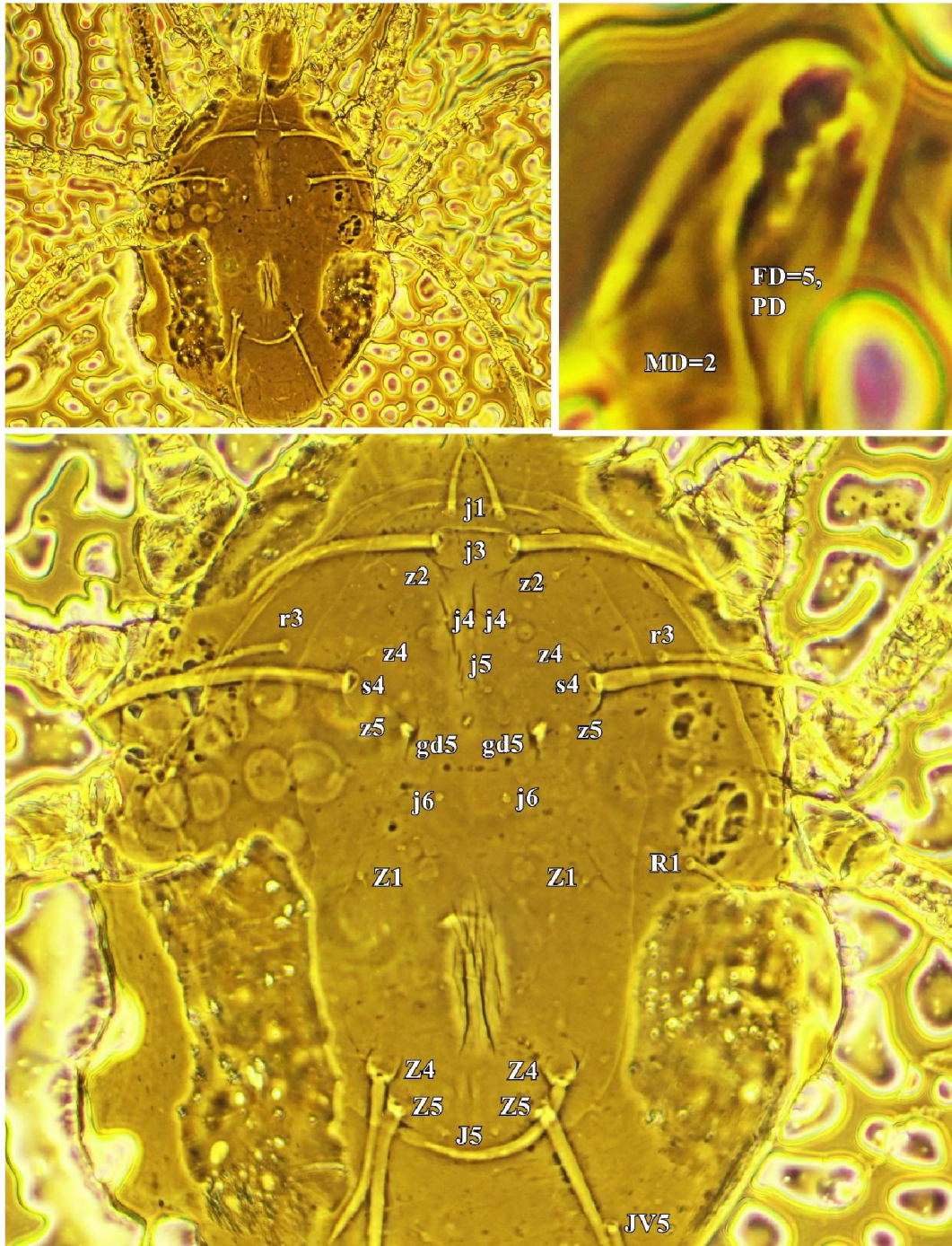
**Figure 33.** *Paraphytoseius santurcensis*: *Top* - Right leg III with absent MgeIII; *Middle* - Left leg IV with macrosetae and modified setae and enlarged MfeIV and MbtaIV; *Bottom* - Enlarged L-MgeIV-1 and MgeIV-2 (right) and L-MtiIV (left) [FSCA, paratype, slide #5, female #5, 400x].



**Figure 34.** *Paraphytoseius santurcensis*: *Top* - Right leg IV with macrosetae and modified setae; *Middle* - Right femur IV with MfeIV; *Bottom* - Enlarged R-MgeIV-1 (left) and MgeIV-2 (right) [FSCA, paratype, slide #5, female #5, 400x].



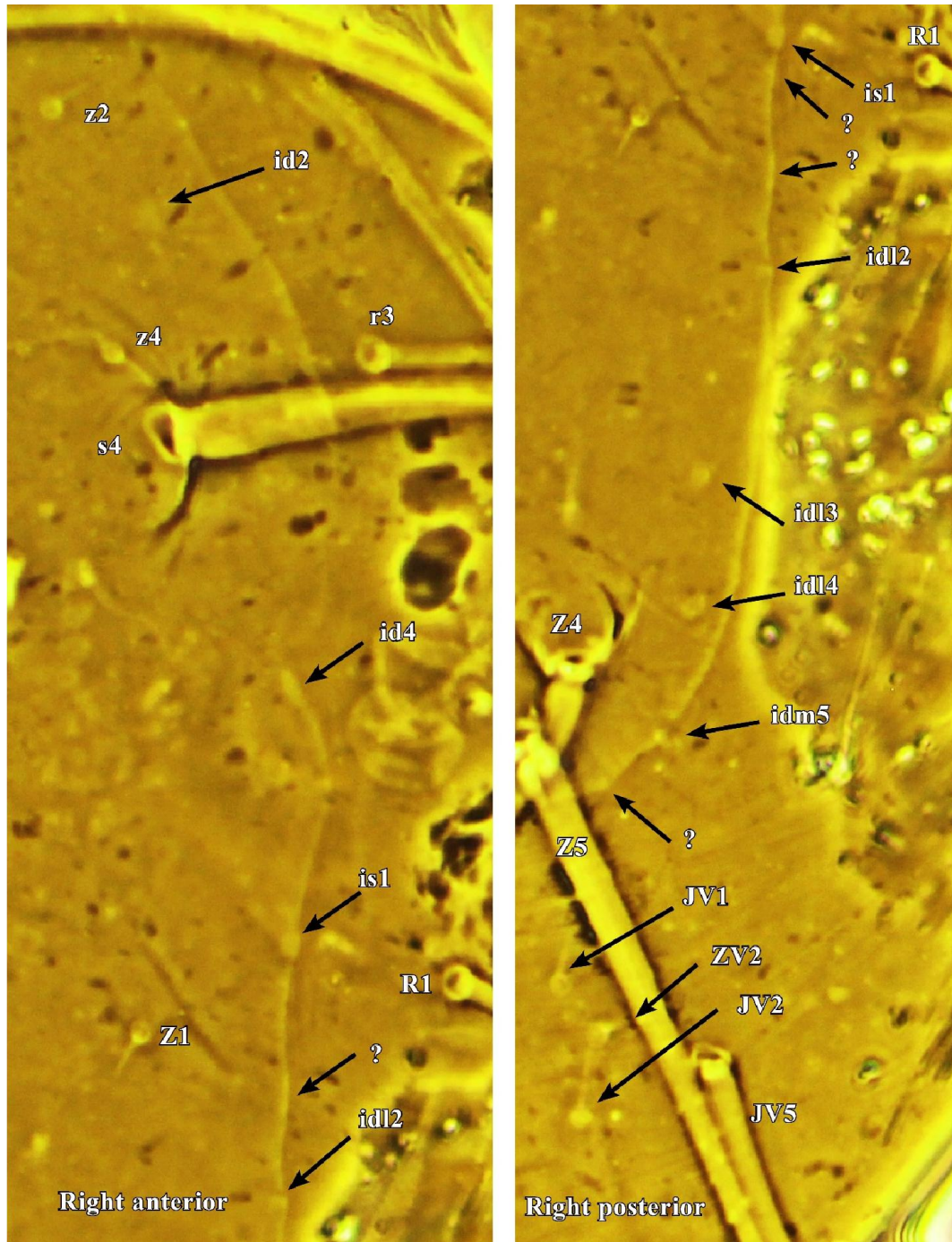
**Figure 35.** *Paraphytoseius santurcensis*: *Top* - Right tibia and part of basitarsus IV with macrosetae and modified setae (enlarged right StiIV in inset); *Bottom* - Right basitarsus IV with macroseta and modified setae (enlarged right MbtaIV in inset) [FSCA, paratype, slide #5, female #5, 400x].



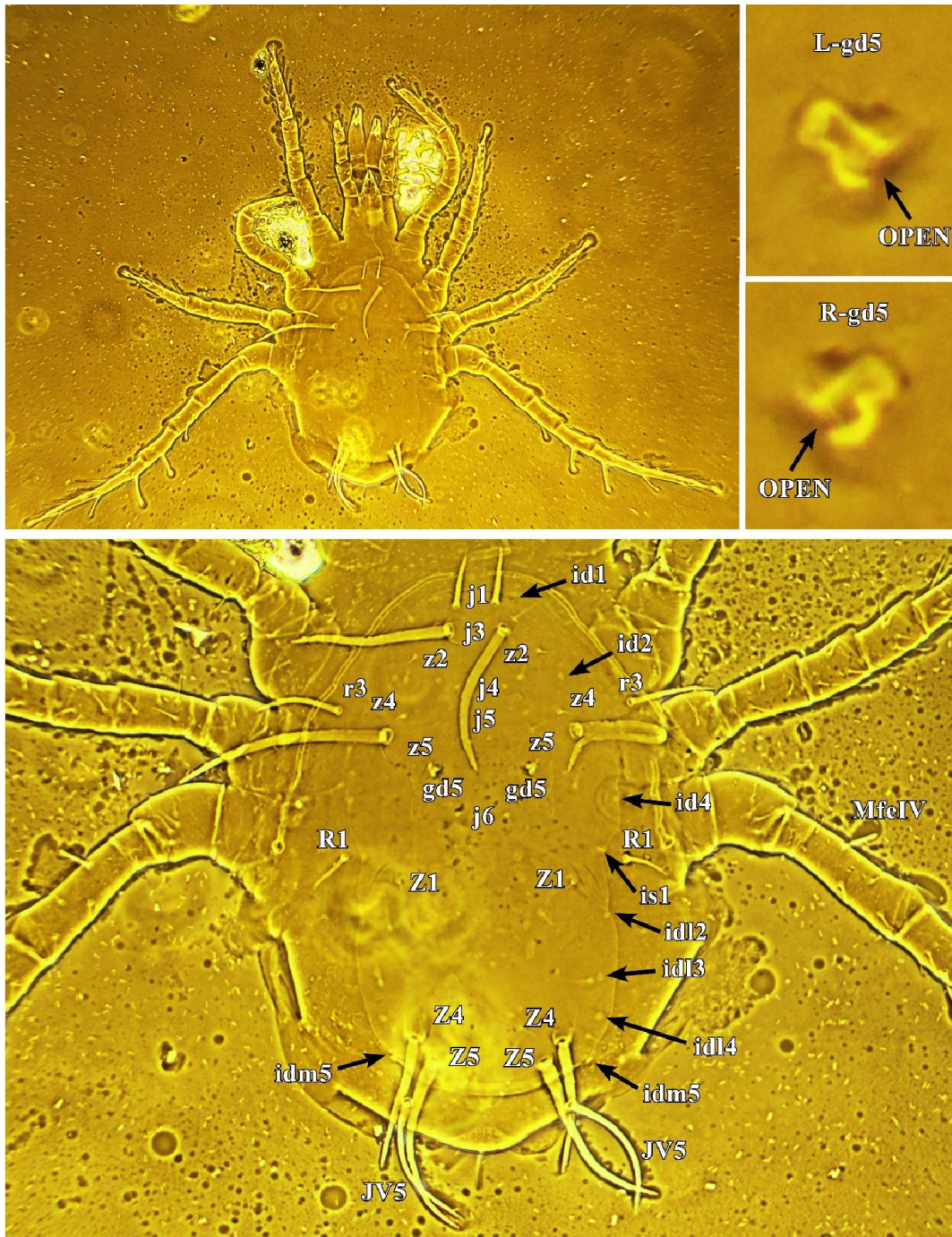
**Figure 36.** *Paraphytoseius santurcensis*: Top left - Dorsal view of body and legs in low magnification; Top right - Chelicerae; Bottom - Dorsal view of idiosoma in high magnification [FSCA, paratype, slide #6, female #6, top left - 100x, top right - 400x, bottom - 200x].



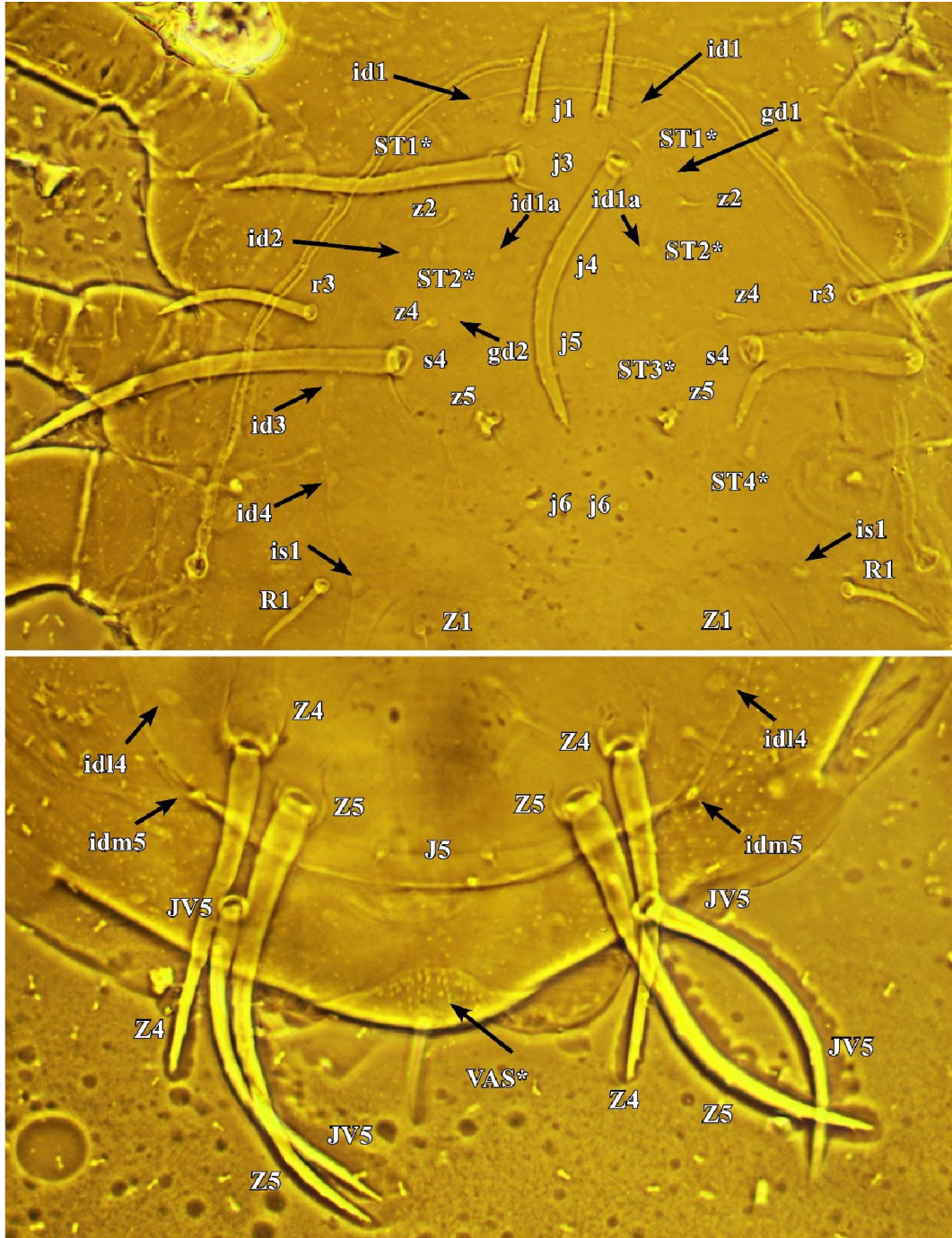
**Figure 37.** *Paraphytoseius santurcensis*: Dorsal view of idiosoma in high magnification showing dorsal setae, crateriform gd5 (Bottom inset), some lyrifissures, sternal setae (\*) and ventrianal shield (VAS) with 3 pairs of preanal setae. Note ZV3 placed at the edge on VAS [FSCA, paratype, slide #6, female #6, 400x].



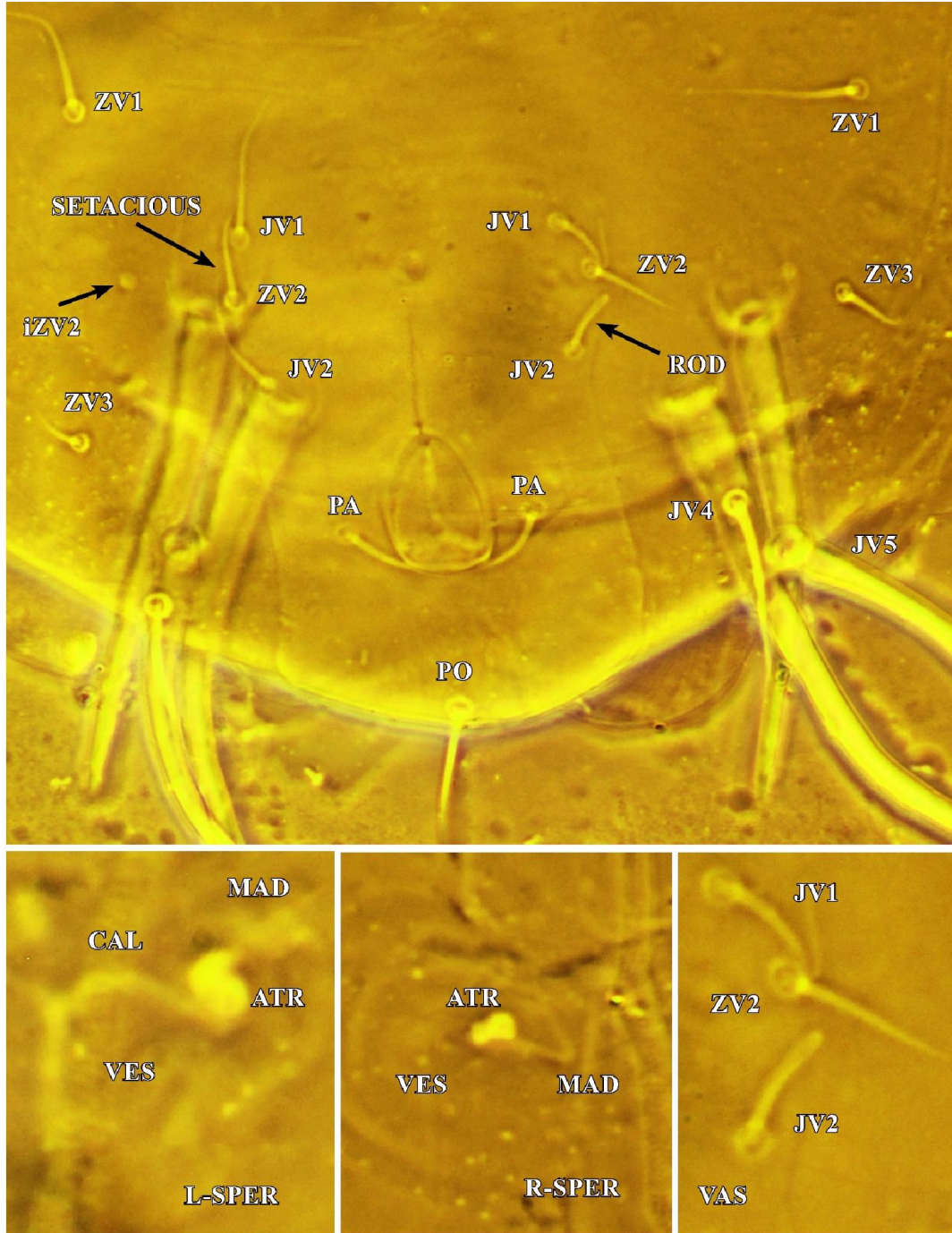
**Figure 38.** *Paraphytoseius santurcensis*: *Left* - Right anterior, *Right* - Right posterior. *Both* - Dorsal view of idiosoma and dorsal shield in high magnification showing some dorsal and ventral setae, some lyrifissures, and right side of ventrianal shield with 3 pairs of preanal setae. Note ZV3 placed at the edge on VAS [FSCA, paratype, slide #6, female #6, 400x].



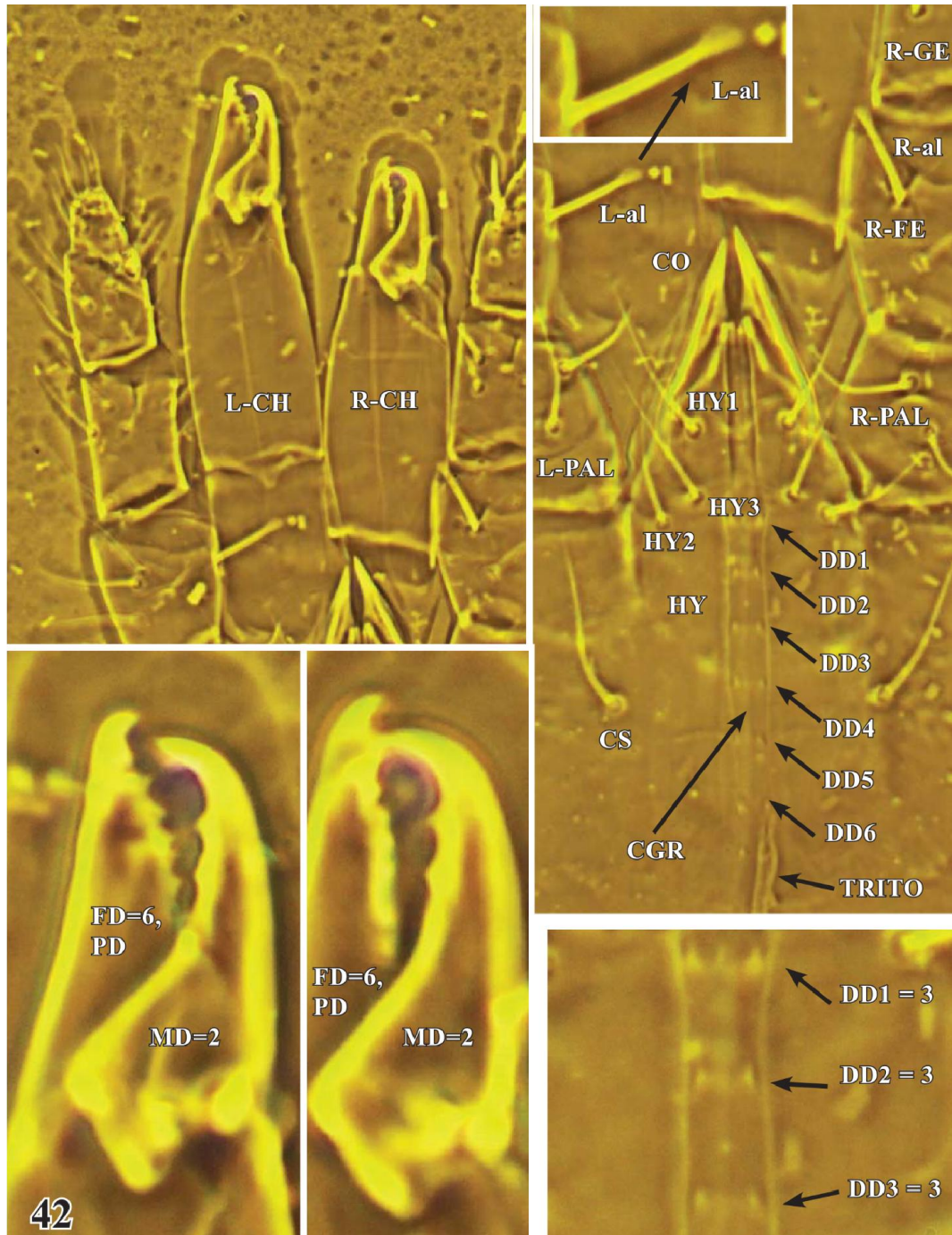
**Figure 39.** *Paraphytoseius santurcensis*: *Top left* - Dorsal view of body and legs in low magnification; *Top right* - Solenostome gd5; *Bottom* - Dorsal view of idiosoma in high magnification. Modified seta MfeIV also seen [FSCA, paratype, slide #7, female #7, *top left* - 100x, *top right* - 400x, *bottom* - 200x].



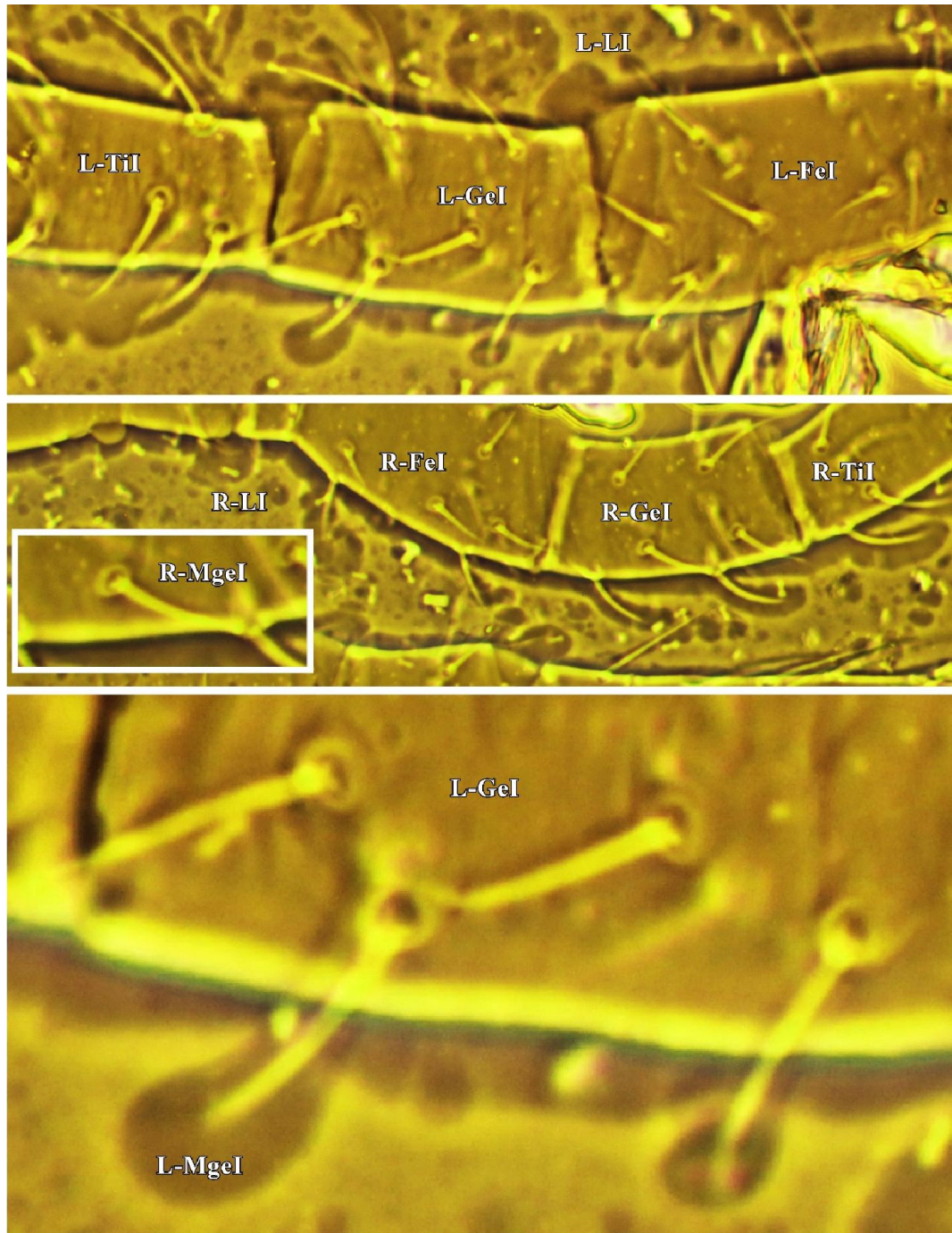
**Figure 40.** *Paraphytoseius santurcensis*: *Top* - Dorsal view of anterior idiosoma; *Bottom* - Dorsal view of posterior idiosoma, both with setae, solenostomes, and lyrifissures. Posterior end of VAS\* (ventral) with cribrum folded over (arrow) seen [FSCA, paratype, slide #7, female #7, 400x].



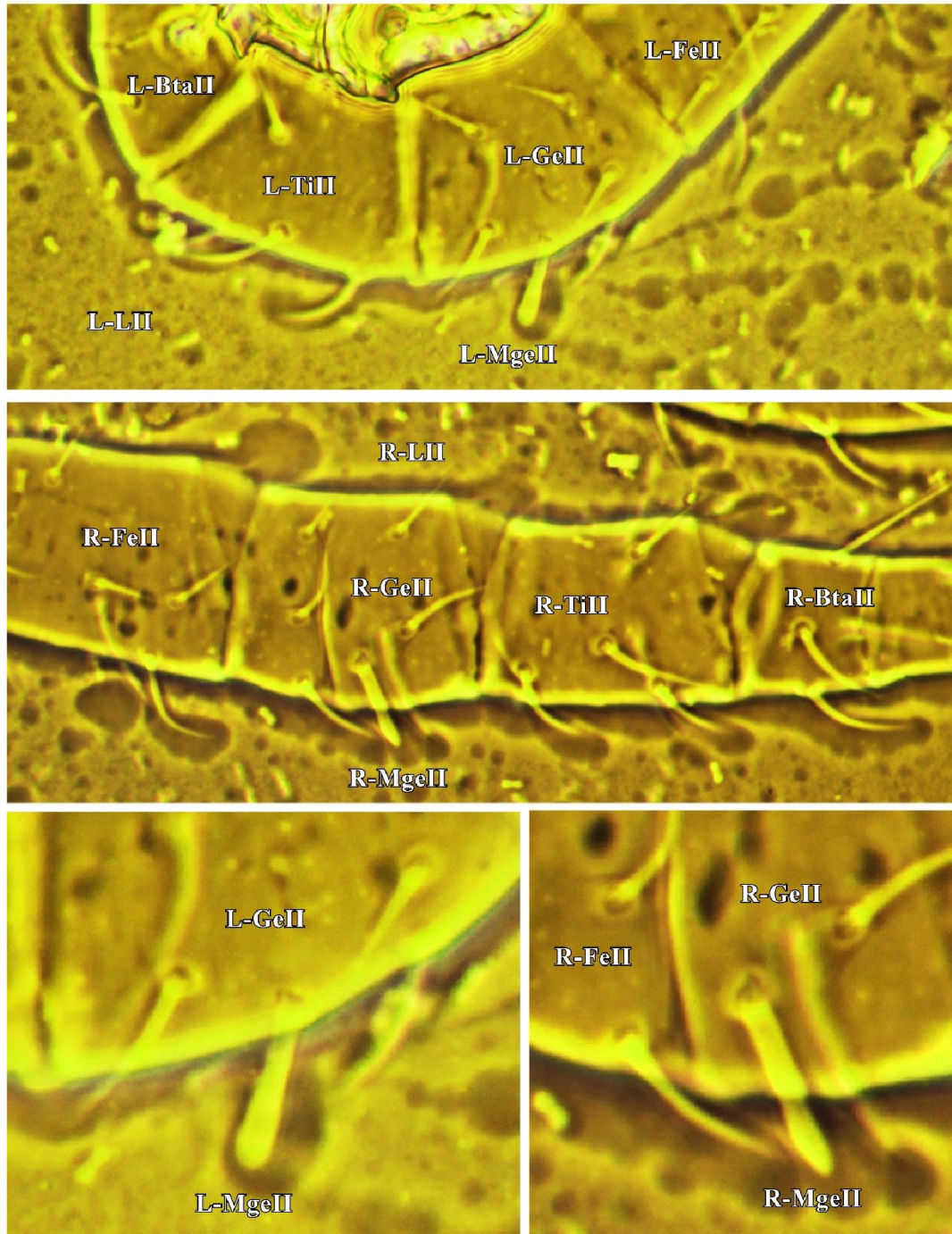
**Figure 41.** *Paraphytoseius santurcensis*: *Top* - Ventral view of idiosoma with 3 pairs of preanal setae but right JV2, unusually, being rod-shaped; *Bottom left and middle* - Left and right spermatheca (twisted, distorted); *Bottom right* - Enlarged, unusual rod-shaped JV2, but normal setaceous or setose JV1 and ZV2 [FSCA, paratype, slide #7, female #7, 400x].



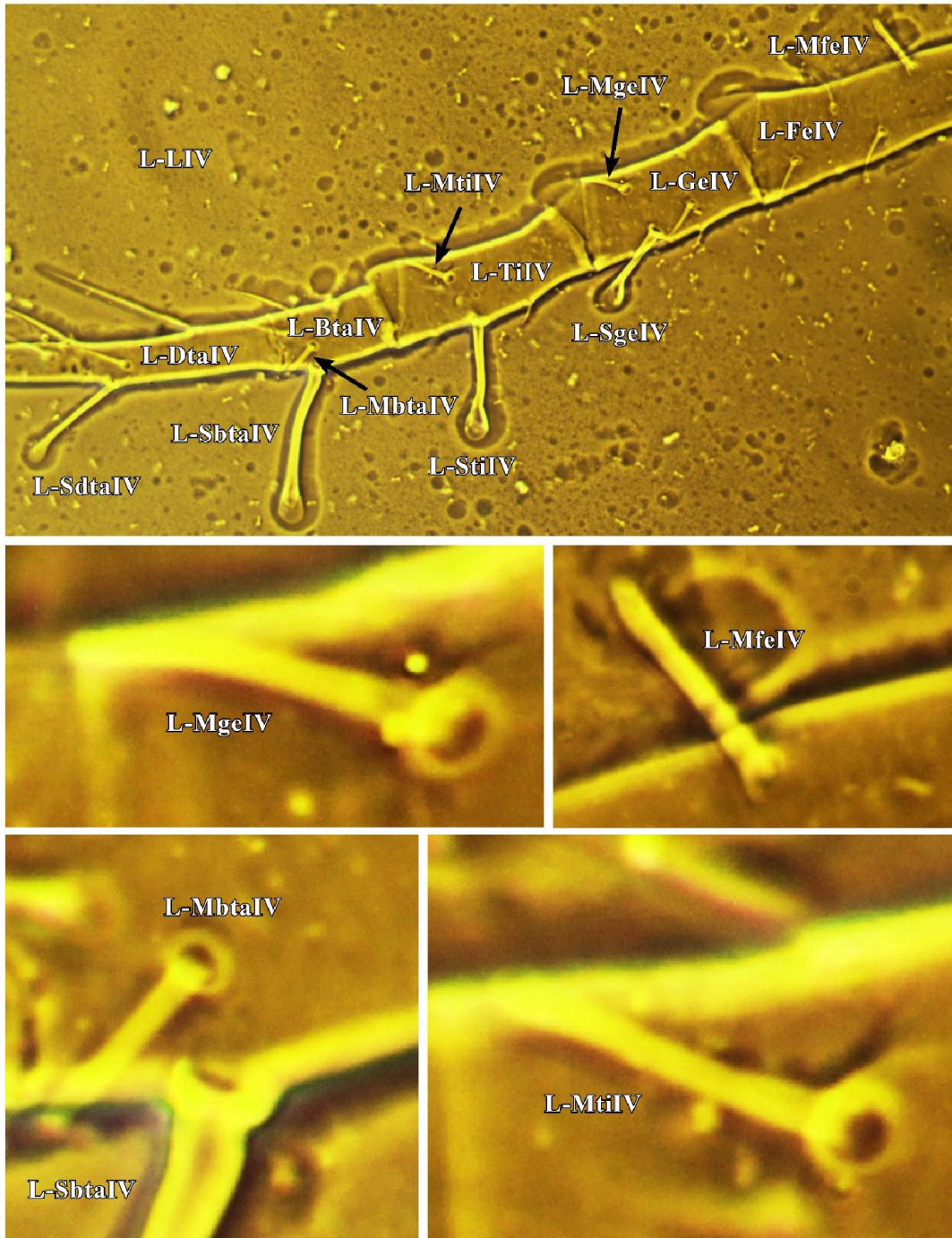
**Figure 42.** *Paraphytoseius santurcensis*: *Top left* - Dorsal view of chelicerae; *Bottom left* - Chelicerae, enlarged; *Right* - Ventral gnathosoma, palp femur with macroseta al, corniculi (CO), hypostome (HY), hypostomal setae (HY1-3), capitular (CS) setae, capitular groove (CGR) with denticles (DD), and tritosternum (TRITO) [FSCA, paratype, slide #7, female #7, 400x].



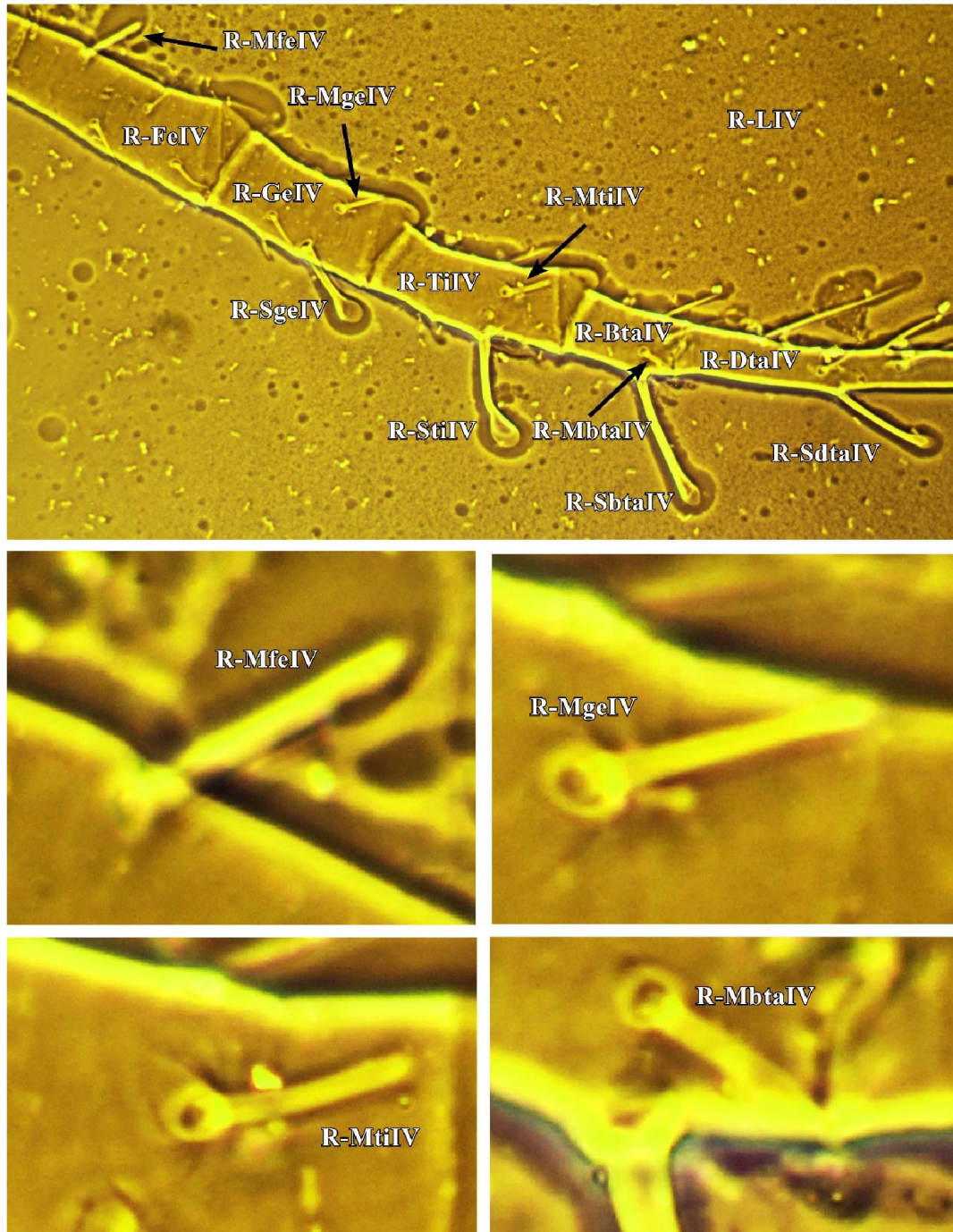
**Figure 43.** *Paraphytoseius santurcensis*: *Top* - Left leg I; *Middle* - Right leg I with enlarged R-Mgel (inset); *Bottom* - Enlarged seta L-Mgel on genu of left leg I [FSCA, paratype, slide #7, female #7, 400x].



**Figure 44.** *Paraphytoseius santurcensis*: Top - Left leg II with L-MgeII; Middle - Right leg II with R-MgeII; Bottom - Enlarged setae L-MgeII (left) and R-MgeII (right) [FSCA, paratype, slide #7, female #7, 400x].



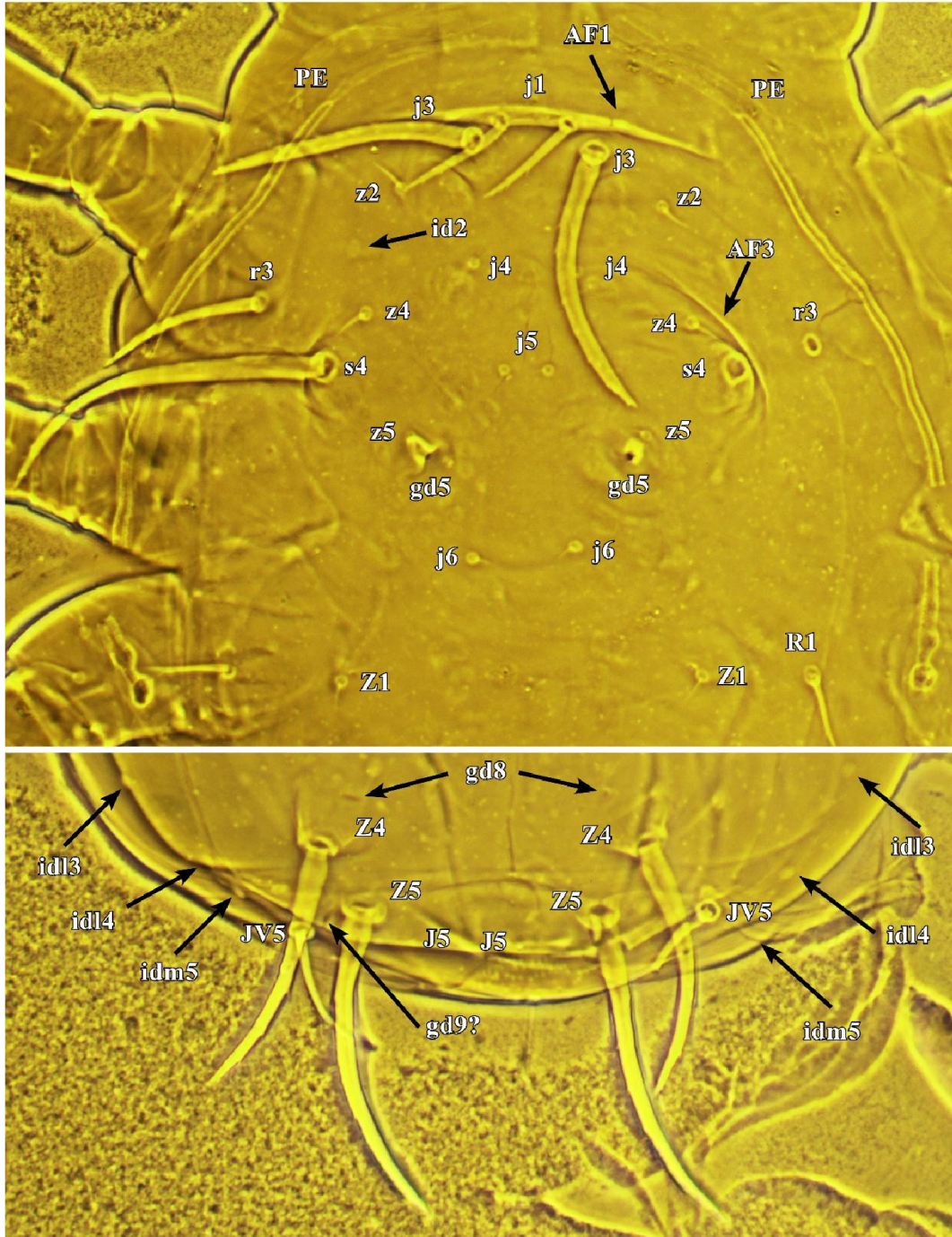
**Figure 45.** *Paraphytoseius santurcensis*: *Top* - Left leg IV with macrosetae and modified setae; *Middle* - Enlarged L-MfeIV (right) and L-MgeIV (left); *Bottom* - Enlarged setae L-MtiIV (right) and L-MbtaIV (left) [FSCA, paratype, slide #7, female #7, 400x].



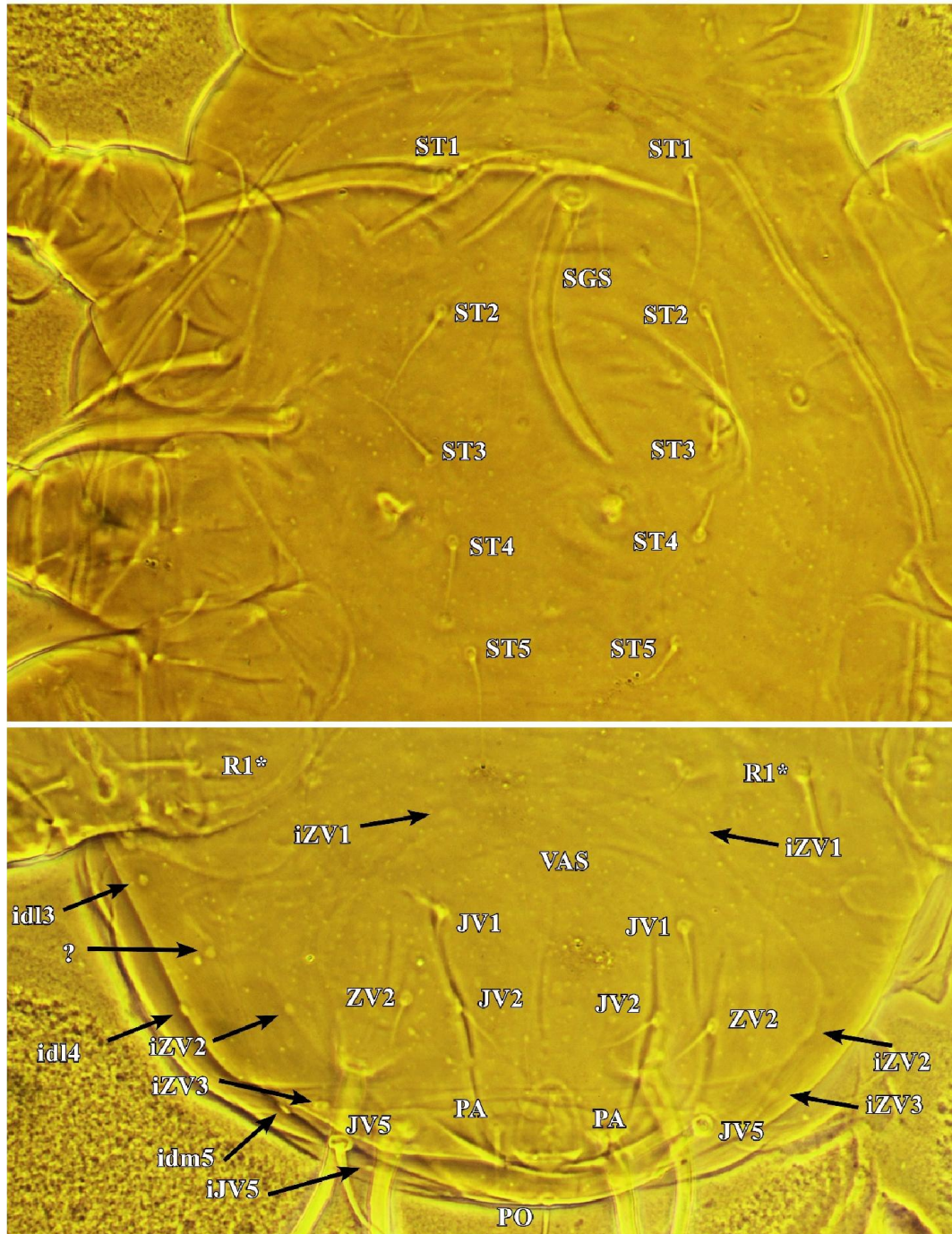
**Figure 46.** *Paraphytoseius santurcensis*: Top - Right leg IV with macrosetae and modified setae; Middle - Enlarged R-MfeIV (left) and R-MgeIV (right); Bottom - Enlarged setae R-MtiIV (left) and R-MbtaIV (right) [FSCA, paratype, slide #7, female #7, 400x].



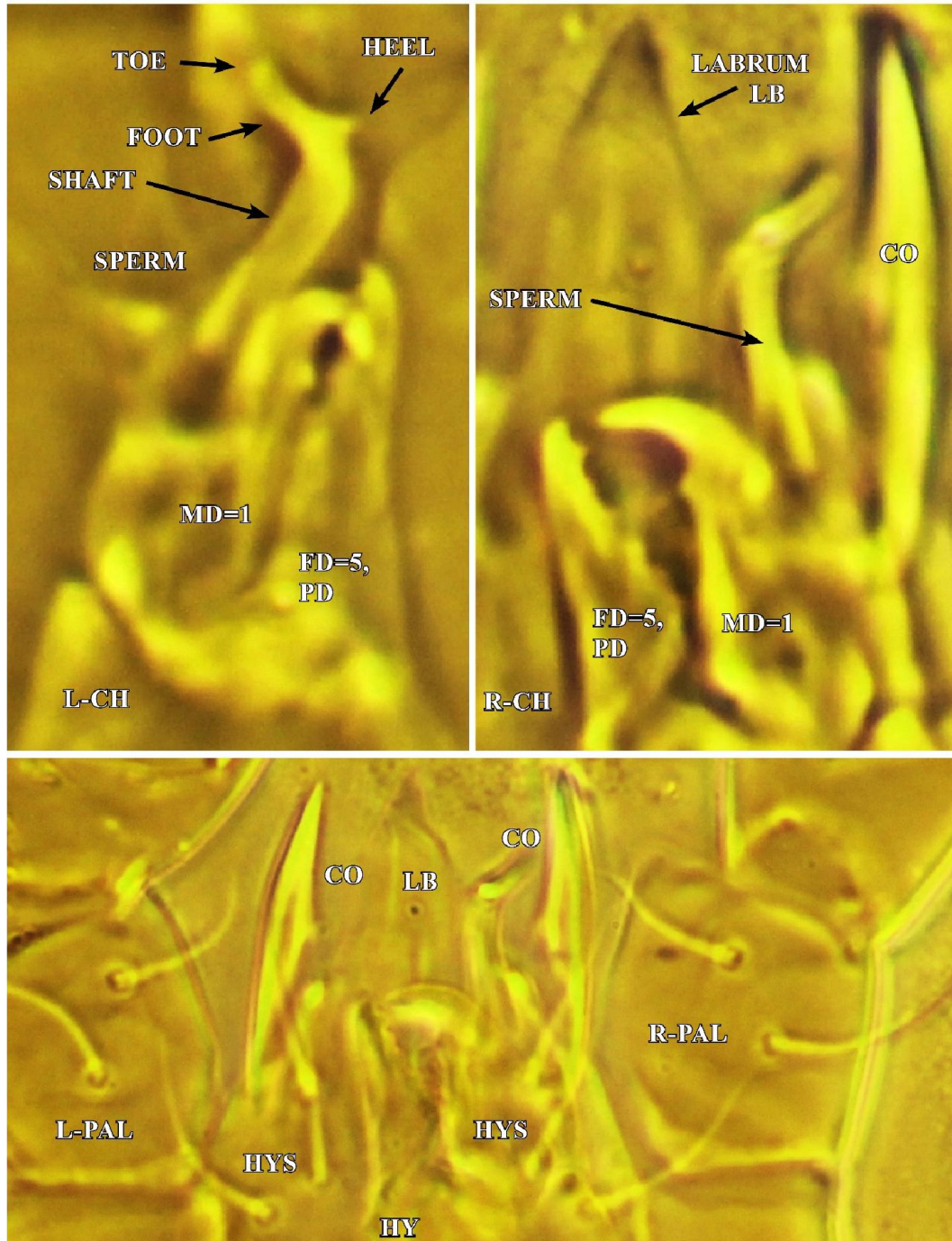
**Figure 47.** *Paraphytoseius santurcensis*: *Top left* - Dorsal view of body and legs in low magnification (old Hoyer's medium attached with remounted male); *Top right* - Enlarged views of left and right solenostome gd5; *Bottom* - Dorsal view of idiosoma in high magnification [FSCA, paratype, slide #8, male #1, *top left* and *bottom* - 200x].



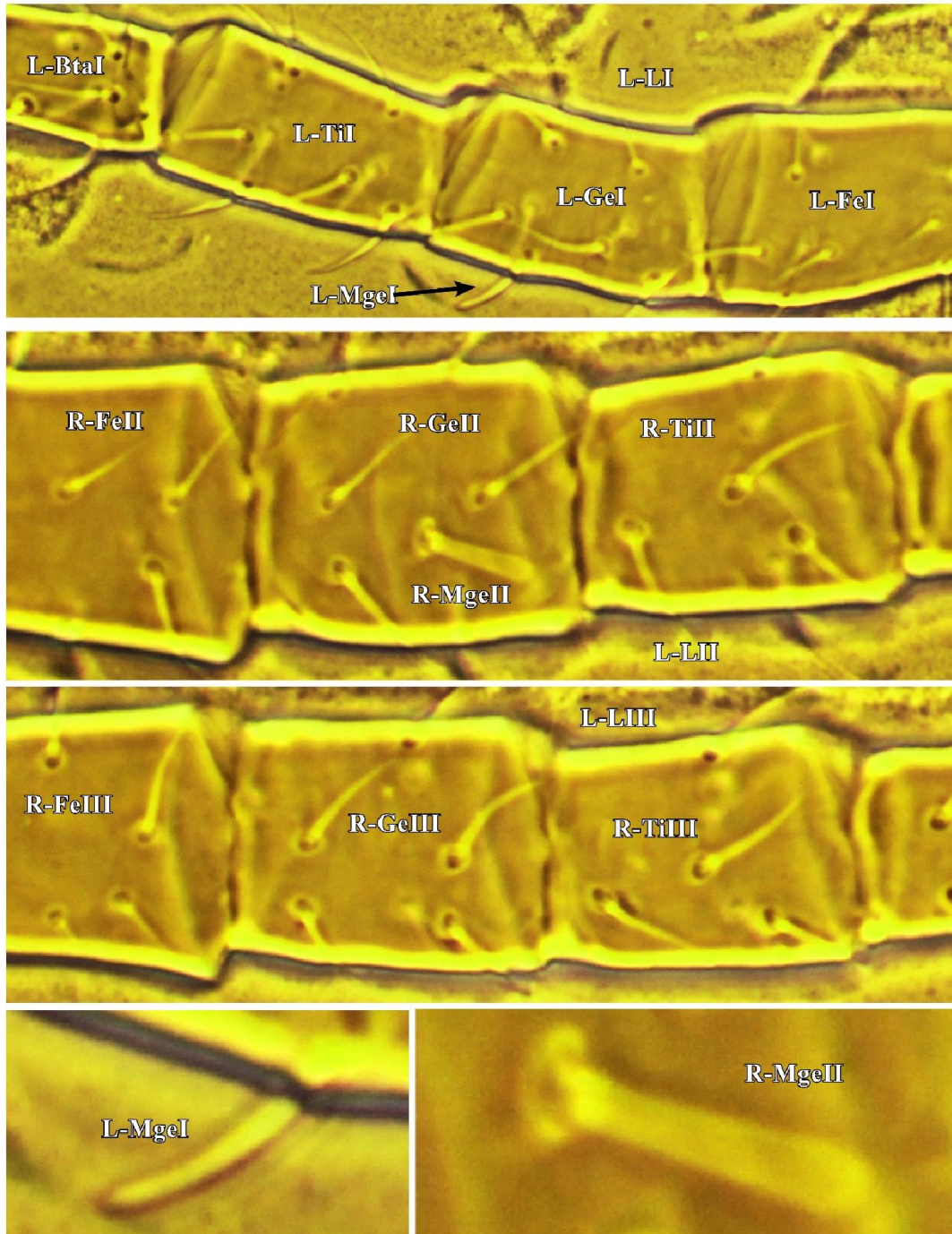
**Figure 48.** *Paraphytoseius santurcensis*: *Top* - Dorsal view of anterior idiosoma in high magnification with setae, gd5 and id2, and anterior folds (AF); *Bottom* - Dorsal view of posterior idiosoma in high magnification with setae, gd8, gd9?, idl3, idl4, and idm5 [FSCA, paratype, slide #8, male #1, 400x].



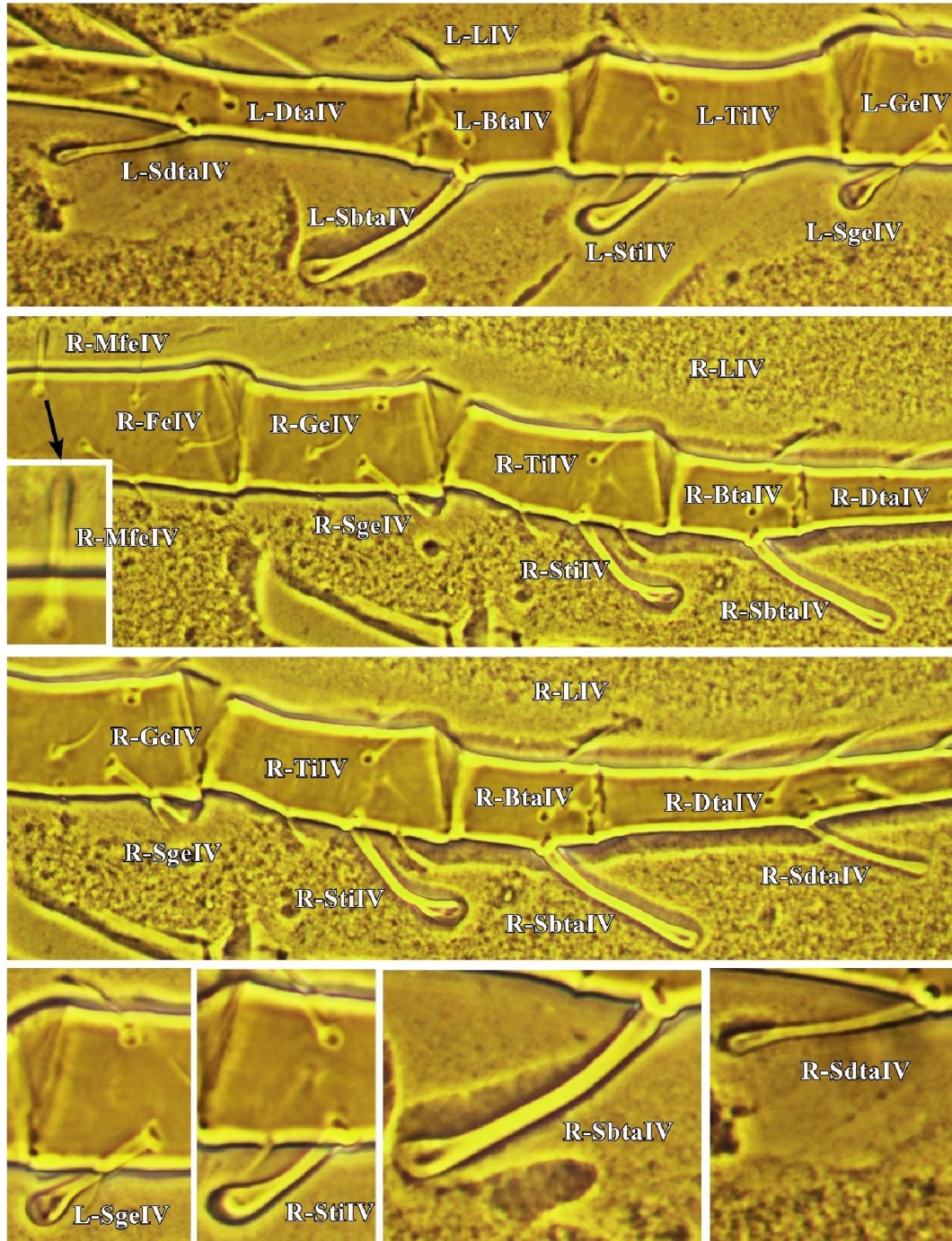
**Figure 49.** *Paraphytoseius santurcensis*: *Top* - Ventral view of anterior idiosoma with sternogenital shield (SGS) and ST1-ST5; *Bottom* - Ventral view of posterior idiosoma with ventrianal shield (VAS) showing 3 pairs of preanal setae (JV1, JV2, ZV2). Seta JV5, idm5 and other lyrifissures also seen [FSCA, paratype, slide #8, male #1, 400x].



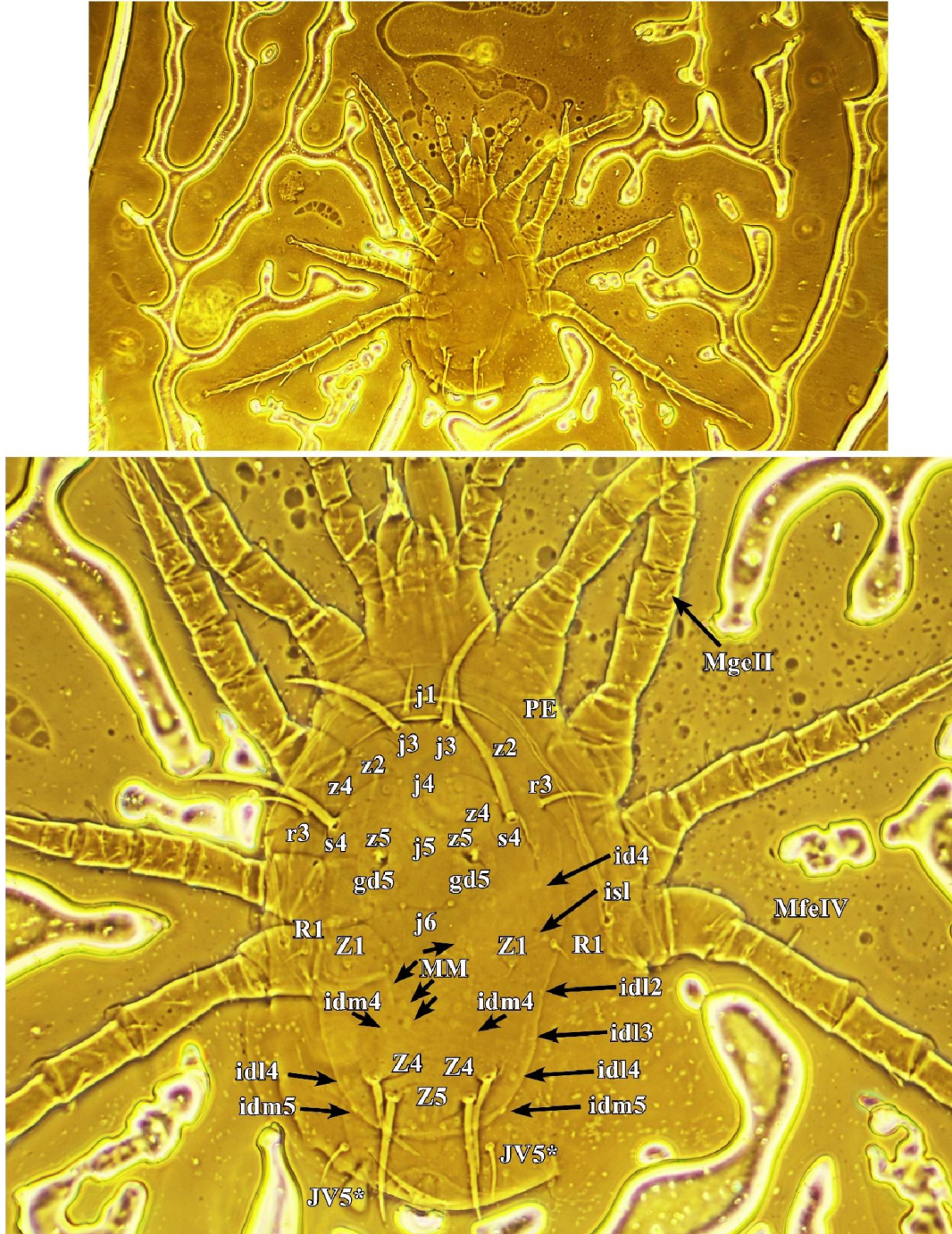
**Figure 50.** *Paraphytoseius santurcensis*: Top - Left and right chelicerae with spermatodactyl and labrum (LB); Bottom - Ventral view of anterior gnathosoma in between left and right palps (L-PAL and R-PAL) showing anterior hypostome (HY), 3 pairs of hypostomal setae (HYS), and labrum (LB) [FSCA, paratype, slide #8, male #1, 400x].



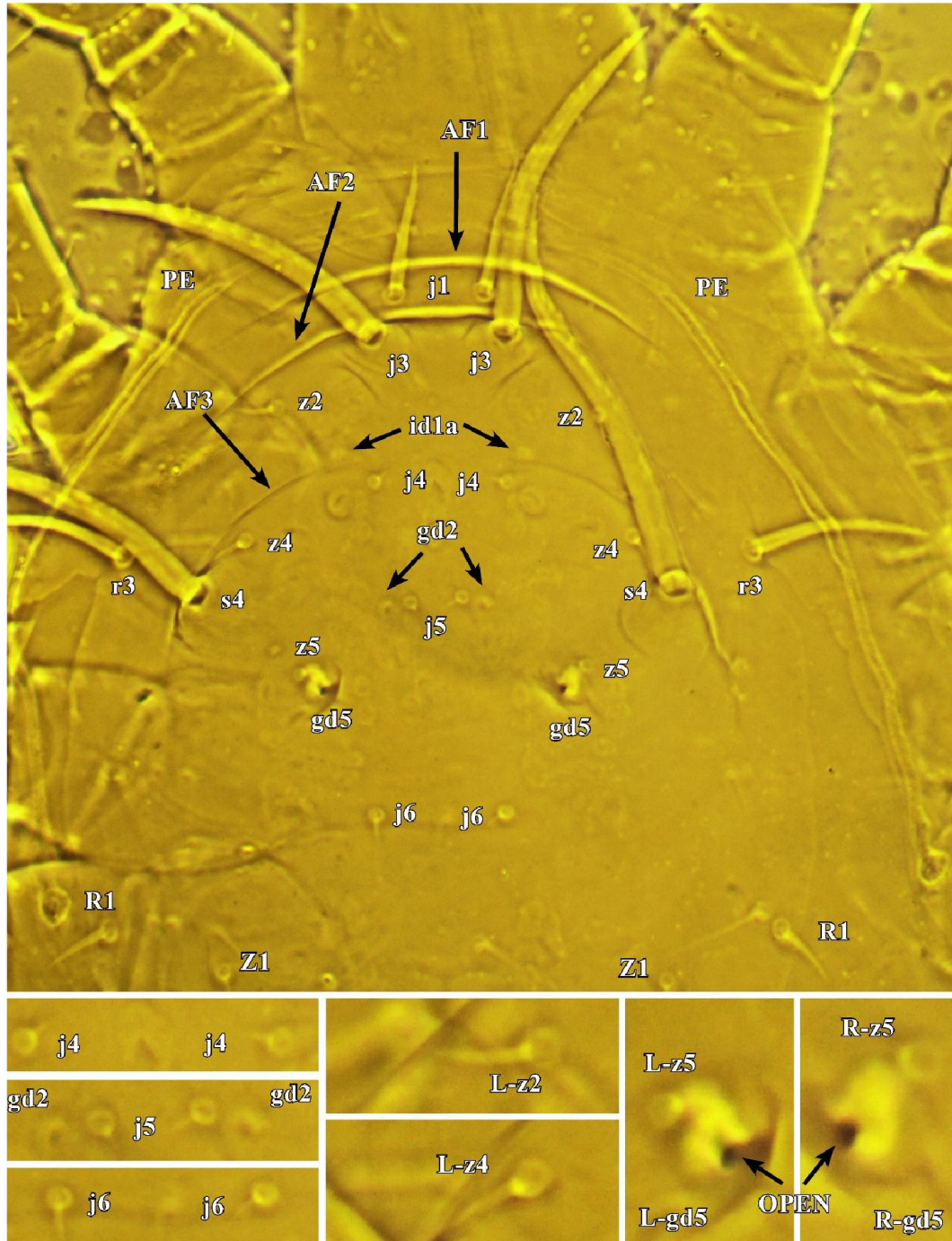
**Figure 51.** *Paraphytoseius santurcensis*: Top - Left leg I (L-LI); Middle - Right leg II (R-LII); Bottom - Right leg III (R-LIII); Bottom, inset - Setae MgeI (left) and MgeII (right), enlarged [FSCA, paratype, slide #8, male #1, 400x].



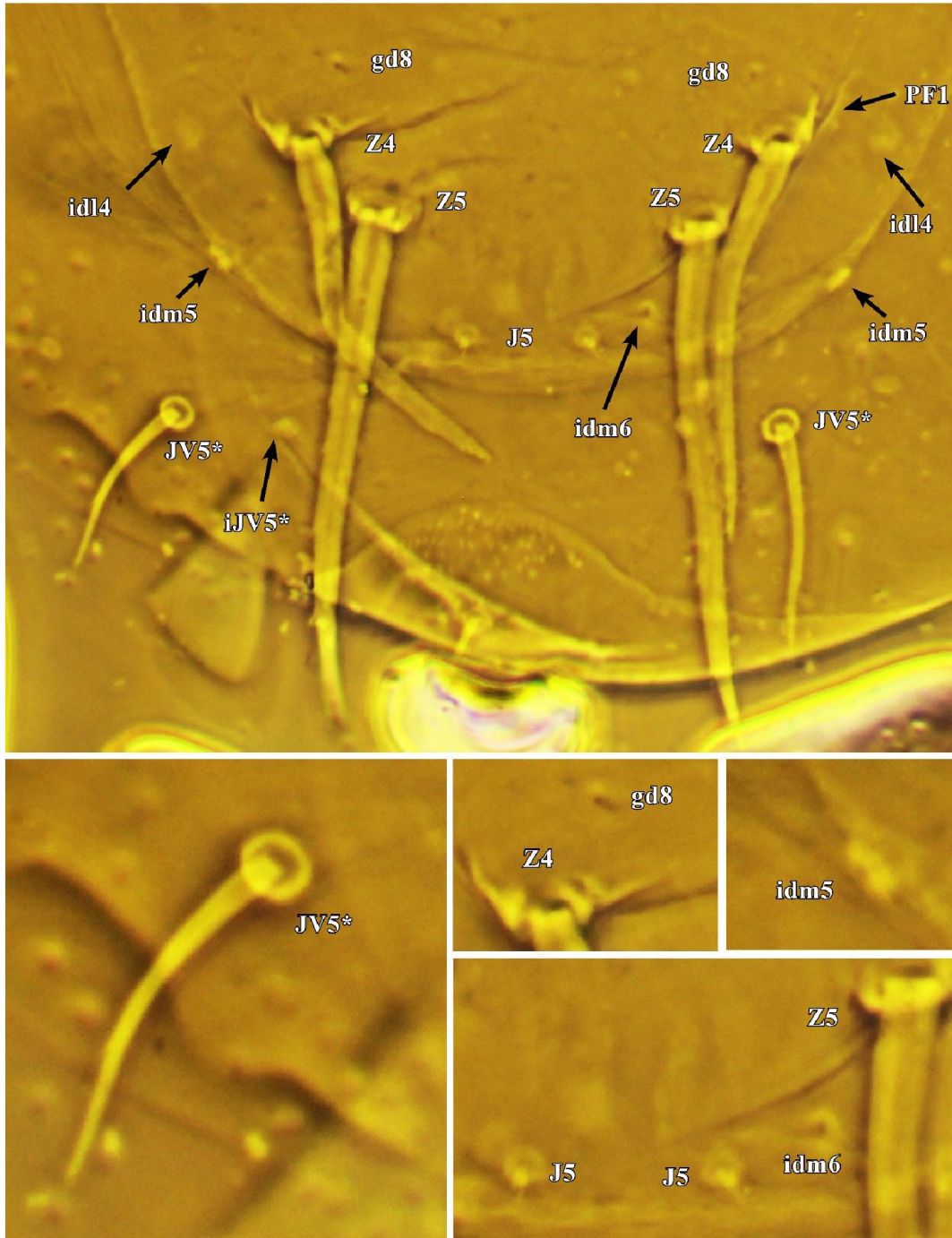
**Figure 52.** *Paraphytoseius santurcensis*: Top - Left leg IV (L-LIV); Middle - Right leg IV (R-LIV); Bottom - Right leg IV (R-LIV) ; Bottom, inset (left to right) - Left and right legs IV - Macrosetae left SgeIV, right StiIV, right SbtaIV, and right SdtaIV - all enlarged [FSCA, paratype, slide #8, male #1, 400x].



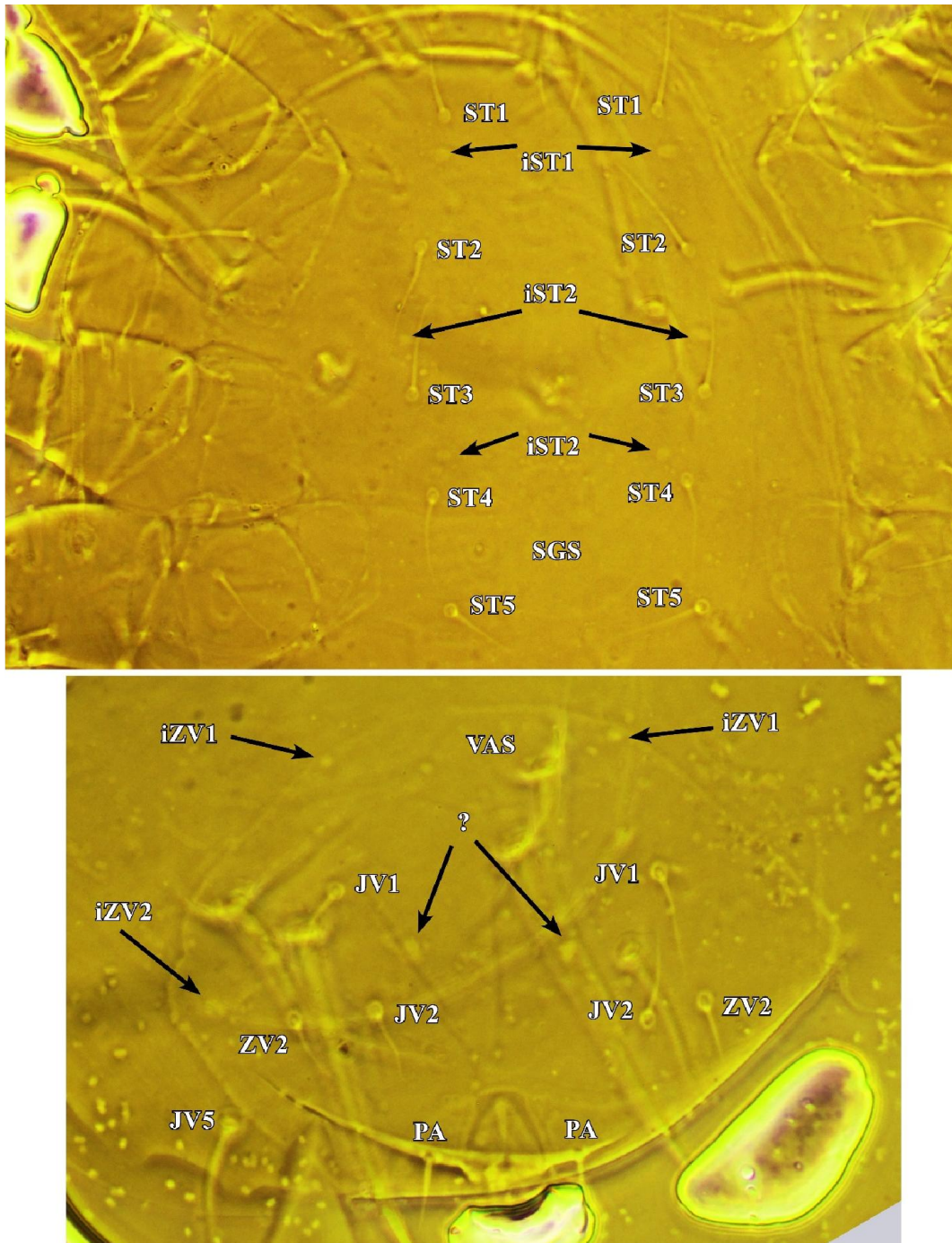
**Figure 53.** *Paraphytoseius santurcensis*: *Top* - Dorsal view of body and legs in low magnification; *Bottom* - Dorsal view of idiosoma in high magnification showing setae, solenostomes (gd), lyrifissures (id), and muscle marks (MM). Modified setae MfeIV and MgeII also seen [FSCA, paratype, slide #9, male #2, *top* - 100x, *bottom* - 200x].



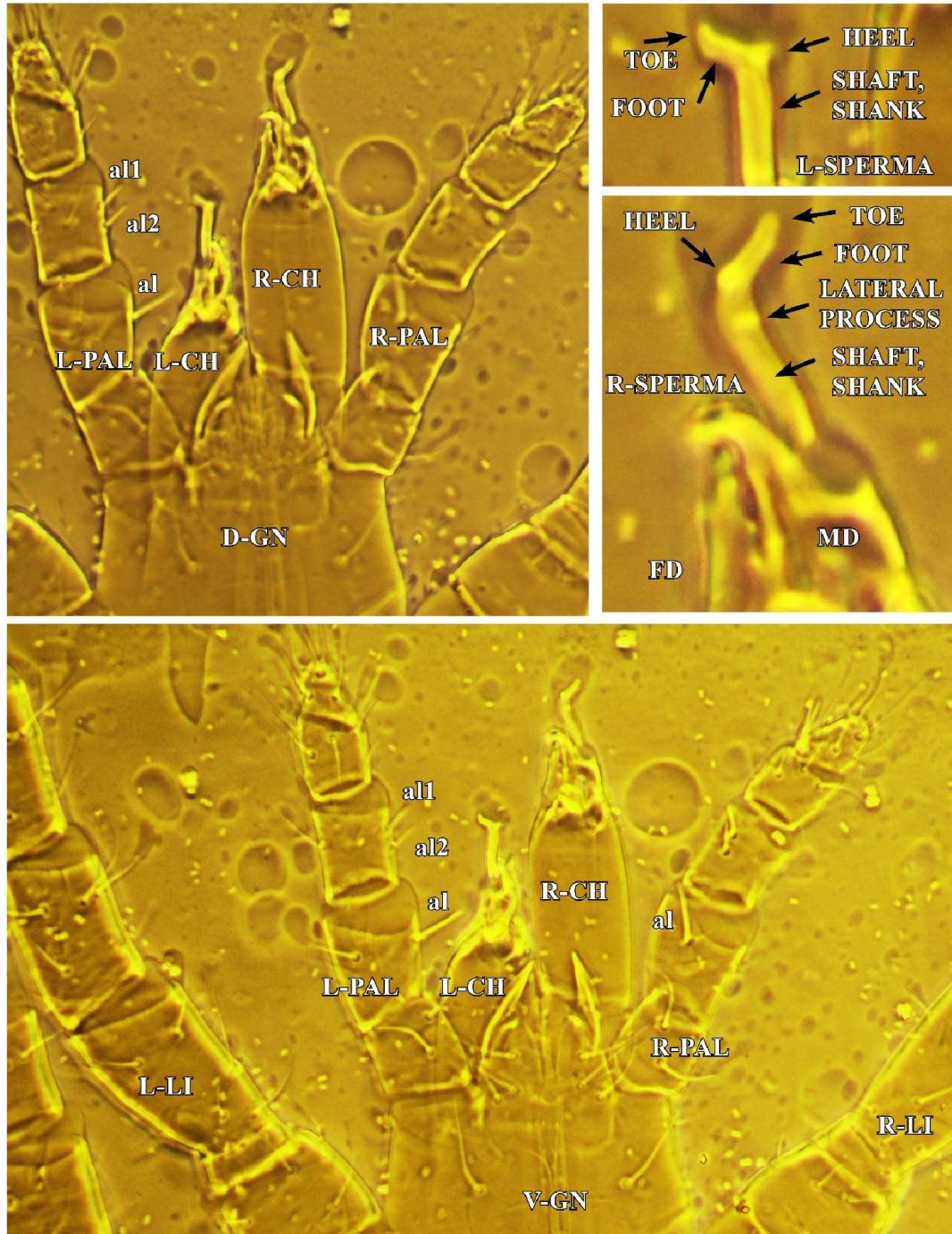
**Figure 54.** *Paraphytoseius santurcensis*: *Top* - Dorsal anterior idiosoma with 3 semicircular anterior folds (AF1-AF3), peritremes (PE), setae, gd2 and gd5; *Bottom* - Dorsal setae j4, j5, j6, left z2 (L-z2), left z4 (L-z4), left and right z5 (L-z5 and R-z5), and crateriform gd5 showing gland opening (OPEN) in high magnification [FSCA, paratype, slide #9, male #2, 400x].



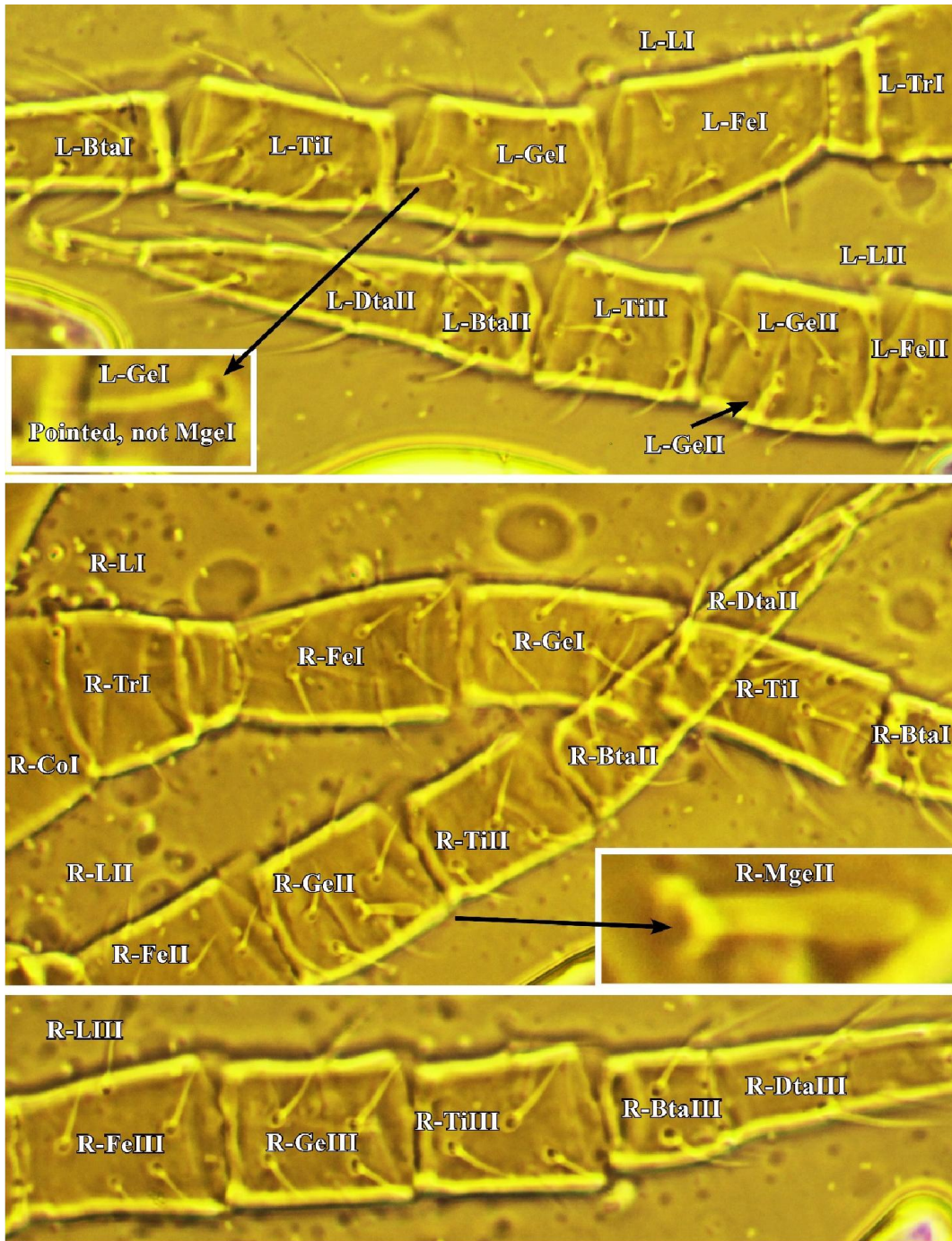
**Figure 55.** *Paraphytoseius santurcensis*: Top - Dorsal view of posterior idiosoma; Bottom, left - Ventral seta *JV5\**; Bottom, right - Dorsal setae *J5*, *Z4*, *Z5*, *gd8*, *idm5*, and *idm6* in high magnification [FSCA, paratype, slide #9, male #2, 400x].



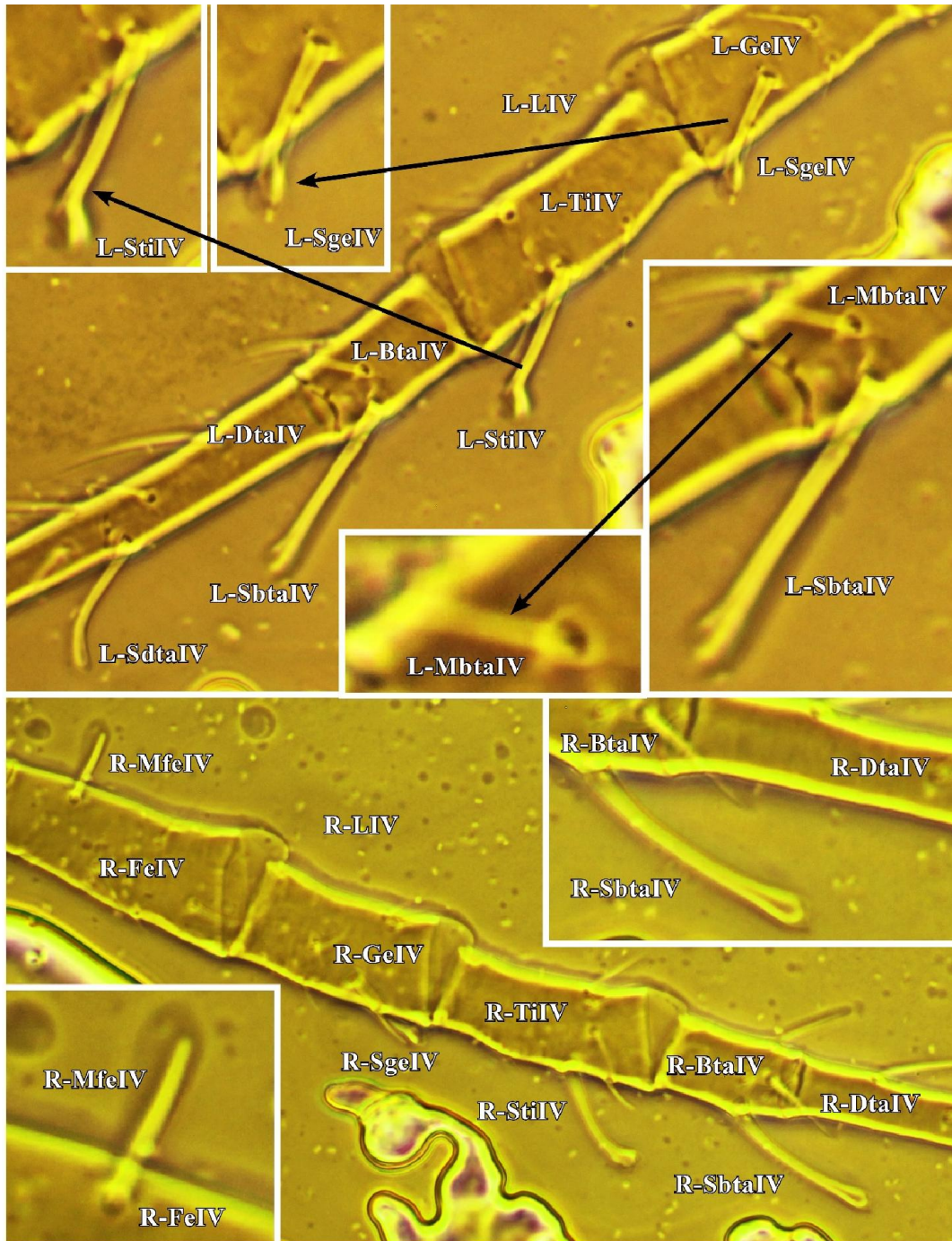
**Figure 56.** *Paraphytoseius santurcensis*: *Top* - Ventral view of anterior idiosoma with sternogenital shield and ST1-ST5 setae; *Bottom* - Ventral view of posterior idiosoma with ventrianal shield (VAS) and 3 pairs of preanal setae. Some lyrifissures (i) also seen [FSCA, paratype, slide #9, male #2, 400x].



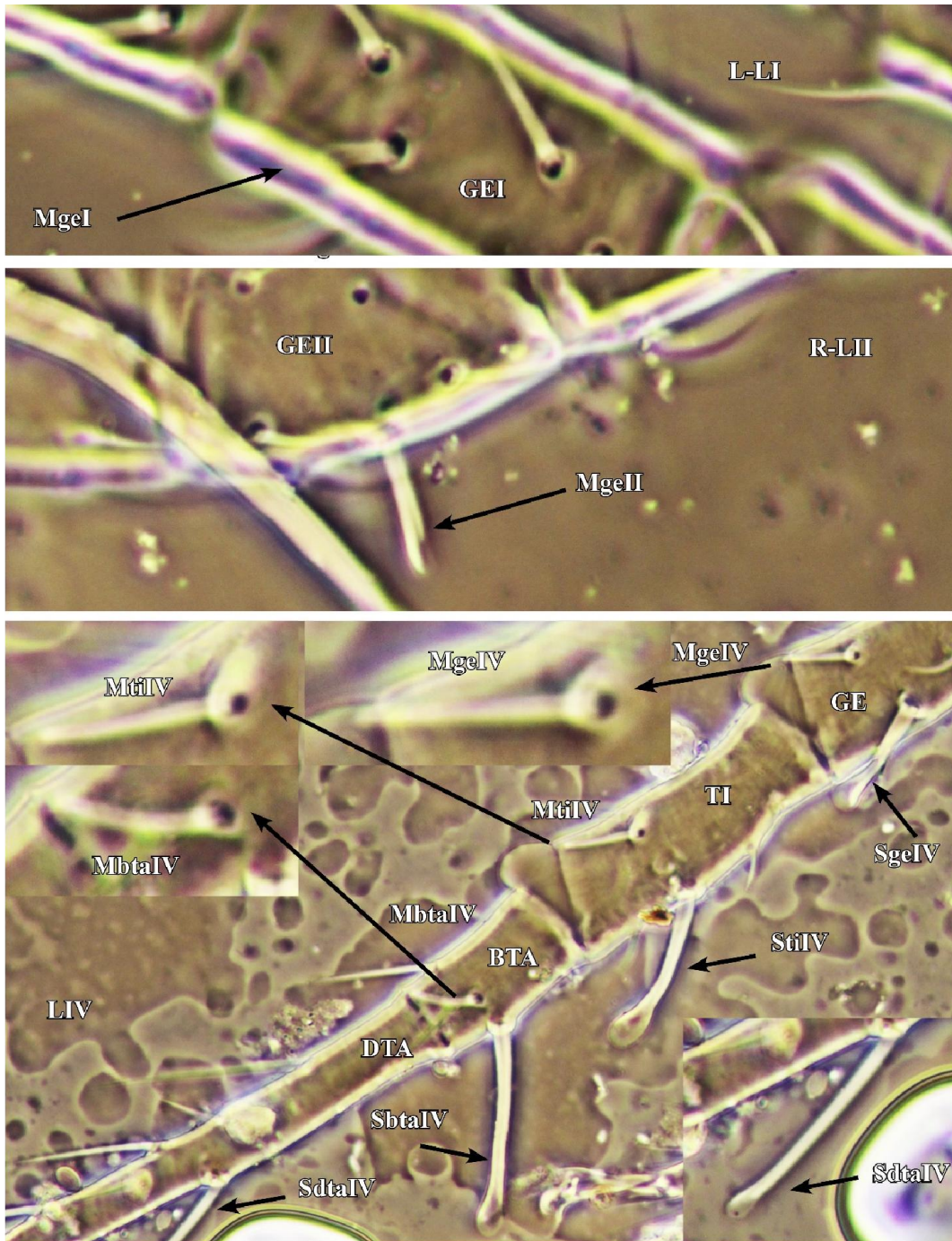
**Figure 57.** *Paraphytoseius santurcensis*: *Top, left* - Dorsal view of gnathosoma (D-GN) with chelicerae and spermatodactyles; *Top right* - Chelicerae and spermatodactyles, enlarged; *Bottom* - Ventral view of gnathosoma (V-GN) showing 3 pairs of hypostomal and 1 pair of capitular setae [FSCA, paratype, slide #9, male #2, 400x].



**Figure 58.** *Paraphytoseius santurcensis*: *Top* - Left leg I without seta MgeI and left leg II with a clavate seta MgeII; *Middle* - Right leg I, similar to leg left leg I, without seta MgeI but right leg II a clavate MgeII (inset); *Bottom* - Right leg III with absent modified seta MgeIII [FSCA, paratype, slide #9, male #2, 400x].



**Figure 59.** *Paraphytoseius santurcensis*: Top - Left leg IV; Bottom - Right leg IV - both with different macrosetae and modified setae (inset) [FSCA, paratype, slide #9, male #2, 400x].



**Figure 60.** *Paraphytoseius orientalis*: *Top* - Genu of left leg I with a short clavate modified seta (MgeI). *Middle* - Genu of right leg II, comparatively, with a longer clavate modified seta (MgeII) than MgeI [India, Orissa, VP73-93, female #2, 400x]. *Bottom* - Leg IV with spatulate macrosetae (SgeIV, StiIV, SbtalIV, and SdtaIV) and clavate modified setae (MgeIV, MtiIV, and MbtalIV) [India, Punjab, VP74-78, female #1, 400x].