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Article

Description of motile immature stages of *Hemipteroseius indicus* (Krantz & Khot) (Acari: Otopheidomenidae)

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ABSTRACT
The larva, protonymph and deutonymph of *Hemipteroseius indicus* (Krantz & Khot, 1962) are described from specimens collected on the red cotton bug, *Dysdercus* sp. (Hemiptera: Pyrrhocoridae) in India and the Democratic Republic of Congo. These are compared with the characteristics of the adult female. In addition, the complete chaetotaxy of the dorsal and ventral idiosoma and some details of the gnathosoma and legs are given. These are compared with the published details of *Hemipteroseius adleri, H. womersleyi, Nabiseius duplicisetus, Noctuiseius treati,* and *Prasadiseius cocytes* representing four genera and six species of Otopheidomenidae. Five tables and many colored figures with details, including a pharate female and a pharate male, are included.

KEY WORDS: Immature stages; Mesostigmata; motile; pharate; Pyrrhocoridae; red cotton bug.

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INTRODUCTION

Krantz and Khot (1962) described *Treatia indica* collected from the red cotton bug, *Dysdercus cingulatus* (F.), in New Delhi, India. Evans (1963) described a new genus *Hemipteroseius* and transferred this species to his new genus as *Hemipteroseius indicus* (Krantz & Khot). Treat (1965) collected *Hemipteroseius indicus* from 3 specimens of *Dysdercus* (host species undetermined) collected in Faradje, a town in the Haut-Uele district, in Democratic Republic of Congo (DRC). In addition, there was one specimen of this species found on an undetermined species of *Dysdercus* collected in Thysville, DRC. Costa (1968) collected *Hemipteroseius indicus* in Israel from a new insect host, *Caenocoris nerii* Germ. (Hemiptera: Lygaeidae). Thus, *Hemipteroseius indicus* is known from 3 countries - Democratic Republic of Congo, India, and Israel - on different hosts, mostly belonging to Pyrrhocoridae (Hemiptera).

Evans (1963) in his new species *H. womersleyi* noted the absence of deutonymphs and having protonymphal chaetotaxy with characteristic of the males and suggested that the deutonymphal stage may be suppressed in the development of the males in this species. Treat (1965) saw a pharate male of *H. indicus* enclosed in a deutonymphal cuticle in the specimens he received from Dr. G.W. Krantz and stated that deutonymphal stage was not suppressed in this species. He also reported a pharate protonymph in *Treatia dysderci* (Otopheidomenidae) he collected from *Dysdercus discolor* (Pyrrhocoridae). In addition, he collected a pharate male in a protonymphal cuticle of *Dicrocheles phalaenodectes* (Laelapidae) which is an ear infesting mite of Noctuidae. Thus, the pharate female is

not known, however the pharate male in a deutonymphal cuticle is known in *H. indicus* indicating that it is not suppressed in the male of this species.

Various authors have also studied the seasonal abundance and other aspects of this mite in India (Prasad 1975; Banerjee and Dutta 1980; Shahi and Krishna 1981; Sarkar *et al.* 1990). Menon *et al.* (2011) described *Hemipteroseius vikrami* Menon from *Dysdercus cingulatus* and *Dysdercus koenigii* from India. Prasad (2017) considered this species to be a junior synonym of *H. indicus*. Sigilla in the adult *H. indicus* were described for the first time by Prasad (2017).

None of the authors mentioned above published any morphological details, including the distance measurements or sigilla, on the immature motile stages of *H. indicus.* The chaetotaxy of these stages and comparison with that of the adult is not known. It was not known if setae *j6, s6, Z5,* and macrosetae on femora I-II and genua I-IV had bulbose tips in the larva, protonymph, and deutonymph. Also, it was not known before if the pharate females were present in this species. No illustrations or photos of pharate female and pharate male of *H. indicus* have been published before.

While studying the specimens of *H. indicus*, this author found several motile immature stages along with pharate female, pharate male, and adults. The result of this study, including the chaetotaxy of the idiosoma, are presented in this paper. Five tables with measurements of different structures of larva, protonymph, deutonymph, and female are given to compare the differences with each other. Photos of pharate female and pharate male are included.

MATERIAL AND METHODS

The details of the specimens of *H. indicus* studied from the collection of this author (VP) and Treat Collection (TC) borrowed from the Acarology Laboratory, Museum of Biological Diversity, The Ohio State University (OSAL) are as follow: **(A) LARVA** - (1) VP74-69, slide #1, larva (having many other mites), mites collected by an unknown person from an unidentified species of red cotton bug in Jorhat (Assam state, India) in July 1974. (2) OSAL 0104170, TC, slide #6, larva (having many other mites on same slide), mites collected by A.E. Treat in November 1963 from red cotton bug (Pyrrhocoridae) from Faradje, Democratic Republic of Congo, preserved in American Museum of Natural History, New York City (New York state, USA). **(B) PROTONYMPH** - (1) VP74-43, PAU #3, slides #2 and 3, protonymph (having many other mites on the same slide), collected in Ludhiana (Punjab state, India) in 1974 from *Dysdercus koenigii* (F.). **(C) DEUTONYMPH** - (1) VP74-43, PAU #3, slide #3, deutonymph (having many other mites on the same slide), collected in Ludhiana (Punjab state, India) in 1974 from *Dysdercus koenigii* (F.). (2) OSAL 0104177, Treat Collection, slide #7, deutonymph (having many other mites on same slide), mites collected by A.E. Treat in November 1963 from red cotton bug (Pyrrhocoridae) from Faradje, Democratic Republic of Congo, preserved in American Museum of Natural History, New York City (New York state, USA). **(D) PHARATE FEMALE AND PHARATE MALE** - (1) OSAL 0104177, Treat Collection, slide #7, pharate female inside a deutonymph (having many other mites on same slide), mites collected by A.E. Treat in November 1963 from red cotton bug (Pyrrhocoridae) from Faradje, Democratic Republic of Congo, preserved in American Museum of Natural History, New York City (New York state, USA). To compare the measurements of the deutonymph, a normal female was measured from collection # VP74-43, PAU #3, slide #3, normal female (having many other mites on the same slide), collected in Ludhiana (Punjab state, India) in 1974 from *Dysdercus koenigii* (F.).

The above mites were examined by the author under 100–400× using an Accu-Scope 3000 phase-contrast microscope (Accu-Scope, New York, USA) to locate and study the details. Measurements were taken directly from the slide mounted specimens using the mounted MicrometricsTH system and recorded in micrometers (µm). Photographs were taken using a Canon EOS 550D camera after mounting on the microscope and saved in Photoshop CS5^{TM}. The photographs were placed in

InDesign™ program to label the structures. The original magnification of the photos was 200–400× as mentioned in the explanation of the figures. As these were enlarged further in different magnifications to show the structures clearly and fit the page, exact magnifications are not given on the figures.

The measurements of dorsal idiosomal characters of larva, protonymph, deutonymph, along with the measurements of a normal female, are given in Tables 1–3. The measurements of female from Menon *et al.* (2011) are also included for comparison with the normal female of this author. Gnathosomal characters of all stages of *H. indicus* are compared in Table 4. In addition, many characters present on dorsal and ventral idiosoma of all stages in *Hemipteroseius adleri*, *H. indicus*, *H. womersleyi*, *Noctuiseius treati*, and *Prasadiseius cocytes* are compared together in Table 5. In case of the length of the left and right setae (Tables 1 and 3), the highest number is selected indicating that setal length measures till that number. For example, if seta *j1* measured 5–6 µm in the larva (Table 1), 6 µm was selected for ease of comparison with that of this seta in the other stages.

All measurements of different shields are taken in 200–400× but of setae only in 400× and given in micrometers (µm). Often, tips of setae are very thin and difficult to measure even in 400×. Only one good specimen of each stage is measured. Therefore, difference of a few micrometers from one to another seta should not be considered absolute unless more specimens of each stage are studied.

RESULTS

(1) LARVA (Figs. 1–10, Tables 1–5)

Three larvae are studied but only two are photographed (OSAL 0104170, Treat Collection, larvae #1 and #2) and another is measured (author's collection #VP74-69, Assam).

Dorsal idiosoma, **shields, and setae (Figs. 1–3, Tables 1–2) –** Podosoma (PO) covered by a large shield-shaped and sculptured podonotal shield (PS) measuring (length and width) 148 × 124 (i.e. longer than wide). The lateral cleavage between setae *z2* and *z4* absent. Sculpturing of podonotal shield more pronounced posterior to *j5-j5*, anterior to *j6-j6*, and medial to *z5-z5*, possibly due to increased dorsal bulging in this region than other regions of this shield. Opisthosoma (OPS) covered by a triangular, sculptured, and much wider than long pygidial shield (PYS). Two oval to triangular, lightly sculptured, mesonotal sclerites (MSC) present in between podonotal shield and pygidial shield.

A total of 10 pairs of setae present on dorsal idiosoma (*j1, j3, j4, j5, j6, z2, z4, z5, s4,* and *Z4*). Of these, podonotal shield with 9 pairs of setae (*j1, j3, j4, j5, j6, z2, z4, z5,* and *s4*) and pygidial shield (PYS) with 1 pair of setae (*Z4*). No setae present on integument. Length of seta: *j1* = 6, *j3* = 7, *j4* = 7, *j5* = 7, *j6* = 18, *z2* = 8, *z4* = 8, *z5* = 8, *s4* = 9, and *Z4* = 18. Setae *j6* and *Z4* relatively long (= 18 µm) and distinctly longer than remaining setae (6–9 µm). Seta *s4* located at the lateral edge of the podonotal shield and may be confused being on integument. All setae on dorsal idiosoma simple, smooth, finely pointed, without serrations, and without bulbose tips. Sigilla absent on podonotal shield and pygidial shield.

Transverse distance between different setal pairs: *j1-j1* = 12, *j3-j3* = 40, *j4-j4* = 35, *j5-j5* = 28, *j6-j6* = 46, *z2-z2* = 63, *z4-z4* = 90, *z5-z5* = 80, and *s4-s4* = 123 (*Z4-Z4* = not measured). Transverse distance between *j4-j4* (= 35 µm) much more than *j5-j5* (= 28 µm) and much less than *j6-j6* (= 46 µm). Vertical distance between different setal pairs: *j1-j3* = 20, *j3-j4* = 30, *j4-j5* = 18, *j5-j6* = 60, *z2-z4* = 26, and *z4-z5* = 44. Vertical distance between different setal pairs indicate minimum (= 18 µm) between *j4-j5* and maximum (= 60 µm) between *j5-j6.* Also, vertical distance between *j3-j4* (= 30 µm) much more than *j4-j5* (= 18 µm) but much less than *j5-j6* (= 60 µm).

Ventral idiosoma, **shields, and setae (Figs. 4 and 5, Table 3) –** Tritosternum with base and bifurcate laciniae in between coxae I. Only 3 pairs of setae (*ST1-ST3*), almost of the same length, on

integument in intercoxal region I-III. Setae *JV2* on integument, *JV4,* and *JV5* absent. Anal shield with the anus, a pair of paraanal setae (*PAA,* also abbreviated as PA or pa in many publications but not used here as used for palp), and single postanal seta (*POA,* also abbreviated as PO or po in many publications but not used here as used for podosoma). Different measurements indicate *ST1-ST1* closer to each other and *ST2-ST2* farthest apart than *ST3-ST3*. Also, *ST1-ST2* being farthest apart than *ST2-ST3*.

Figure 1. *Hemipteroseius indicus* (OSAL 0104170, TC, slide #6, larva #2, photo #3, dorsal) – Podonotal shield (PS) with 9 pairs of setae *(j1, j3, j4, j5, j6, z2, z4, z5,* and *s4*). Pygidial shield (PYS) with 1 pair of setae (*Z4*). A pair of triangular mesonotal sclerites (MES) in between PS and PYS [I-III = legs I-III; D-GN = dorsal gnathosoma, MD = movable digit with 2 teeth, original magnification = 200×].

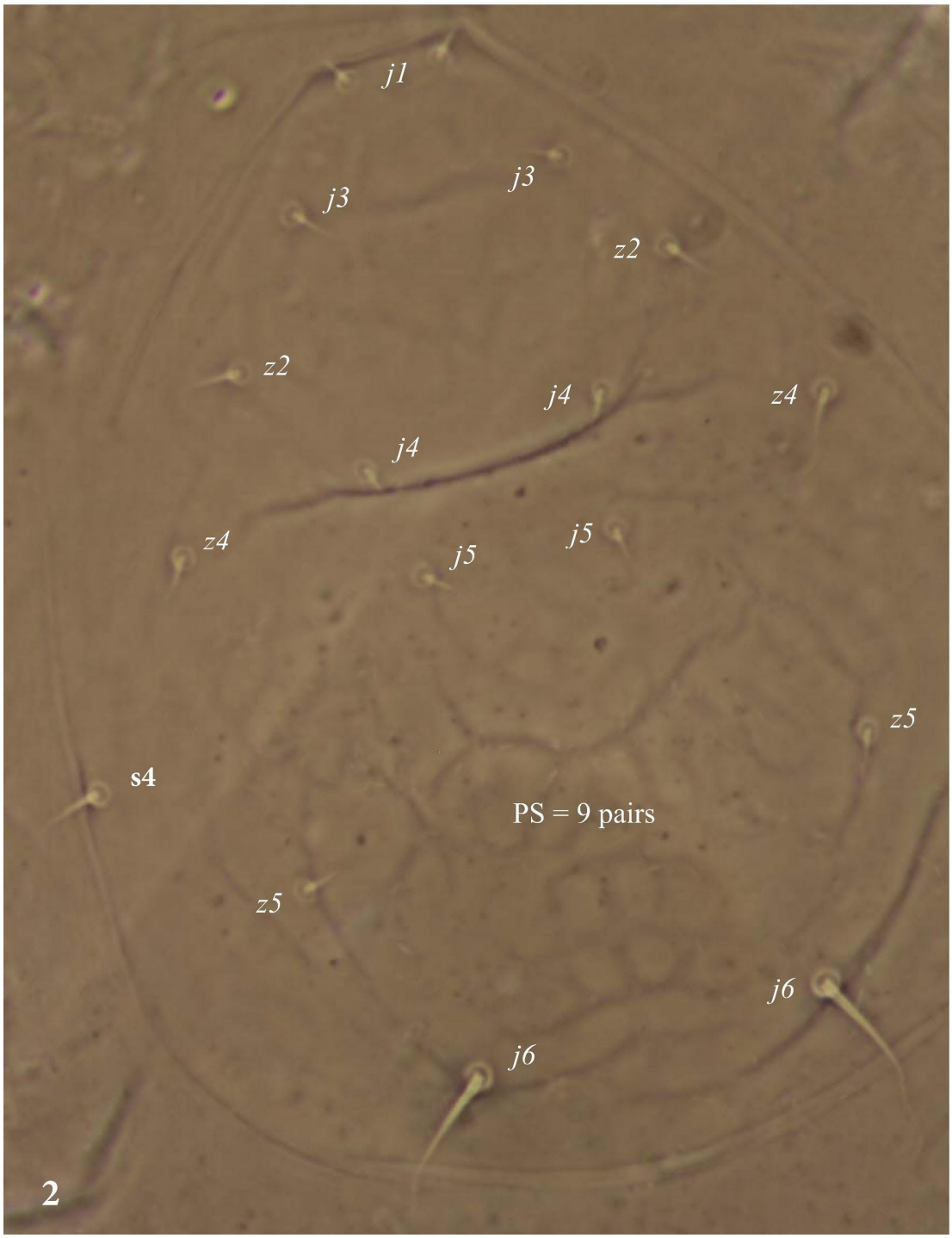


Figure 2. *Hemipteroseius indicus* (OSAL 0104170, TC, slide #6, larva #2, photo #16, dorsal) – Enlarged sculptured podonotal shield (PS) with 9 pairs of setae *j1, j3, j4, j5* (*j5* located close to each other than *j4*), *j6, z2, z4, z5,* and *s4* [original magnification = 400×].

Legs and macrosetae (Figs. 6–10) – Femora I and II and genua I-III with a large macroseta (*pd1*) on each (absent on femur III) posterior to *ad1*; some appear to have bulbose tips. Claws well developed.

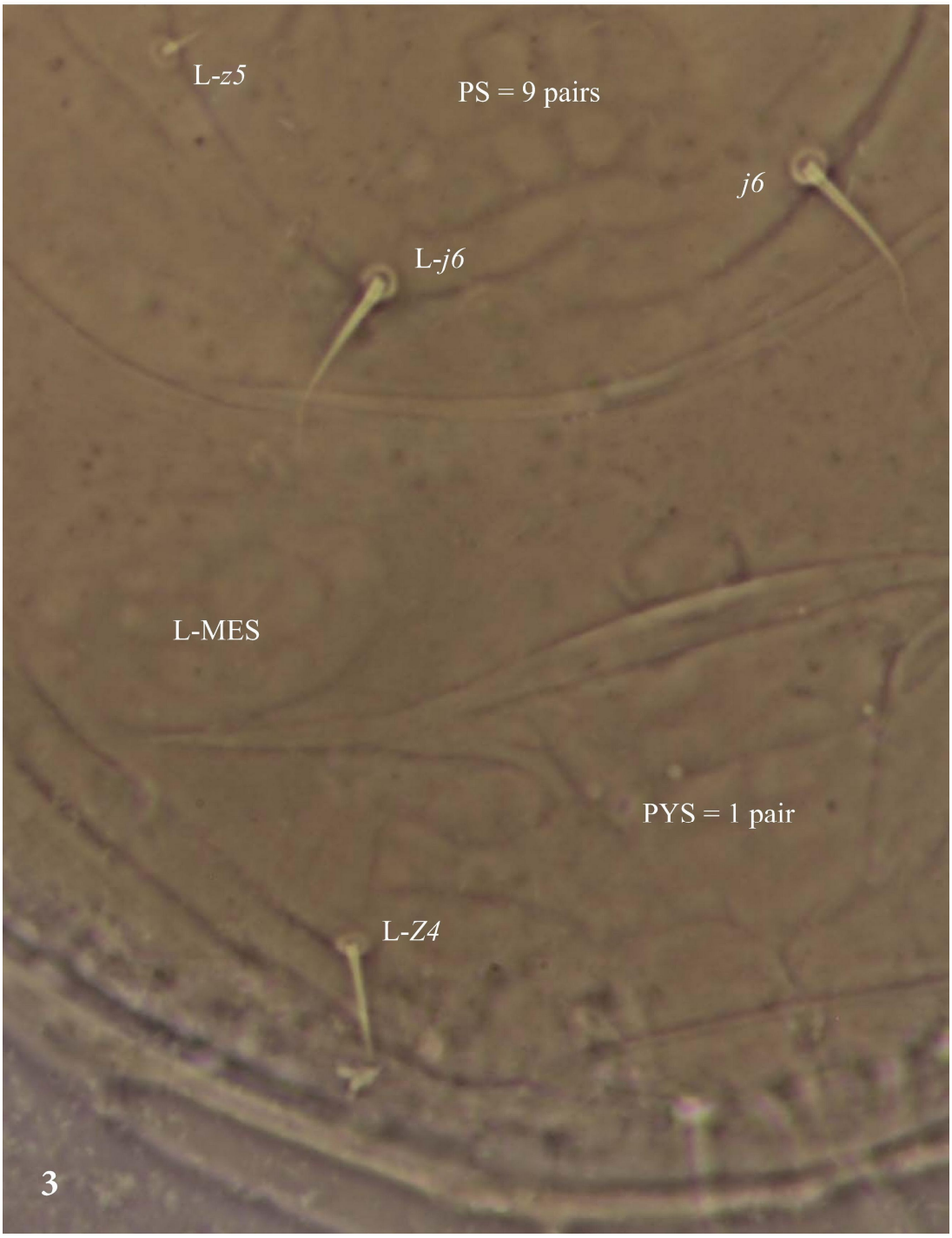
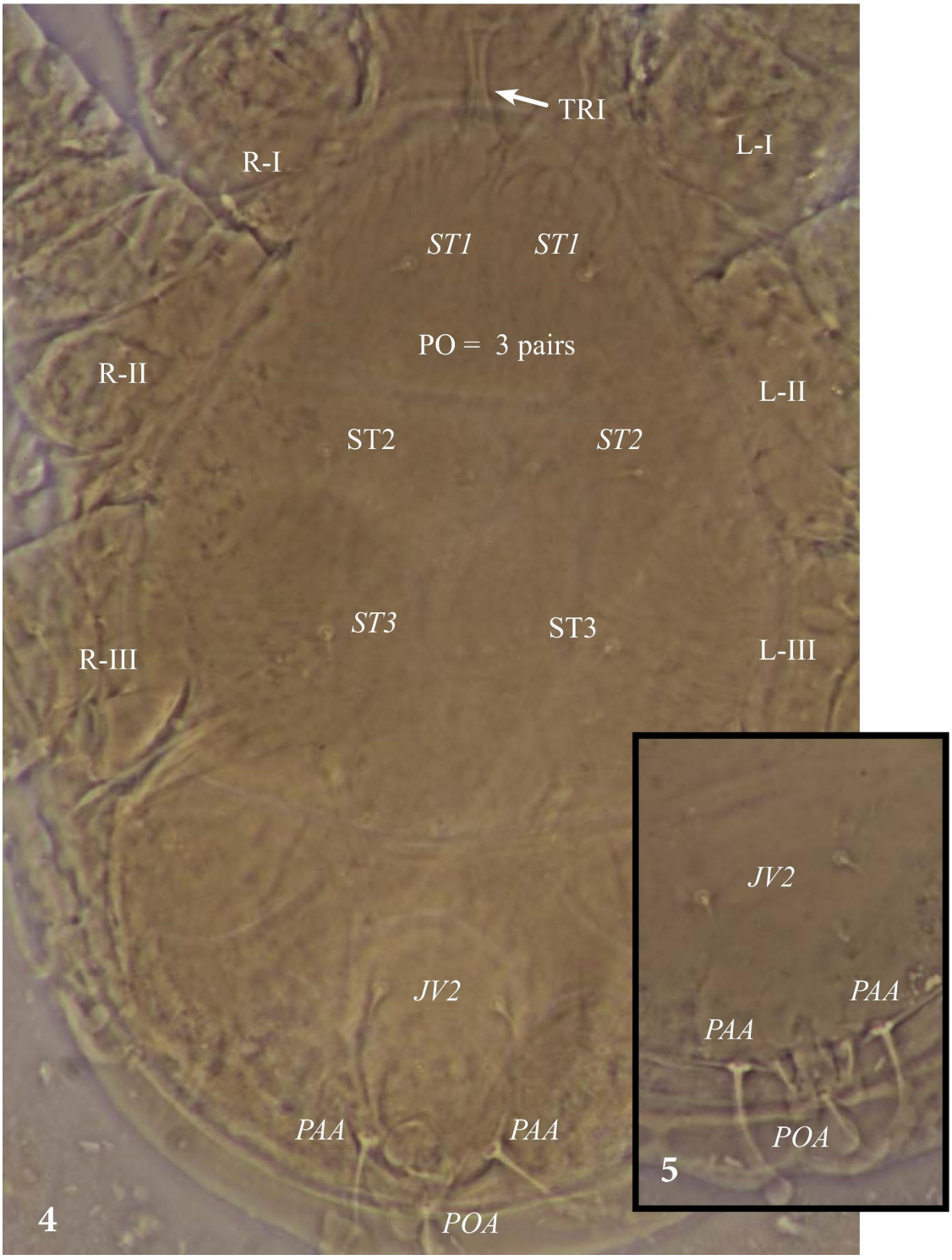


Figure 3. *Hemipteroseius indicus* (OSAL 0104170, TC, slide #6, larva #2, photo #16, dorsal) – Enlarged pygidial shield (PYS) with left seta *Z4*. Left mesonotal sclerite (L-MES) in between PS and PYS [original magnification = 400×].

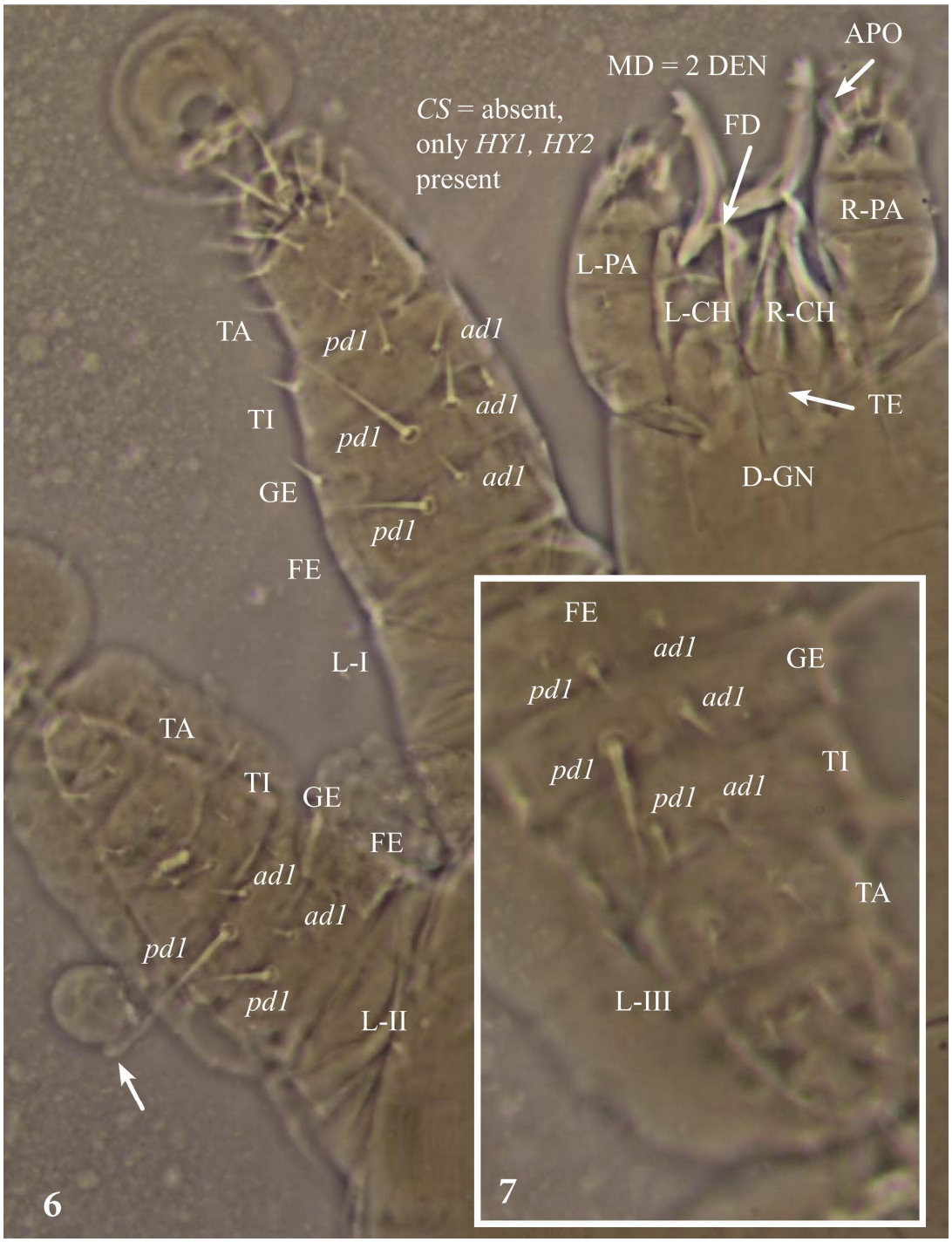
Gnathosoma (Figs. 1, 6, 10, Table 4) – Dorsal gnathosoma (D-GN) barely showing anteriorly rounded tectum (TE). Under this, a pair of elongate chelicerae (CH) distally having reduced fixed digit (FD) and narrowly elongate movable digit (MD) having 2 denticles posterior and close to pointed and curved tip present. Ventral gnathosoma (V-GN) with faintly visible capitular groove and 5–6 denticular rows. Each row with 1–2 denticles. Capitular setae (*CS*) absent. Hypostomal setae *HY1* and *HY2* present. Palp tarsus (PA) with a bifurcate apotele (APO).

(2) PROTONYMPH (Figs. 11–16, Tables 1–3)

Two protonymphs are studied but only one is photographed (author's collection #VP74-43, PAU, slide #2) and another is measured (author's collection #VP74-43, PAU, slide #3).



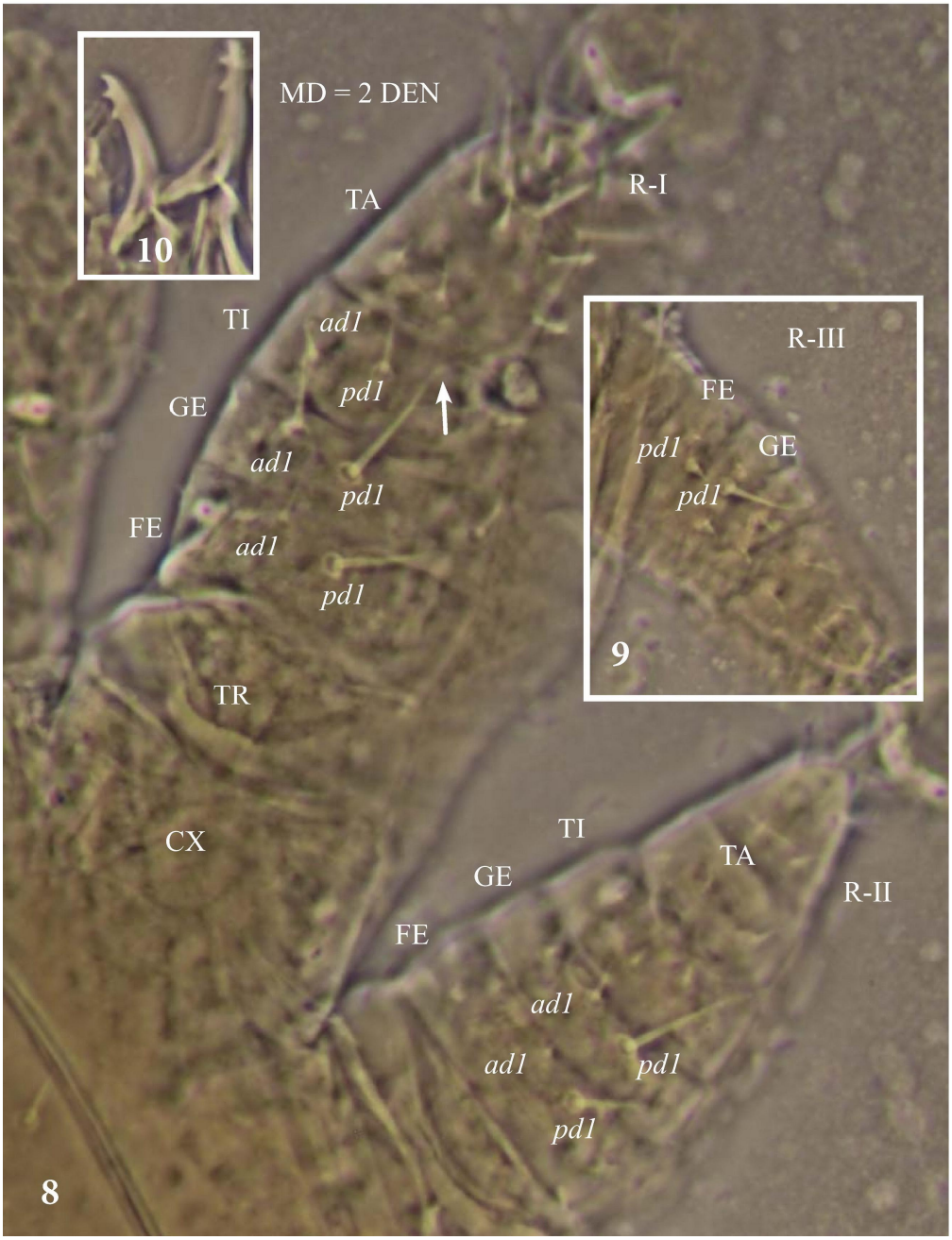
Figures 4–5. *Hemipteroseius indicus* (OSAL 0104170, TC, slide #6) – 4. Larva #1, photo #16, ventral: Idiosoma with setae *ST1, ST2, ST3,* and *JV2* on integument. Peritremes absent. Bifurcate tritosternum (TRI) and parts of legs I-III also seen; 5. Larva #2, photo #26, ventral: Setae *JV2* and terminal anus with pair of paraanal (*PAA*) and single postanal (*POA*) setae [original magnification = 400×].



Figures 6–7. *Hemipteroseius indicus* (OSAL 0104170, TC, slide #6, larva #2) – 6. Photo #28, dorsal: Enlarged left legs I and II with one macroseta (*pd1*) on each femur and genu; 7. Photo #31, dorsal: Enlarged left leg III with one macroseta (*pd1*) only on genu [III = leg III; original magnification = 400×].

Dorsal idiosoma, shields, and setae (Figs. 11 and 12, Tables 1–2) – Idiosoma covered by a shield-shaped and sculptured podonotal shield (PS), a triangular and sculptured pygidial shield (PYS), and 2 round to triangular, sculptured mesonotal scutellae (MSC). Podonotal shield laterally incised and cleaved (CLE) near *z2-z4*. Length 154 and width 138 at level of *s4*.

A total of 16 pairs of setae present on the dorsal idiosoma (*j1, j3, j4, j5, j6, J2, J5, z2, z4, z5, Z4, Z5, s4, s6, r3,* and *R1*). Thus, 6 pairs of setae *J2, J5, Z5, s6, r3,* and *R1* added to setal complement of larva. Of these, 9 pairs (*j1, j3, j4, j5, j6, z2, z4, z5,* and *s4*) on podonotal shield and 2 pairs (*r3* and *s6*) lateral to this shield on integument of podosoma. Pygidial shield (PYS) with 3 pairs of setae (*J5, Z4,* and *Z5*). One pair of setae (*J2*) on integument of opisthosoma anteromedial to pygidial shield. Another pair of setae (*R1*) also present on integument but anterolateral to pygidial shield. Thus, 4 pairs of setae (*s6, J2, r3,* and *R1*) present on dorsal idiosomal integument. All setae on dorsal idiosoma simple, smooth, finely pointed, without serrations, and without bulbose tips. Sigilla absent on podonotal and pygidial shields.



Figures 8–10. *Hemipteroseius indicus* (OSAL 0104170, TC, slides #6, larvae #1–2, dorsal) – 8. Right legs I-II (larva #1, photo #9); 9. Right leg III (larva #1, photo #22) with one macroseta (*pd1*) on each femur and genu of which one on genu I with knobbed tip; 10 (larva #2, photo #14): Movable digit of chelicera with 2 denticles [I-III = legs I-III; original magnification = 400×].

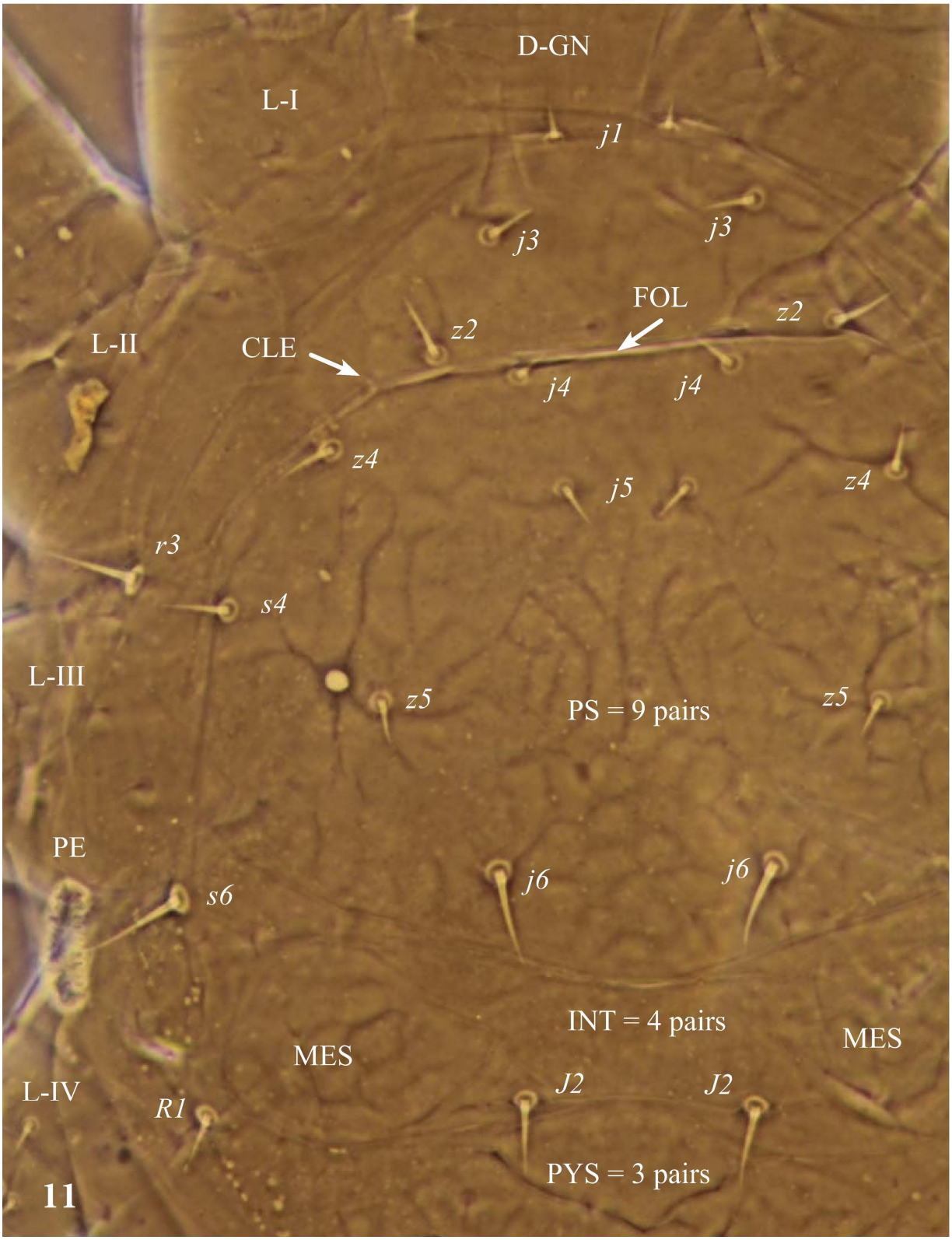


Figure 11. *Hemipteroseius indicus* (VP74-43, PAU #3, slide #2, protonymph, photo #21, dorsal, anterior) – Podonotal shield with lateral cleavage and setae *j1, j3, j4, j5, j6, z2, z4, z5,* and *s4*. Triangular mesonotal sclerites (MES). Setae *r3* and *s6* on podosomal and *R1* and *J2* on opisthosomal integument. Peritreme (PE) also seen [CLE = cleavage, FOL = fold, PYS = pygidial shield; original magnification = 400×].

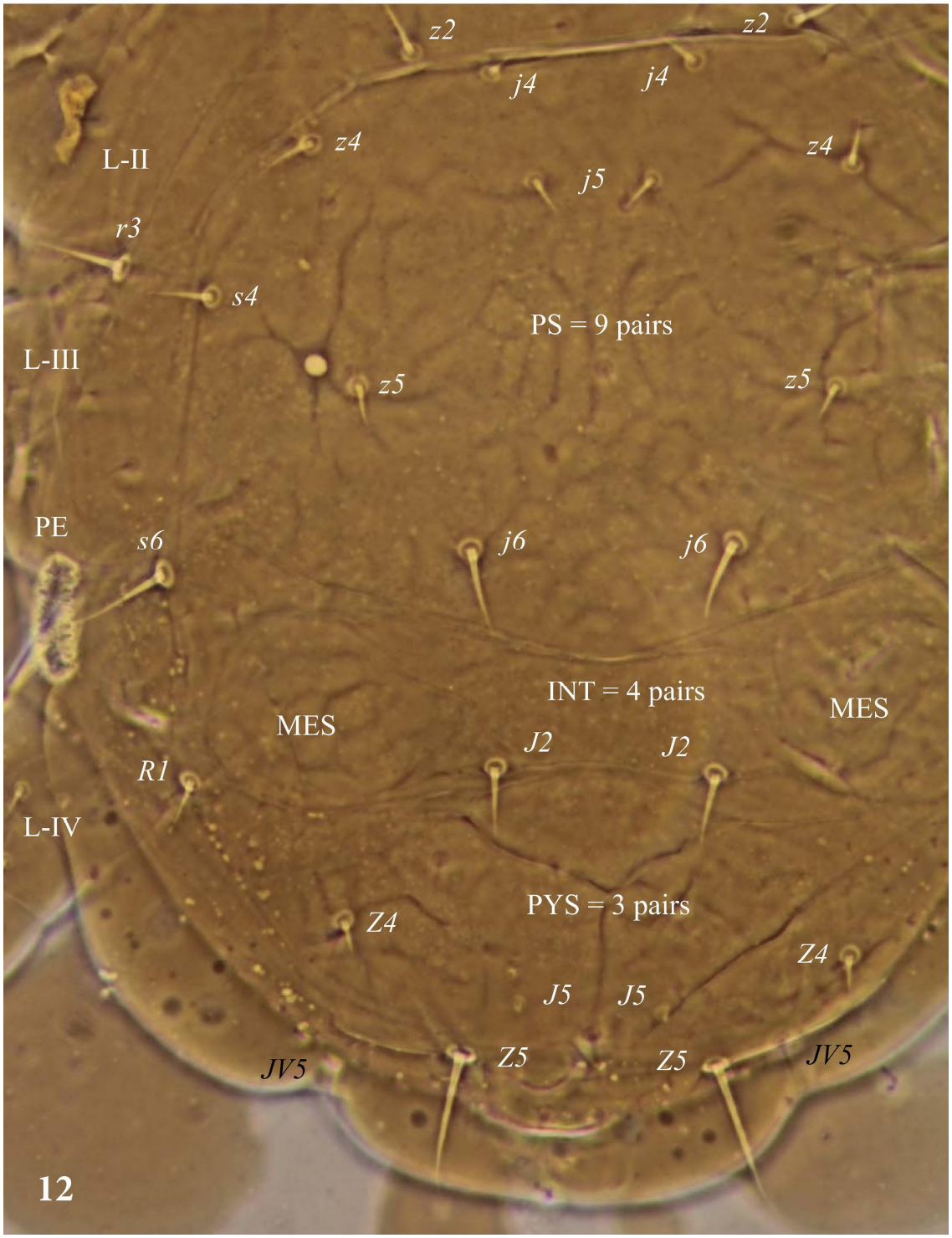


Figure 12. *Hemipteroseius indicus* (VP74-43, PAU #3, slide #2, protonymph, photo #20, dorsal, posterior) – Podonotal shield (PS) with setae *j4, j5, j6, z2, z4, z5,* and *s4*. Mesonotal sclerites (MES) without seta. Setae *r3* and *s6* on podosomal and *R1* and *J2* on opisthosomal integument. Pygidial shield with setae *J5, Z4* and *Z5*. Short peritreme (PE) and parts of left legs I-IV also seen [original magnification = 400×].

Length of seta: *j1* = 8, *j3* = 12, *j4* = 10, *j5* = 10, *j6* = 17, *J2* = 16, *J5* = 2, *z2* = 12, *z4* = 12, *z5* = 10, *Z4* = 11, *Z5* = 27, *s4* = 11, *s6* = 17, *r3* = 15, and *R1* = 12. Of all, setae *j6* (= 17), *J2* (= 16), *s6* (= 17), and *r3* (= 15) of about same length. Remaining podosomal setae short (= 8-12). Seta *J5* minute (= 2).

Transverse distance between different setal pairs: *j1-j1* = 19, *j3-j3* = 47, *j4-j4* = 34, *j5-j5* = 25, *j6-j6* = 47, *J2-J2* = 35, *J5-J5* = not measured, *z2-z2* = 65, *z4-z4* = 95, *z5-z5* = 82, *Z4-Z4* = 89, *Z5-Z5* = 47, and *s4-s4* = 133. Vertical distance between different setal pairs: *j1-j3* = 19, *j3-j4* = 32, *j4-j5* = 22, *j5-j6* = 62, *z2-z4* = 28, *z4-z5* = 41, and *Z4-Z5* = 28. Thus, transverse distance between *j5-j5* much less (= 25 µm) than between *j4-j4* (= 34 µm) and *j6-j6* (= 47 µm). Also, vertical distance between *j4-j5* much less (= 22 µm), almost similar to *j1-j3* (= 19 µm), than between *j5-j6* (= 62 µm).

Ventral idiosoma, shields, setae, and peritreme (Figs. 13, 14, Table 3) – Tritosternum (TRI) bifurcate as in larva but large. Sternal, genital, and ventrianal shields absent. Setae *ST1-ST3* in intercoxal region of coxae II-III, *ST4* absent, but minute *ST5* (*JV1?*) present posterior to coxae IV. Setae *JV2, JV5,* and *ZV2* on integument. Anal shield with anus, paraanal (*PAA*), and postanal setae (*POA*).

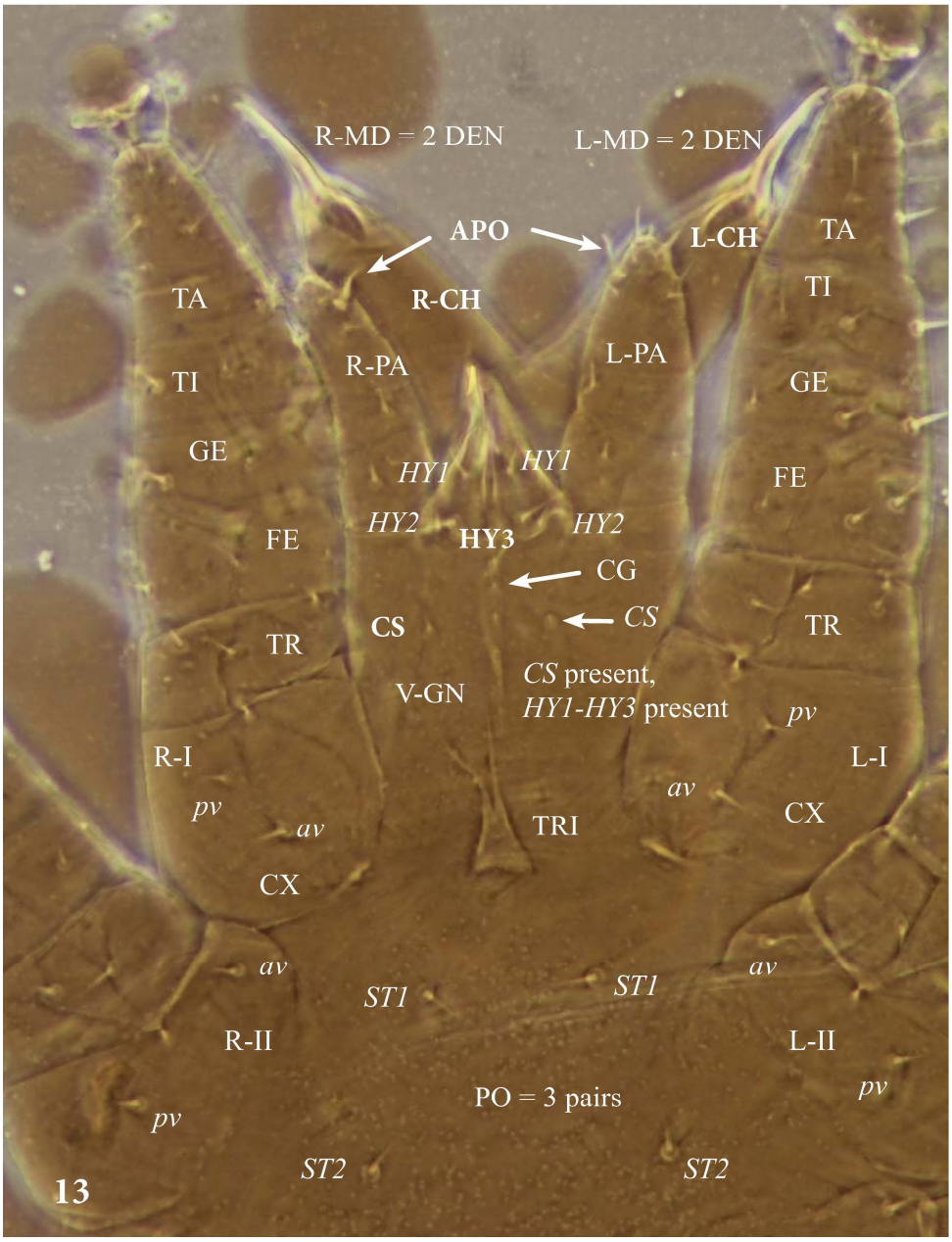


Figure 13. *Hemipteroseius indicus* (VP74-43, PAU #3, slide #2, protonymph, photo #17, ventral, anterior) – Podosoma (PO) with tritosternum (TRI) between coxae I and sternal setae *ST1* and *ST2* between coxae II - all on integument. Ventral gnathosoma (V-GN) with capitular setae (*CS*), capitular gutter (CG), hypostomal setae (*HY1-HY3*), chelicerae (CH), and palps (PA) [original magnification = 400×].

Length of seta: *ST1* = 10, *ST2* = 9, *ST3* = 9, *ST5* = minute, *JV2* = 10, *JV4* = not seen, and *JV5* = difficult to measure, and *ZV2* = 7 (*ST4, ZV1,* and *ZV3* absent). Transverse distance: *ST1-ST1* = 30, *ST2-ST2* = 57, and *ST3-ST3* = 52. Vertical distance: *ST1-ST2* = 35, *ST2-ST3* = 32, and *JV2-JV2* = 23. Thus, *ST1-ST1* closer to each other and *ST2-ST2* farthest apart than *ST3-ST3*. Also, *ST1-ST2* farthest apart (= 35 µm) than *ST2-ST3* (= 32 µm). Peritreme short (= 23–24 µm).

Legs and macrosetae (Figs. 13–16) – Femora I and II and genua I-IV with a large macroseta (*pd1*) without bulbose tip on each (absent on femora III-IV). Tarsus of leg I with several setae clustered together on dorsodistal tip proximal to claws. Coxae I-III with tiny setae *av* and *pv* and coxa IV with seta *av*. Contrary to coxae II-III, typical in Gamasina, seta *av* on coxa I located proximal to distally located *pv*.

Gnathosoma (Fig. 13, Table 4) – Ventral gnathosoma with 3 pairs of hypostomal setae (*HY1-HY3*), pair of capitular setae (*CS*), elongate capitular groove (CG) with 6–7 denticular rows (DR), and 1–2 denticles (DE) in each row. Ventral palp tarsus with bifurcate palpal apotele (APO). Fixed digit reduced and movable digit, similar to larva, with 2 teeth.

(3) DEUTONYMPH (Figs. 17–21, Tables 1–3)

Two deutonymphs are studied but only one is photographed (OSAL 0104177, Treat Collection) and another is measured (author's collection #VP74-43, PAU, slide #3).

Dorsal idiosoma, **shields, and setae (Figs. 17 and 18, Tables 1 and 2) –** Similar to adult, idiosoma with 2 separate shields, anteriorly located podonotal shield (PS) and posteriorly located opisthonotal shield (OS). Podonotal shield (PS) larger than in protonymph and, similar to it, laterally cleaved (CLE) near *z2-z4*, shield-shaped, well sculptured and measures (length and width at level of s4) 140 × 148 µm. Opisthonotal shield (OS) straight or slightly concave anteriorly, rounded posteriorly, lightly sculptured, 97 long and 138 wide. Thus, podonotal shield slightly wider than long but opisthonotal shield much wider than long. Mesonotal sclerites (MSC) absent.

A total of 16 pairs of setae on dorsal idiosoma (*j1, j3, j4, j5, j6, J2, J5, z2, z4, z5, Z4, Z5, s4, s6, r3,* and *R1*). Of these, 9 pairs (*j1, j3, j4, j5, j6, z2, z4, z5,* and *s4*) on podonotal shield and 2 pairs (*r3* and *s6*), lateral to this shield, on integument of podosoma. Opisthonotal shield (OS) with 4 pairs of setae (*J2, J5, Z4,* and *Z5*). One pair of setae (*s6*) on integument of opisthosoma anteromedial to opisthonotal shield. Another pair of setae (*R1*) also present on integument but anterolateral to opisthonotal shield. Thus, 3 pairs of setae (*s6, r3,* and *R1*), as in the adult, present on dorsal idiosomal integument. All setae on dorsal idiosoma simple, smooth, finely pointed, without serrations, and without bulbose tips. Sigilla present on podonotal shield and opisthonotal shield but difficult to identify as not well pronounced.

Length of seta: *j1* = 10, *j3* = 16, *j4* = 15, *j5* = 12, *j6* = 22, *J2* = 18, *J5* = 3, *z2* = 15, *z4* = 15, *z5* = 12, *Z4* = 14, *Z5* = 27, *s4* = 16, *s6* = 22, *r3* = 18, and *R1* = 18. Of all, seta *Z5* longest (= 27 µm), *j6* and *s6* of about same length (= 22 µm) and longer than remaining setae (= 10-18 µm) but seta *J5* minute (= 3 µm).

Transverse distance between different setal pairs: *j1-j1* = 22, *j3-j3* = 50, *j4-j4* = 39, *j5-j5* = 27, *j6-j6* = 45, *J2-J2* = 33, *J5-J5* = 31, *z2-z2* = 68, *z4-z4* = 98, *z5-z5* = 83, *Z4-Z4* = 94, *Z5-Z5* = 58, and *s4-s4* = 133. Vertical distance: *j1-j3* = 19, *j3-j4* = 32, *j4-j5* = 20, *j5-j6* = 64, *J2-J5* = 58, *z2-z4* = 30, *z4-z5* = 43, and *Z4-Z5* = 38. Thus, transverse distance between *j5-j5* much less (= 27 µm) than between *j4-j4* (= 39 µm) and *j6-j6* (= 45 µm). Also, vertical distance between *j4-j5* much less (= 20 µm), almost similar to *j1-j3* (= 19 µm), than between *j5-j6* (= 64 µm).

Ventral idiosoma, **shields, setae, and peritreme (Figs. 19 and 20, Table 3) –** Tritosternum (TRI) with its triangular base as in adult. Sternal, genital, and ventrianal shields absent. Setae *ST1-ST4* in between coxae I-III and *ST5* posterior to coxae IV. Thus, absent ST4 in larva and protonymph, added in deutonymph. Setae *JV2, JV4, JV5, ZV1, ZV2,* and *ZV3* on integument. Anal shield with anus, paraanal (*PAA*), and postanal setae (*POA*). Length of seta: *ST1* = 11, *ST2* = 11, *ST3* = 12, *ST4* = 9,

ST5 = 12, *JV2* = 11, *JV4* = 10, *JV5* = difficult to measure, *ZV1* = 10, *ZV2* = 10, and *ZV3* = 10. Peritreme much longer (= 67-68 µm) than in protonymph (= 23-24 µm).

Table 1. Measurement (µm) of dorsal idiosomal characters showing increase (+) or decrease (−) in different stages of *Hemipteroseius indicus* (ID = idiosoma, IN = integument, MES = mesonotal sclerite, OP = opisthosoma, OS = opisthonotal shield, PS = podonotal shield, PYS = pygidial shield, T = transverse, V = vertical).

Particulars	Larva (n = 1) Assam, VP74-69, slide #1	Protonymph PAU, VP74-43, slide #3	Deutonymph PAU, VP74-43, slide #3	Female PAU, VP74-43, slide #3	Female, Menon *et al.* (2011)
Dorsal:					
PS length	148	154 (+6)	140 (-14)	146 (+6)	155.0 ± 3.5
PS width	124	138 (+14)	148 (+10)	177 (+29)	-
OS length	absent	78	97 (+19)	125 (+28)	134.5 ± 10.1
OS width	absent	134	138 (+4)	179 (+41)	-
MES L x W	40-41 x 23-30	not measured	absent	absent	-
PYS L x W	not measured	not measured	absent	absent	-
ID setae, total	10 pairs	16 pairs	16 pairs	16 pairs	-
PS setae, total	9 pairs	9 pairs	9 pairs	9 pairs	-
PYS setae, total	1 pair	3 pairs	absent	absent	
OS setae, total	absent	absent	4 pairs	4 pairs	-
INT setae, total	absent	4 pairs	3 pairs	3 pairs	-
Length of setae:					
j1	6	8 (+2)	10 (+2)	18 (+8)	11.0 ± 2.2
j3	7	12 (+5)	16 (+4)	19 (+3)	17.0 ± 2.0
j4	7	10 (+3)	15 (+5)	18 (+3)	15.0 ± 1.7
j5	7	10 (+3)	12 (+2)	18 (+6)	15.5 ± 2.0
j6	18	17 (-1)	22 (+5)	31 (+9)	29.5 ± 2.7 bulb
J2	absent	16	18 (+2)	22 (+4)	20.5 ± 2.7
J5	absent	2	3 (+1)	3 (+0)	2.5 ± 0.0
z2	8	12 (+4)	15 (+3)	20 (+5)	21.0 ± 2.2
z4	8	12 (+4)	15 (+3)	20 (+5)	20.5 ± 2.0
z5	8	10 (+2)	12 (+2)	20 (+8)	18.0 ± 2.0
Z4	18	11 (-7)	14 (+3)	19 (+5)	14.0 ± 1.3
Z5	absent	27	27 (+0)	37 (+10)	38.0 ± 2.0 bulb
s4	9	11 (+2)	16 (+5)	22 (+6)	20.0 ± 2.0
s6 (integument)	absent	17	22 (+5)	31 (+9)	28.5 ± 3.3 bulb
r3 (integument)	absent	15	18 (+3)	24 (+6)	18.0 ± 1.1
R1 (integument)	absent	12	18 (+6)	19 (+1)	17.0 ± 1.1
Growth-Length (Total: average)	-	= 25/8 (+3)	= 51/15 (+3)	= 88/15 (+6)	-

Transverse distance between different setal pairs: *ST1-ST1* = 38, *ST2-ST2* = 69, *ST3-ST3* = 66; *ST4-ST4* = 55; and *ST5-ST5* = 34. Vertical distances between different setal pairs: *ST1-ST2* = 35, *ST2-ST3* = 30, *ST3-ST4* = 17, *ST4-ST5* = 43, and *JV2-JV2* = 24. Thus, *ST1-ST1* much closer to each other (= 38 µm) and *ST2-ST2* much apart (= 69 µm) than other sternal setae. Also, *ST1-ST2* farthest apart (= 35 µm) and *ST3-ST4* much closer (= 17 µm) to each other than others.

Legs and macrosetae (Fig. 21) – Femora I and II and genua I-IV with a large macroseta (*pd1*) on each (absent on femora III-IV) and some with bulbose tips. Tarsus of leg I with several setae clustered together on dorsodistal tip proximal to claws. Setae *av* and *pv* on coxae I-IV as in protonymph.

Gnathosoma (Fig. 21, Table 4) – Dorsal gnathosoma with anteriorly rounded tectum under which chelicerae having reduced fixed digit and long movable digit having 2 denticles located anteriorly just posterior to tip. Ventral gnathosoma with 3 pairs of hypostomal setae (*HY1-HY3*), pair

of capitular setae (*CS*), elongate capitular groove with a few, but more than in protonymph, denticular rows with a few denticles in each row. Ventral palp tarsus with bifurcate palpal apotele.

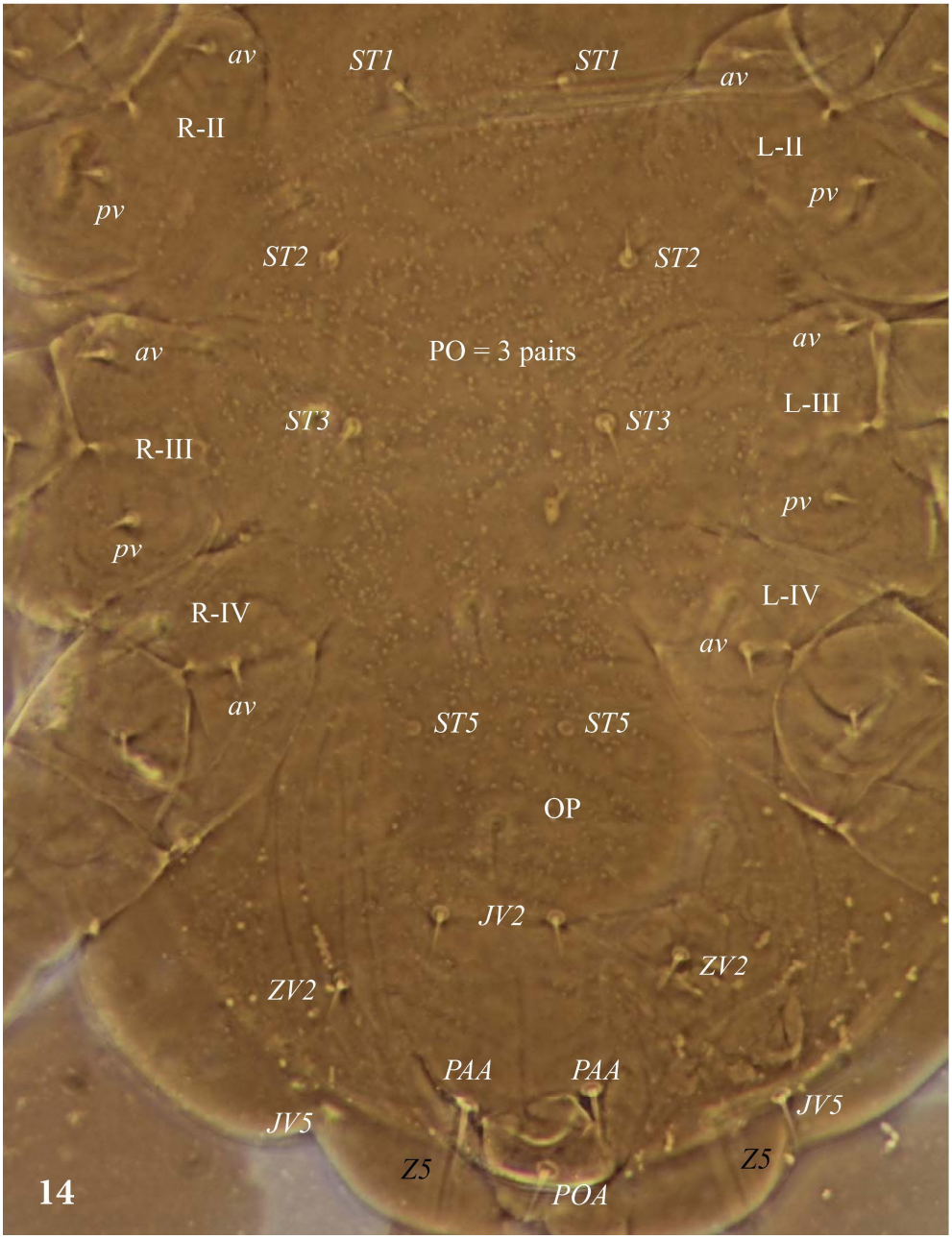


Figure 14. *Hemipteroseius indicus* (VP74-43, PAU #3, slide #2, protonymph, photo #18, ventral, posterior) – Podosoma with sternal setae *ST1* and *ST2* in between coxae II, *ST3* in between coxae III, and minute *ST5* (*JV1?*) posterior to coxae IV - all on integument. Opisthosoma with setae *JV2, JV5, ZV2, PAA,* and *POA*. Some dorsal setae (*Z5*) and parts of legs II-IV also seen [original magnification = 400×].

(4) FEMALE (Figs. 22–26, Tables 1–4)

An adult female is measured (author's collection #VP74-43, PAU, slide #3) to compare with the deutonymph described above. Measurements of Menon *et al.* (2011) are also included in Table 1 to compare with that of this author. Many photos of adults of *H. indicus* showing different structures and setae are given in Prasad (2017) and, therefore, not included here. But, no measurements of the female structures were included in that work and given here.

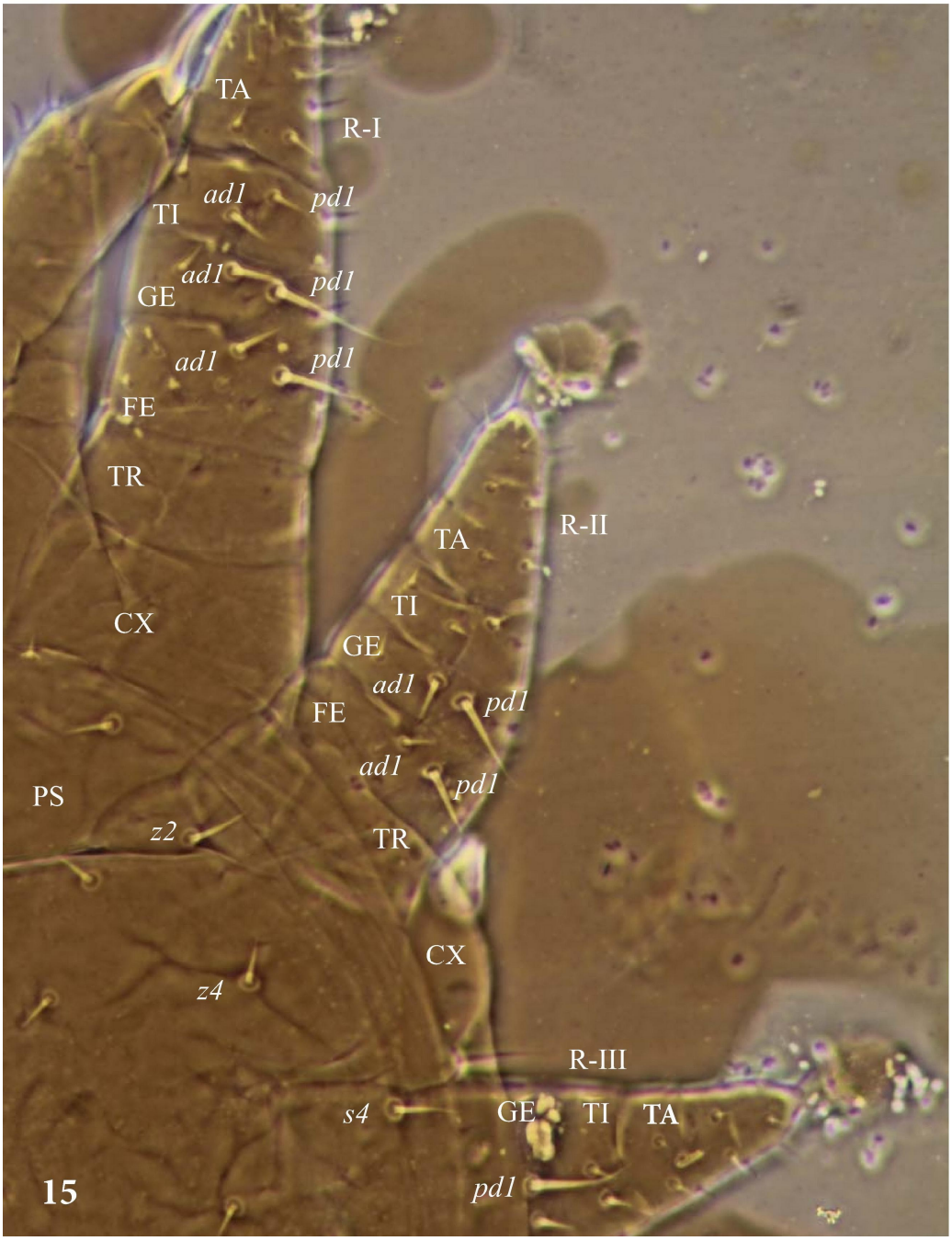


Figure 15. *Hemipteroseius indicus* (VP74-43, PAU #3, slide #2, protonymph, photo #24, dorsal - anterior) – Podosoma (PO) with legs I-III showing single macroseta (*pd1*) on each femur (FE) and genu (GE) of legs I-III [PS = podosomal shield; original magnification = 400×].

Dorsal idiosoma, shields, and setae (Fig. 22, Tables 1, 2) – Similar to protonymph and deutonymph, idiosoma with 2 separate and well sculptured shields, anteriorly located podonotal shield (PS) and posteriorly located opisthonotal shield (OS). Also, similar to these stages, podonotal shield (PS) shield-shaped, laterally incised and cleaved (CLE) between *z2-z4*, but roughly truncate posterior to *j6-j6* and much wider than long near *s4-s4*. Opisthonotal shield (OS) straight or slightly concave anterior to *J2-J2* and posterior to *J5-J5*. All sigilla clearly seen. Measurements (length and

width at level of *s4*) of podonotal shield = 146 × 177 and opisthonotal shield = 125 × 179. Thus, both shields much wider than long and almost of same width.

Table 2. Measurement (µm) of distance between dorsal idiosomal setal pairs showing increase (+) or decrease (−) in different stages of *Hemipteroseius indicus* (T = transverse, V = vertical).

Particulars	Larva (n = 1) Assam, VP74-69, slide #1	Protonymph PAU, VP74-43, slide #3	Deutonymph PAU, VP74-43, slide #3	Female PAU, VP74-43, slide #3	Female, Menon *et al.* (2011)
Distance - T					
j1-j1	12	19 (+7)	22 (+3)	23 (+1)	-
j3-j3	40	47 (+7)	50 (+3)	52 (+2)	-
j4-j4	35	34 (-1)	39 (+5)	34 (-5)	-
j5-j5	28	25 (-3)	27 (+2)	29 (+2)	-
j6-j6	46	47 (+1)	45 (-2)	49 (+4)	-
J2-J2	absent	35	33 (-2)	50 (+17)	-
J5-J5	absent	not measured	31	41 (+10)	-
z2-z2	63	65 (+2)	68 (+3)	70 (+2)	-
z4-z4	90	95 (+5)	98 (+3)	110 (+12)	-
z5-z5	80	82 (+2)	83 (+1)	95 (+12)	-
Z4-Z4	not measured	89	94 (+5)	121 (+27)	-
Z5-Z5	absent	47	58 (+11)	69 (+11)	-
s4-s4	123	133 (+10)	133 (+0)	154 (+21)	-
Growth-T (Total: average)	-	= 34/7 (+5)	= 36/9 (+4)	= 121/12 (+10)	
Distance: V					
j1-j3	20	19 (-1)	19 (+0)	18 (-1)	-
j3-j4	30	32 (+2)	32 (+0)	33 (+1)	-
j4-j5	18	22 (+4)	20 (-2)	25 (+5)	-
j5-j6	60	62 (+2)	64 (+2)	59 (-5)	-
J2-J5	absent	not measured	58	83 (+25)	-
z2-z4	26	28 (+2)	30 (+2)	38 (+8)	-
z4-z5	44	41 (-3)	43 (+2)	42 (-1)	-
Z4-Z5	Z5 absent	28	38 (+10)	49 (+11)	-
Growth-V (Total: average)	-	= 10/4 (+3)	= 16/4 (+4)	= 50/5 (+10)	-

A total of 16 pairs of setae on dorsal idiosoma (*j1, j3, j4, j5, j6, J2, J5, z2, z4, z5, Z4, Z5, s4, s6, r3,* and *R1*) as in protonymph and deutonymph. Of these, 9 pairs (*j1, j3, j4, j5, j6, z2, z4, z5,* and *s4*) on podonotal shield and 2 pairs (*r3* and *s6*) lateral to this shield, on integument of podosoma. Opisthonotal shield (OS) with 4 pairs of setae (*J2, J5, Z4,* and *Z5*). One pair of setae (*s6*) on integument anteromedial to opisthonotal shield. Another pair of setae (*R1*) also present on integument but anterolateral to opisthonotal shield. Thus, 3 pairs of setae (*s6, r3,* and *R1*), as in deutonymph, present on dorsal idiosomal integument of female. All setae on dorsal idiosoma simple, smooth, finely pointed, without serrations, and without bulbose tips and longer than in deutonymph. Sigilla on podonotal and opisthonotal shields.

Length of seta: *j1* = 18, *j3* = 19, *j4* = 18, *j5* = 18, *j6* = 31, *J2* = 22, *J5* = 3, *z2* = 20, *z4* = 20, *z5* = 20, *Z4* = 19, *Z5* = 37, *s4* = 22, *s6* = 31, *r3* = 24, and *R1* = 19. Of all, seta *Z5* longest (= 37 µm), *j6* and *s6* of about same length (= 31 µm) and longer than remaining setae (= 18-24 µm) but seta *J5* minute (= 3 µm). Most measurements being very close to those of Menon *et al.* (2011) as given in Table 1.

Transverse distance between different setal pairs: *j1-j1* = 23, *j3-j3* = 52, *j4-j4* = 34, *j5-j5* = 29, *j6-j6* = 49, *J2-J2* = 33, *J5-J5* = 41, *z2-z2* = 70, *z4-z4* = 110, *z5-z5* = 95, *Z4-Z4* = 121, *Z5-Z5* = 69, and *s4-s4* = 154. Vertical distance: *j1-j3* = 18, *j3-j4* = 33, *j4-j5* = 25, *j5-j6* = 59, *J2-J5* = 83, *z2-z4* = 38,

z4-z5 = 42, and *Z4-Z5* = 49. Thus, transverse distance between *j5-j5* much less (= 29 µm) than between *j4-j4* (= 34 µm) and *j6-j6* (= 49 µm). Also, vertical distance between *j4-j5* much less (= 25 µm), almost similar to *j1-j3*, than between *j5-j6* (= 59 µm).

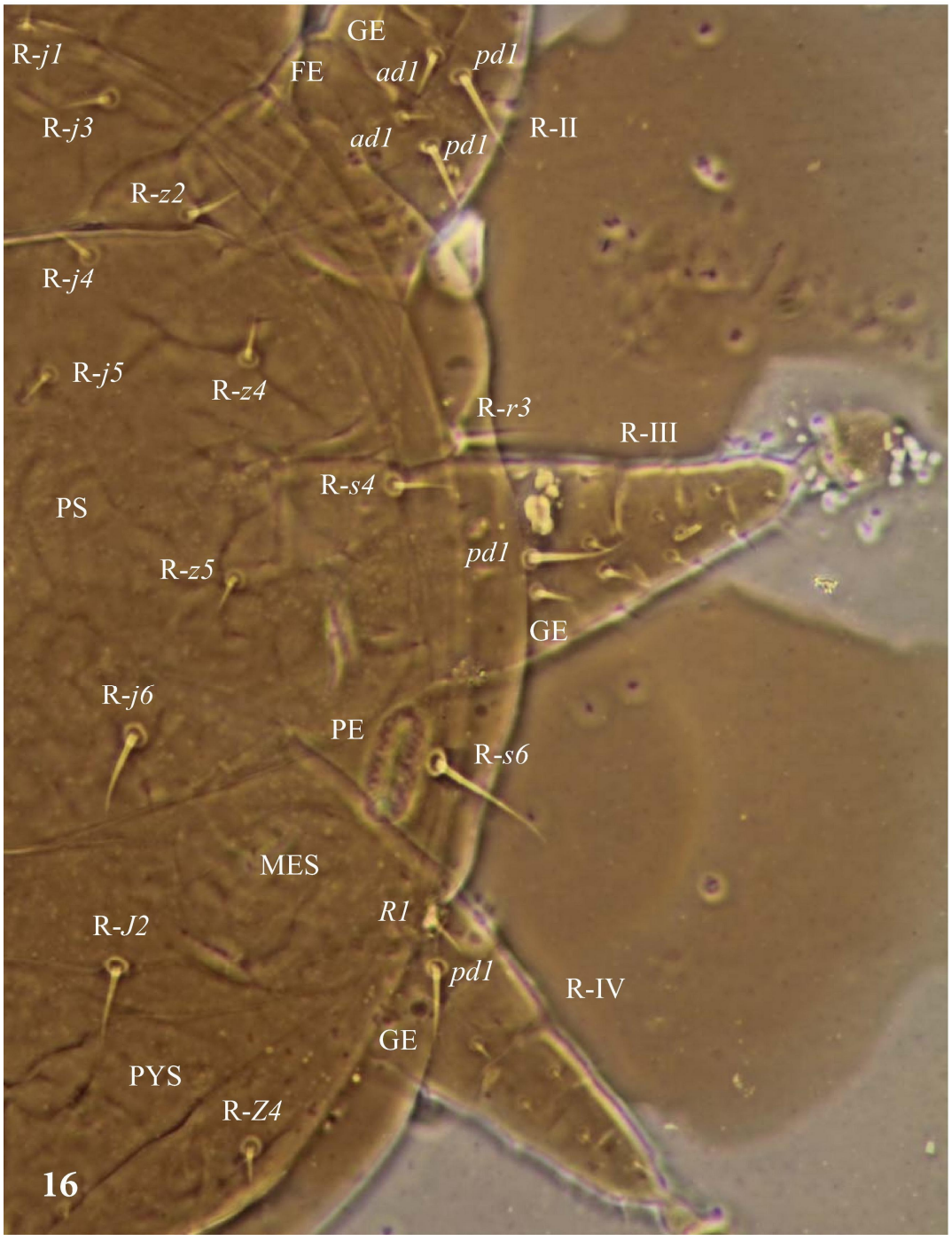


Figure 16. *Hemipteroseius indicus* (VP74-43, PAU #3, slide #2, protonymph, photo #26, dorsal - posterior) – Podosoma (PO) with legs II-IV showing single macroseta on each femur (FE) and genu (GE) of legs II-IV. Short peritreme (PE) in between coxa III-IV [MES = mesonotal sclerites, PS = podosomal shield, PYS = pygidial shield; original magnification = 400x].

Ventral idiosoma, shields, setae, and peritreme (Figs. 23, 24, Table 3) – Tritosternum (TRI) with its triangular base and anteriorly located bifurcate laciniae in between coxae I. Lightly

sclerotized sternal shield (SS) and well defined genital shield (GS) and ventrianal shield (VAS) present. Several, narrowly wide metagenital sclerites (MEGS) and 1-2 narrowly elongate metapodal sclerites (MEPO) posterior to coxa IV which may or may not be seen in some specimens. Setae *ST1-ST4* in between coxae II-IV, and seta *ST5* on integument posterior to coxa IV beside genital shield. Setae *JV1, JV4, JV5, ZV1, ZV2,* and *ZV3* on integument. Anal shield with anus, paraanal (*PAA*), and postanal setae (*POA*). Peritreme long (= 68 µm), similar to deutonymph (= 69 µm).

Table 3. Measurement (µm) of ventral idiosomal setae and distance between them showing increase (+) or decrease (−) in different stages of *Hemipteroseius indicus* (ID = idiosoma, IN = integument, SH = shield, T = transverse, V = vertical).

Particulars	Larva (n = 1) Assam, VP74-69, slide #1	Protonymph PAU, VP74-43, slide #3	Deutonymph PAU, VP74-43, slide #3	Female, PAU, VP74-43, slide #3	Female, Menon *et al.* (2011)
Ventral:					
ST1	8	10 (+2)	11 (+1)	26 (+15)	-
ST2	8	9 (+1)	11 (+2)	26 (+15)	-
ST3	8	9 (+1)	12 (+3)	23(+11)	-
ST4	absent	absent	9	25(+16)	-
ST5	absent	minute	12	30 (+18)	-
JV1	absent	absent	absent	absent	
JV2	10	10 (+0)	11 (+1)	21 (+10)	-
JV4	absent	not seen	10	19 (+9)	-
JV5	absent	not measured	present	16	18.0 ± 2.0
ZV1	absent	absent	10	18 (+8)	-
ZV2	absent	7	10 (+3)	18 (+8)	-
ZV3	absent	absent	10	17 (+7)	-
PAA	present	present	present	present	present
POA	present	present	present	present	present
Distance: T					
ST1-ST1	27	30 (+3)	38 (+8)	52 (+14)	-
ST2-ST2	49	57 (+8)	69 (+12)	80 (+11)	-
ST3-ST3	42	52 (+10)	66 (+14)	105 (+39)	-
ST4-ST4	absent	absent	55	110 (+55)	-
ST5-ST5	absent	not measured	34	65 (+31)	-
JV2-JV2	20	23 (+3)	24 (+1)	28 (+4)	-
Distance: V					-
ST1-ST2	34	35 (+1)	35 (+0)	35 (+0)	-
ST2-ST3	29	32 (+3)	30 (-2)	29 (-1)	-
ST3-ST4	ST4 absent	ST4 absent	17	10 (-10)	-
ST4-ST5	ST4 absent	ST4 absent	43	90 (+47)	-
Peritreme	absent	24 (short)	69 long (+45)	68 long (-1)	77.2± 4.1 (long)
Tritosternum	present	present	present	present	present

Length of seta: *ST1* = 26, *ST2* = 26, *ST3* = 23, *ST4* = 25, *ST5* = 30, *JV2* = 21, *JV4* = 19, *JV5* = 16, *ZV1* = 18, *ZV2* = 18, and *ZV3* = 17. Ventral podosoma with 4 pairs of setae (*ST1-ST4*) and opisthosoma, including paraanal and postanal setae, with 9 pairs of setae (*ST5, JV2, JV4, JV5, ZV1, ZV2, ZV3, PAA,* and *POA*).

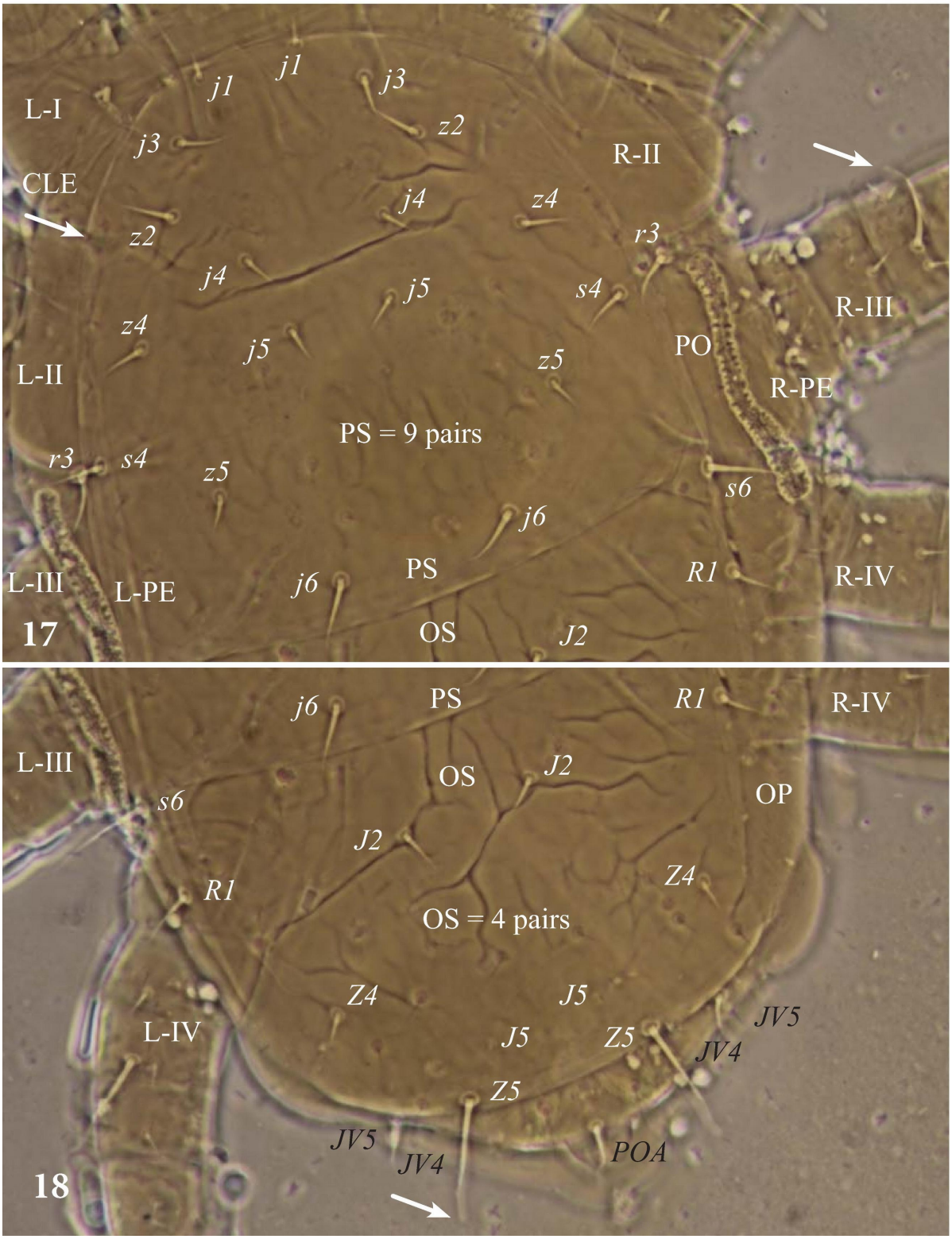
Table 4. Gnathosomal characteristics in different stages of *Hemipteroseius indicus*.

Particulars	Larva (n = 1) Assam, VP74-69, slide #1	Protonymph PAU, VP74-43, slide #3	Deutonymph PAU, VP74-43, slide #3	Female PAU, VP74-43, slide #3	Female, Menon *et al.* (2011)
Dorsal:					
Tectum-smooth	present	present	present	present	present
Fixed digit	reduced	reduced	reduced	reduced	reduced
Movable digit	2 teeth	2 teeth	2 teeth	2 teeth	2 teeth
Ventral:					
Capitular setae	absent	present	present	present	present
Hypostomal setae	2 pairs (HY1 & HY2)	3 pairs (HY1-HY3)	3 pairs (HY1-HY3)	3 pairs (HY1-HY3)	3 pairs (HY1-HY3)
Capitular gutter	5–6 denticular rows	6–7 denticular rows	6–7 denticular rows	6–7 denticular rows	6–7 denticular rows
Palp:					
Apotele-bifurcate	present	present	present	present	present
Setae on palp:	Evans (1964)	Evans (1964)	Evans (1964)	Evans (1963)	Evans (1963)
Trochanter	0	1 (v1 added)	2 (v2 added)	2	0
Femur	4 (al,d1,d2,pl)	4	5 (d3 added)	5	4
Genu	5 (al,d1-d3,pl)	5	6 (al2 added)	6	5
Tibia	12	12	14 (2 added)	14	12
Tarsus	11	15 (4 setae added)	15	15 (Total = 42) As in *Treatia*	13 (Total = 34) As in *Otopheidomenis* But as: 1 3 0 8 12 (Total = 24) in *Hemipteroseius*. Thus, marked hypotrophy in these 2 genera than in *Treatia*

Transverse distance between setal pairs: *ST1-ST1* = 52, *ST2-ST2* = 80, *ST3-ST3* = 105, *ST4-ST4* = 110, *ST5-ST5* = 65, and *JV2-JV2* = 28. Vertical distance between different pairs: *ST1-ST2* = 35, *ST2-ST3* = 29, *ST3-ST4* = 10, and *ST4-ST5* = 90. Thus, *ST1-ST1* are much closer to each other (= 52 µm) and *ST4-ST4* farthest apart (= 110 µm) than other sternal setae. Also, *ST1-ST2* farthest apart (= 35 µm) than *ST2-ST3* (= 29 µm) or *ST3-ST4* (10 µm). Thus, in vertical line, *ST4* located much closer to *ST3* than *ST1* to *ST2* or *ST2* to *ST3*.

Legs and macrosetae (Figs. 22, 23, 25) – Femora I and II and genua I-IV with a large macroseta (*pd1*) on each (absent on femora III-IV) and bulbose tip. Tarsus of leg I with several setae clustered together on dorsodistal tip proximal to claws. Ventral coxae I-III with tiny setae *av* and *pv* and coxa IV with seta *av*.

Gnathosoma (Figs. 25, 26, Table 4) - Dorsal gnathosoma with anteriorly rounded tectum under which chelicerae having reduced fixed digit and long movable digit having 2 denticles located subapically. Ventral gnathosoma with 3 pairs of hypostomal setae (*HY1-HY3*), pair of capitular setae (*CS*), and elongate capitular groove (CG) having 7 denticular rows with one denticle in each. Ventral palp tarsus with bifurcate palpal apotele.



Figures 17–18. *Hemipteroseius indicus* (OSAL 0104177, TC, slide #7, normal deutonymph #1–18, 1–20, dorsal) – 17. Podonotal shield with *j1, j3, j4, j5, j6, z2, z4, z5,* and *s4*; 18. Opisthonotal shield with *J2, J5, Z4,* and *Z5* with knobbed tip. Setae *s6* and *r3* on podosomal (PO) and *R1* on opisthosomal (OP) integument. Knobbed macroseta on femur II. Longer peritreme (PE) than in PN [original = 400×].

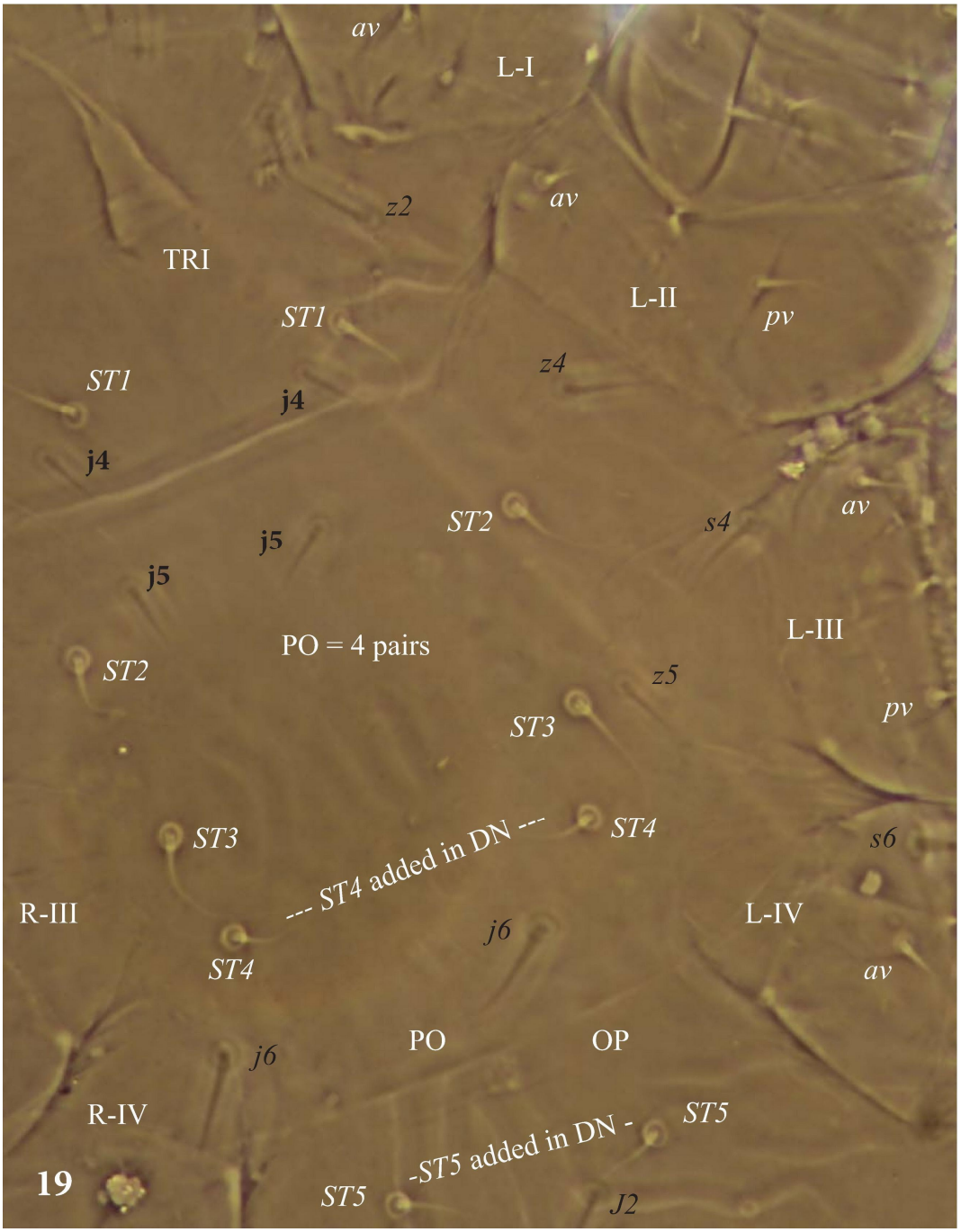


Figure 19. *Hemipteroseius indicus* (OSAL 0104177, TC, slide #7, normal deutonymph #1–21, ventral) – Podosoma (PO) with tritosternum (TRI) and sternal setae *ST1-ST4*, and opisthosoma (OP) with genital setae *ST5* - all on integument. Legs I-IV and dorsal setae *j4, j5* (*j5* located close to each other than *j4*), *j6, z2, z4, z5, s4,* and *s6* on podosoma and *J2* on opisthosoma barely seen [original magnification = 400×].

(5) PHARATE FEMALE (Figs. 27, 28)

A deutonymph with a developing female inside the body, representing a pharate female, having duplicate peritremes and duplicate setae of both stages, is photographed in dorsal and ventral views (OSAL 0104177, Treat Collection, slide #7, #1-1, dorsal, and #1-2, ventral).

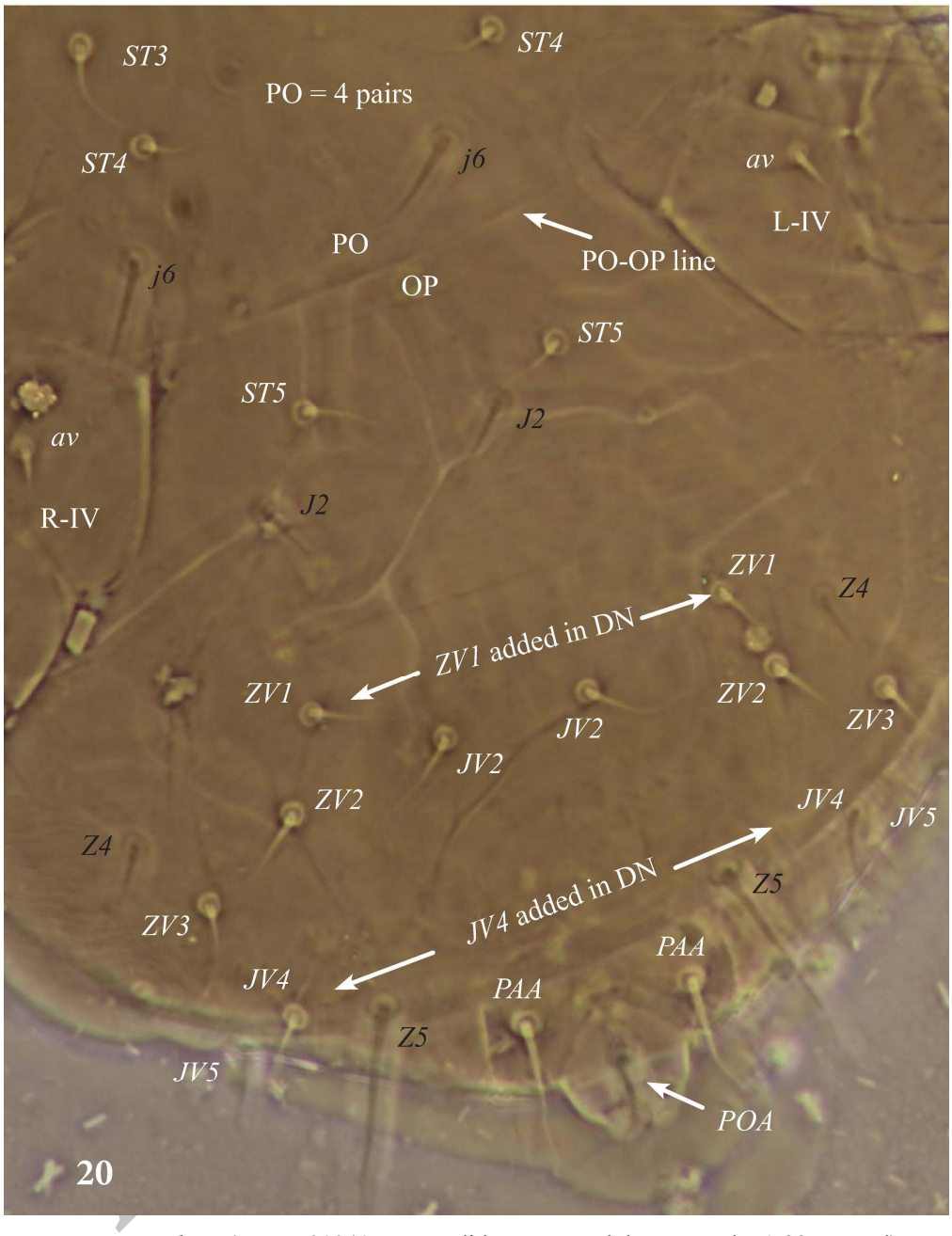


Figure 20. *Hemipteroseius indicus* (OSAL 0104177, TC, slide #7, normal deutonymph #1-23, ventral) – Podosoma (PO) with sternal setae *ST3* and *ST4* on integument. Opisthosoma (OP) with genital setae *ST5*, ventral setae *JV2*, *JV4*, *JV5*, *ZV1*, *ZV2*, and *ZV3* on integument. Pair of paraanal (*PAA*), single postanal seta (*POA*) and several dorsal setae (*j6*, *J2, Z4,* and *Z5*) barely seen [I-IV = legs I-IV; original = 400×].

Remarks

No detail descriptions are given but figures are labeled and included for information of the readers. In these, DN refers to deutonymph and PF to pharate female. Dorsally, pharate female cannot be identified but could be identified ventrally having genital shield (GS) with anteriorly located membranous flap and pentagonal ventrianal shield (VAS) with usual setae *ST5, JV2, ZV1, ZV2, ZV3, PAA* seen in the female. Bases of most dorsal setae on podonotal shield and anterior opisthonotal

shield of both stages are located very close to each other except for *Z4* and *Z5* in which these are located well apart from each other (Fig. 27).

(6) PHARATE MALE (Figs. 29, 30)

Another deutonymph with a developing male inside the body, representing a pharate male, having duplicate peritremes and duplicate setae of both stages, is also photographed in dorsal and ventral views (OSAL 0104177, Treat Collection, slide #7, #1-3, dorsal, and #1-7, ventral).

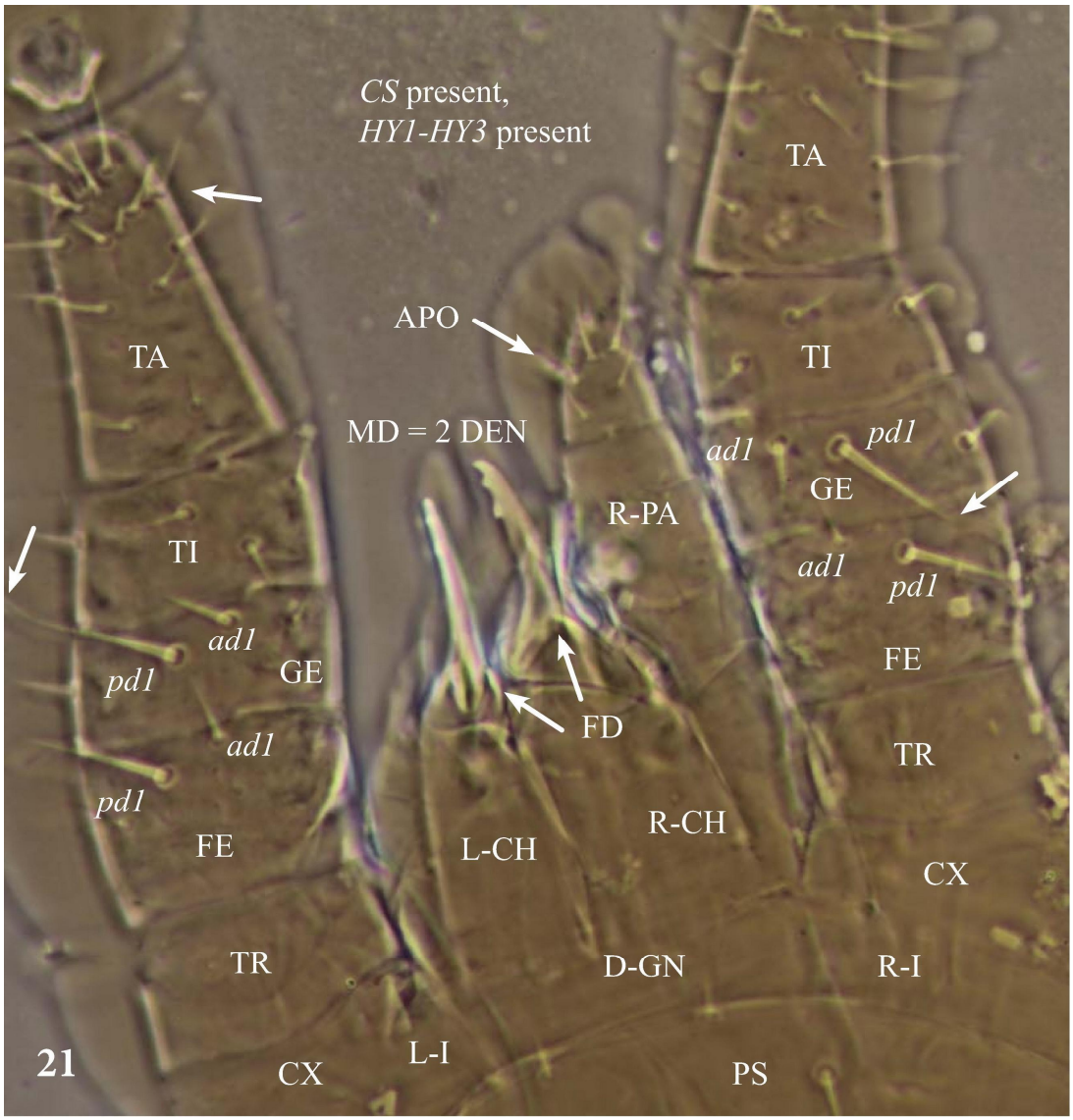


Figure 21. *Hemipteroseius indicus* (OSAL 0104177, TC, slide #7, normal deutonymph #1-17, dorsal) – Gnathosoma (GN) showing chelicerae (CH), reduced fixed digit (FD), and long movable digit (MD) with 2 denticles (DE = 2) posterior to curved tip. Right palp (R-PA) with apotele (APO), podonotal shield (PS), and legs I (I) from coxa (CX) to tarsus (TA) without knobbed macrosetae on femur (FE) but left genu (GE) with knobbed macroseta. Note dorsal distal tarsus (TA) with many dorsal setae located close to each other (arrow) [I-IV = legs I-IV; original magnification = 400×].

Remarks

No detail descriptions are given but figures are labeled and included for information of the readers. In these, DN refers to deutonymph and PM to pharate male. Dorsally, pharate male cannot

be identified as spermatodactyles are not seen but could be identified ventrally having poorly defined sternogenital shield (SGS) and anteriorly located elongate male genital apparatus. Even in this stage, movable digit of chelicera (MD) having 2 denticles (DEN), present in deutonymph and not in male, is seen (Fig. 29). All setae, including on palps and legs, similar to idiosoma, and peritremes (PE) are duplicate. Similar to pharate female, peritremes of pharate male (PE-PM) are lateral to and longer than that of deutonymph (PE-DN).

Table 5. Total number of dorsal and ventral idiosomal setae (in pair) in different stages of some species of *Hemipteroseius, Noctuiseius,* and *Prasadiseius* (IN = integument, OS = opisthonotal shield, PS = podonotal shield, PYS = pygidial shield, S-SS = sternal region-sternal shield).

Particulars	Larva	Protonymph	Deutonymph	Female
(1) *H. adleri*:				
Dorsal shield(s)	2	2	2	2
Dorsal setae on				
Podonotal shield	9	9	9	9
Pygidial shield	1	3	absent	absent
Opisthonotal shield	absent	absent	4	4
Integument	0	4 (J2, s6, r3, R1)	3 (s6, r3, R1)	3 (s6, r3, R1)
Total dorsal setae	10	16	16	16
Ventral setae				
Sternal-intercoxal	3-IN	3-IN	3-SS	3-SS-IN
Opisthogastric	1-IN	3-IN	1ST5+3 = 4	1ST5+3 = 4
Anal shield	2 (PAA+POA)	2 (PAA+POA)	2 (PAA+POA)	1+2 (VAS)
Total ventral setae	6	8	9	10
(2) *H. indicus*:				
Dorsal shield(s)	2	2	2	2
Dorsal setae on				
Podonotal shield	9	9	9	9
Pygidial shield	1	3	absent	absent
Opisthonotal shield	absent	absent	4	4
Integument	0	4 (J2,s6,r3,R1)	3 (s6,r3,R1)	3 (s6,r3,R1)
Total dorsal setae	10	16	16	16
Ventral setae				
Sternal-intercoxal	3-IN	3-IN	4-IN	4-SS-IN
Opisthogastric	1-IN	4-IN	1ST5+5 = 6-IN	1ST5+3 = 4-IN
Anal shield	2 (PAA+POA)	2 (PAA+POA)	2 (PAA+POA)	1+2 (VAS)
Total ventral setae	6	9	12	11
(3) *H. womersleyi*:				
Dorsal shield(s)	2	2	2	2
Dorsal setae on				
Podonotal shield	9	9	9	9
Pygidial shield	1	3	absent	PYS absent
Opisthonotal shield	absent	absent	5	5
Integument	0	5 (J1,J2,s6,r3,R1)	3 (s6,r3,R1)	3 (s6,r3,R1)
Total dorsal setae	10	17	17	17
Ventral setae				
Sternal-intercoxal	3-IN	3-IN	4-SS	4-SS-IN
Opisthogastric	1-IN	3-IN	1ST5+6 = 7	1ST5+5 = 6
Anal shield	2 (PAA+POA)	2 (PAA+POA)	2 (PAA+POA)	1+2 (VAS)
Total ventral setae	6	8	13	13

Table 5. Continued.

Particulars	Larva	Protonymph	Deutonymph	Female
(4) *N. treati*:				
Dorsal shield(s)	2	2	2	2
Dorsal setae on				
Podonotal shield	9	10	10	10
Pygidial shield	0	2 (J5, Z5)	absent	absent
Opisthonotal shield	absent	absent	2 (J5,Z5)	2
Integument	0	2 (J2?, r3?)	2 (J2, r3)	2 (J2, r3)
Total ventral setae	6	8	9	9
(5) *P. cocytes*:				
Dorsal shield(s)	2	2	1	1
Dorsal setae on				
Podonotal shield	8	8	8	8
Pygidial shield	0	2 (J5,Z5)	absent	absent
Opisthonotal shield	absent	absent	3	3
Integument	0	2 (J2?, r3?)	1 (r3)	1 (r3)
Total dorsal setae	8	12	12	12
Ventral setae				
Sternal shield	3-SS	3-SS	3-SS	3-SS
Opisthogastric	2-IN	2-IN	2-IN	2-IN (ST5+1)
Anal shield	2 (PAA+POA)	2 (PAA+POA)	2 (PAA+POA)	2 (PAA+POA)
Total ventral setae	7	7	7	7

DISCUSSION

Dorsal idiosomal shields – Evans (1963) described *H. womersleyi* from Nigeria collected on *Odontopus sexpunctatus* (Hemiptera: Pyrrhocoridae). The larva and protonymph of this species have a podonotal shield, a pygidial shield, and 2 mesonotal scutellae. The deutonymph, however, has a podonotal shield and an opisthonotal shield. He did not report if the pharate female and the pharate male were present. Costa (1968) described *H. adleri* from Israel collected on *Pyrrhocoris apterus* and *Scanthius aegyptius* (both Pyrrhocoridae). The larva, protonymph, deutonymph, and adult female and adult male of this species have all dorsal idiosomal shields as in *H. womersleyi*, including absence of mesonotal scutellae in the deutonymph. He also did not report if the pharate female and the pharate male were present. He also reported a collection of many *H. indicus* in Israel on *Caenocoris nerii* (Hemiptera: Lygaeidae) but did not describe immature stages and did not report if the pharate female and the pharate male were present. As given in the Result section of the present study, the larva (Figs. 1-3), the protonymph (Figs. 11, 12), and the deutonymph (Figs. 17, 18) of *H. indicus* from India collected on *Dysdercus* sp. (Pyrrhocoridae) along with females and males also have all dorsal idiosomal shields as in *H. womersleyi.* But, in addition, the pharate female (Fig. 27) and the pharate male (Fig. 29) are also in the collection that are given here.

Chant and Lindquist (1965) described a new species in a new genus as *Nabiseius duplicisetus* from Chile, intercepted at N.Y., USA, collected on an unidentified nabid bug (Hemiptera: Nabidae). The larva, protonymph, deutonymph, and adult female of this species are described and, except for deutonymph, illustrated. Mesonotal scutellae are shown absent on figures of larva and protonymph and not included in the description. No pharate female or pharate male are reported. Prasad (1969) described immature stages of *Noctuiseius treati* collected on a noctuid moth *Achaea janata*

(Lepidoptera: Noctuidae) in Oahu Island, Hawaii, USA along with the adult female and male without seeing pharate females or pharate males. In this species, the larva, the protonymph, and the deutonymph are similar to *H. womersleyi* in having 2 shields but the mesonotal scutellae are absent as in *Nabiseius duplicisetus*. Prasad (2011) redescribed the adult females and males (Prasad, 2012b) of *Prasadiseius cocytes*.

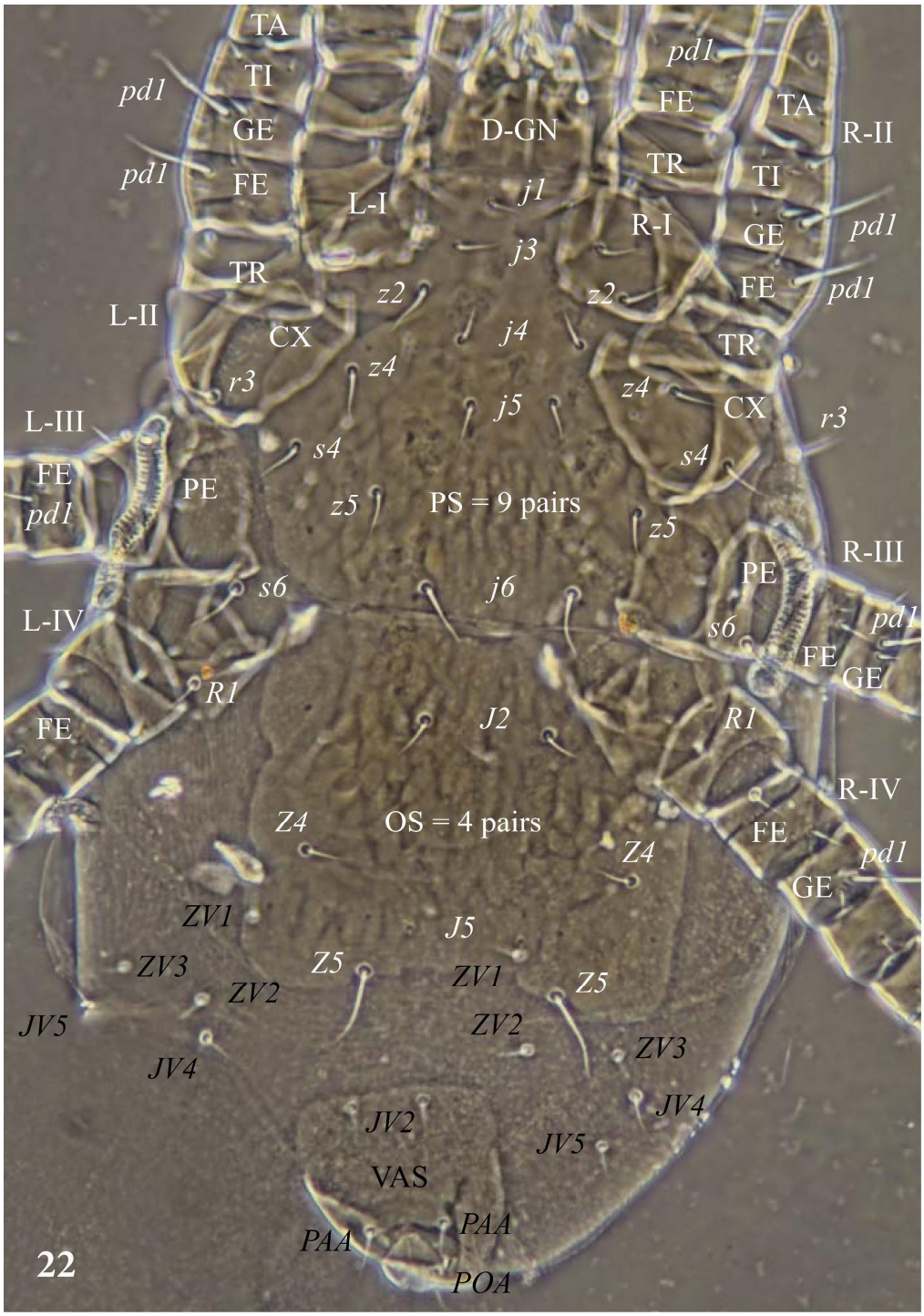
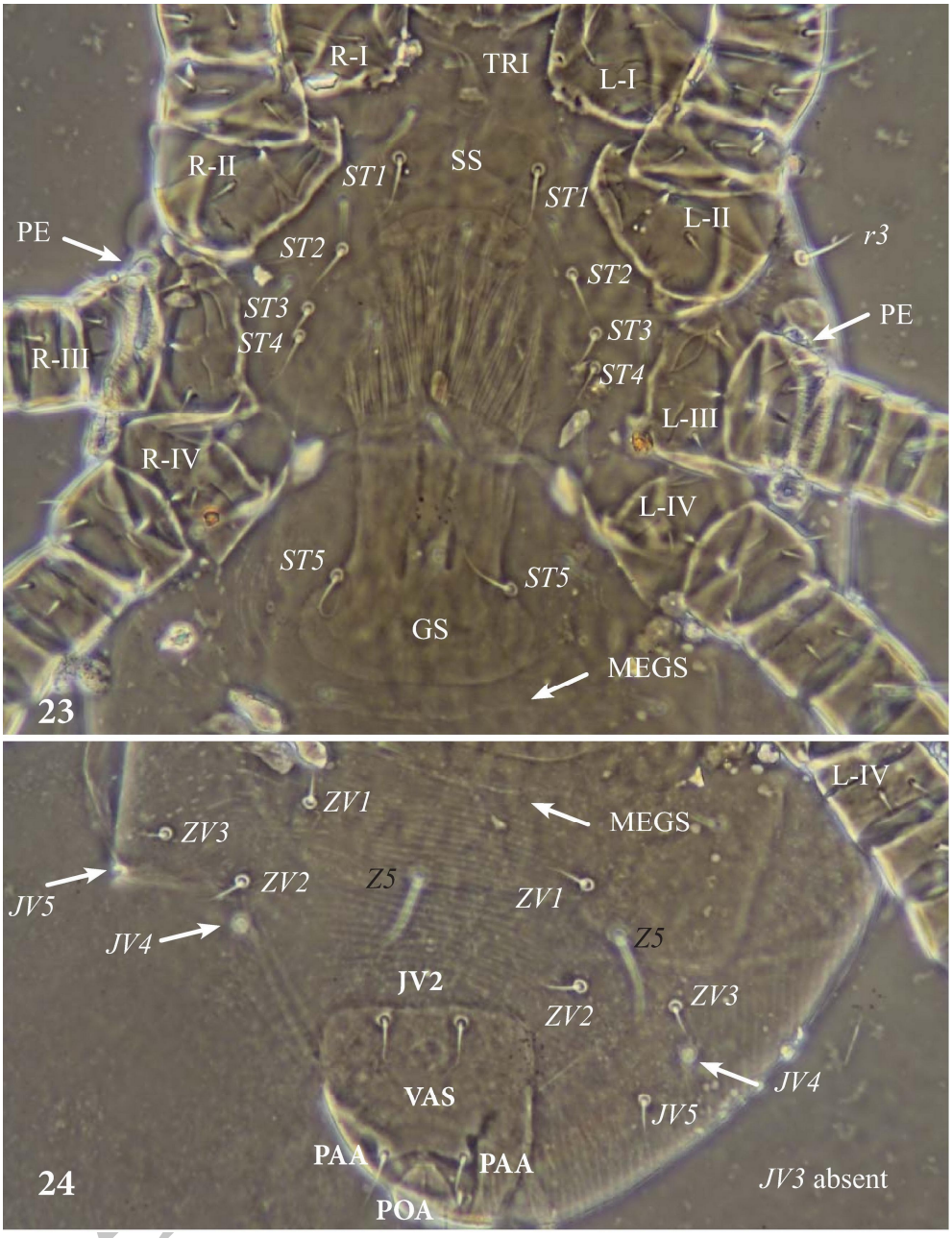


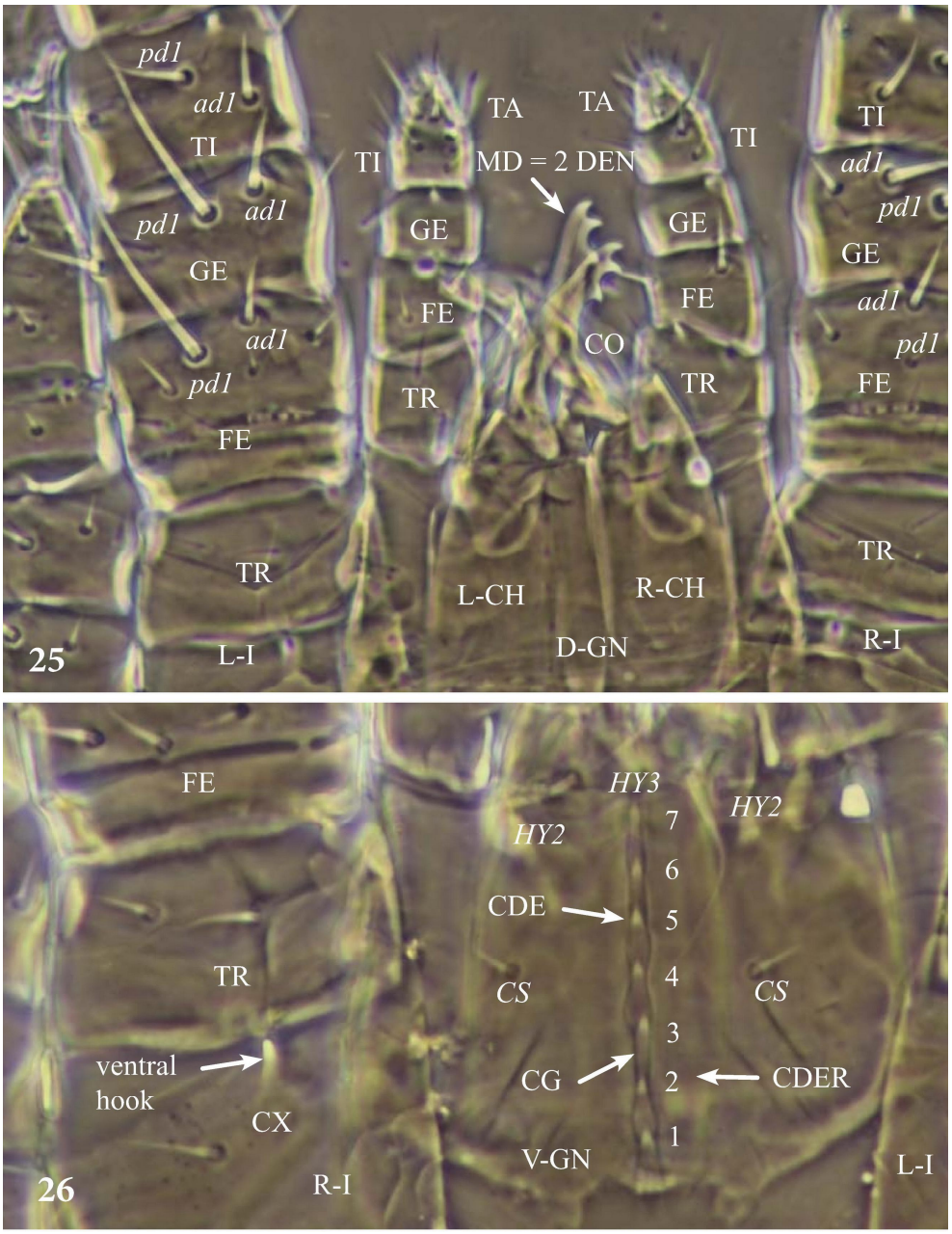
Figure 22. *Hemipteroseius indicus* (Menon, slide #6, female #1, photo # 2, dorsal) – Podonotal shield (PS) with *j1*, *j3*, *j4*, *j5*, *j6*, *z2*, *z4*, *z5*, and *s4*. Opisthonotal shield (OS) with *J2, J5, Z4,* and *Z5* with knobbed tip. Setae *s6* and *r3* on podosomal (PO) and *R1* on opisthosomal (OP) integument. Knobbed macroseta on femur and genu II. Some ventral setae also seen [PE = peritreme; original magnification = 200×].



Figures 23–24. *Hemipteroseius indicus* (Menon, slide #6, female #1, photo # 7, ventral) – 23. Sternal shield (SS) and genital shield (GS) with respective setae on each and on the integument in between legs I-IV. Peritreme (PE) under coxa III seen; 24. Opisthosoma posterior to coxae IV showing ventrianal shield (VAS) and associated setae [MEGS = metagenital sclerites, original magnification = 200×].

He also described immature stages of this species collected on *Adhemarius sexoculata* and *Xylophanes nabuchondonosor* (both from Lepidoptera: Sphingidae) in Peru (Prasad 2012). In this species, the larva and the protonymph also have a large podonotal shield and a small pygidial shield but no mesonotal scutellae. In addition, unusually, the deutonymph has a single dorsal shield in which the large podonotal shield and the small opisthonotal shield are connected by a roughly elongate and rectangular shield having irregular lateral margins referred to as the connecting shield. Also, dissimilar to the adults of *H. adleri, H. indicus, H. womersleyi, Nabiseius duplicisetus, Noctuiseius*

treati, known to have 2 dorsal shields, the adults of *Prasadiseius cocytes* have only one large dorsal shield that is incised laterally posterior to pair of setae j6.



Figures 25–26. *Hemipteroseius indicus* (Menon, slide #6, female #1) – 25. Photo # 8 - Dorsal gnathosoma (D-GN) with chelicerae; 26. Photo # 9 - Ventral gnathosoma (V-GN) with different structures [CDE = capitular denticle, CDER = capitular denticle row, CG = capitular groove, CO = corniculus, *CS* = capitular seta, *HY* = hypostomal seta, and left and right legs I [original magnification, both = 400×].

Thus, in 4 genera of Otopheidomenidae for which immature stages are known (*Hemipteroseius, Nabiseius, Noctuiseius,* and *Prasadiseius*), the following 4 patterns of the dorsal shield are seen: (1) Single dorsal shield is present in the deutonymph of *Prasadiseius* but 2 shields are present in the deutonymph of the remaining 3 other genera (*Hemipteroseius, Nabiseius,* and *Noctuiseius*). (2) Mesonotal sclerites are present in the larva and the protonymph of *Hemipteroseius* but absent in the larva and the protonymph of *Nabiseius, Noctuiseius,* and *Prasadiseius*. (3) Mites parasitizing

Hemiptera do not have the mesonotal sclerites (MES) in larva and protonymph when parasitizing Nabidae (*Nabiseius duplicisetus*) but have these mesonotal sclerites present in larva and protonymph when parasitizing Pyrrhocoridae (*Hemipteroseius adleri, H. agenius, H. antilleus, H. indicus,* and *H. womersleyi*). (4) Mites parasitizing Lepidoptera (Noctuidae and Sphingidae) do not have the mesonotal sclerites and have 2 shields in the deutonymph parasitizing Noctuidae but have only one shield parasitizing Sphingidae. Are the above patterns related to the parasitism of the host family of the insects and present in other otopheidomenid mites also? These cannot be answered at this time unless immature stages of more species are studied in future.

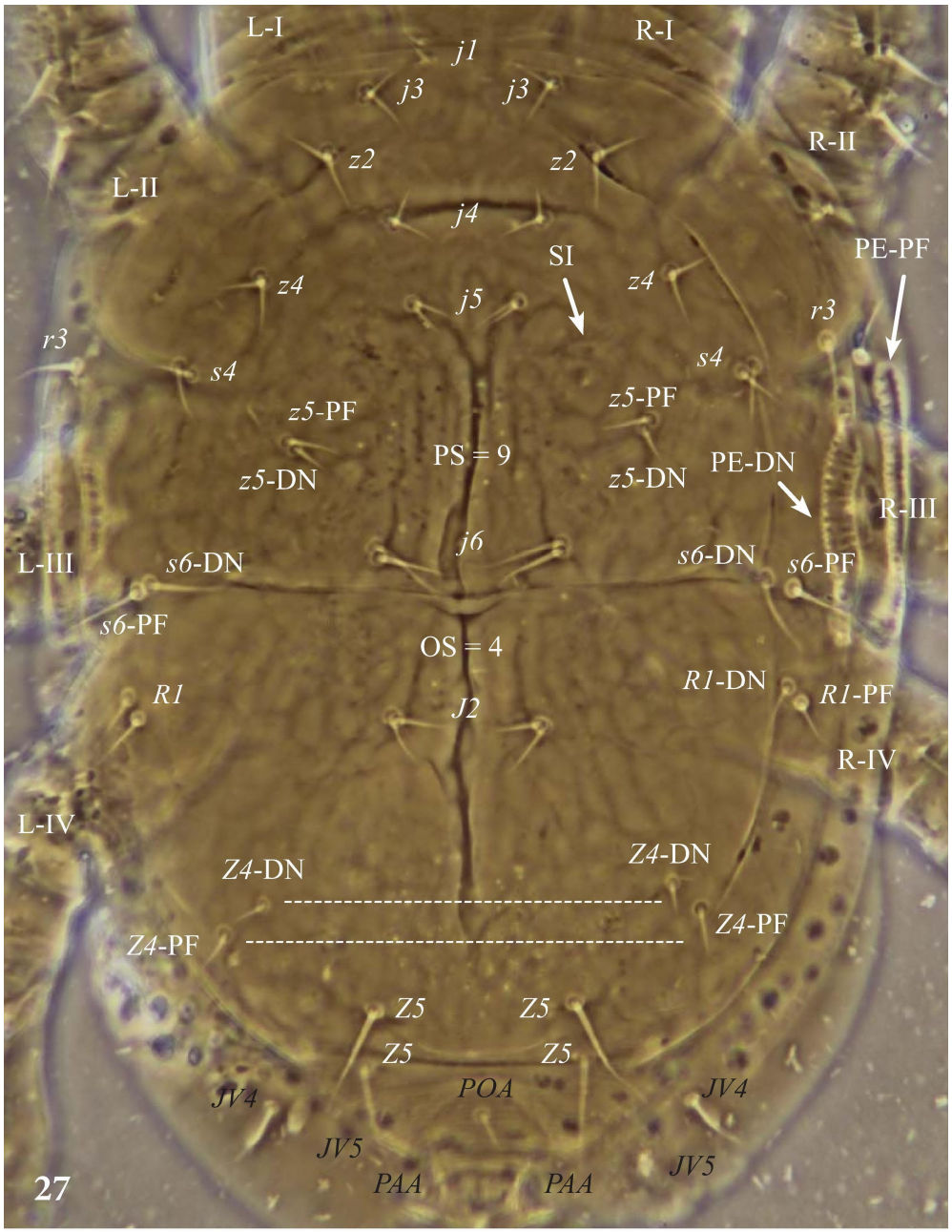


Figure 27. *Hemipteroseius indicus* (OSAL 0104177, TC, slide #7, pharate female inside a deutonymph #1-1, dorsal) – Duplicate setae *j1*, *j3*, *j4*, *j5*, *j6*, *z2*, *z4*, *z5*, and *s4* on podonotal shield; *s6* and *r3* on podosomal integument; *J2,* (minute *J5* not visible), *Z4, Z5* on opisthonotal shield; and *R1* on opisthosomal integument. Duplicate peritremes (PE) and sigilla (SI) also seen [original magnification = 200×].

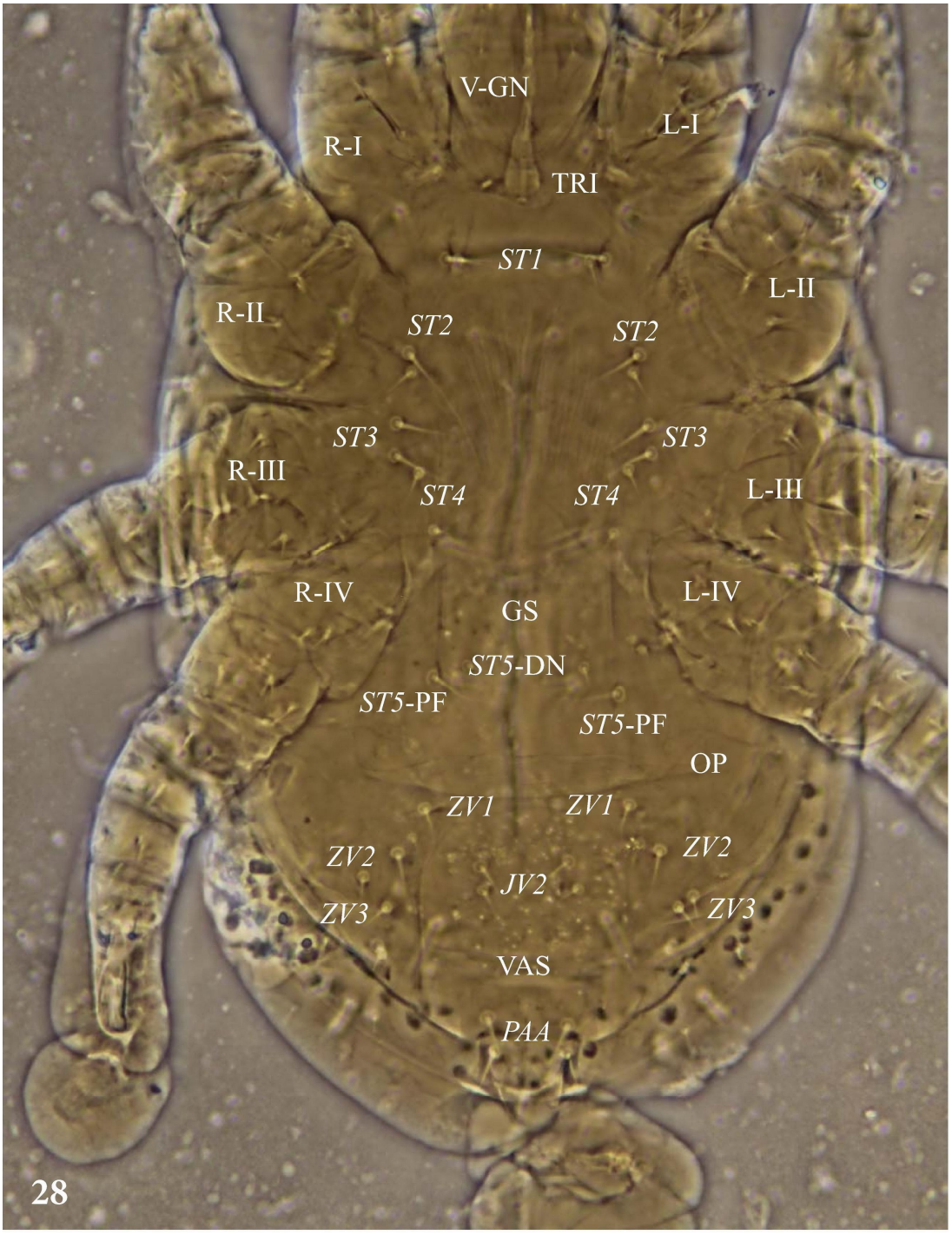


Figure 28. *Hemipteroseius indicus* (OSAL 0104177, TC, slide #7, pharate female inside a deutonymph #1-2, ventral) – Podosoma (PO) with duplicate sternal-genital setae *ST1*-*ST5* and tritosternum (TRI) on integument. Sternal shield, genital shield (GS), ventrianal shield (VAS), and duplicate opisthosomal setae barely seen [*PAA* = paraanal setae; original magnification = 200×].

Comparing the immature stages of closely related Phytoseiidae as *Amblyseius colimensis* described by Aponte and McMurtry (1987) and *Typhlodromus erymanthii* by Papadoulis and Emmanouel (1990, 1992), it is evident that the dorsal idiosoma has the podonotal shield and the pygidial shield (later called by them as opisthonotal shield) in the larva and the protonymph and the podonotal shield and the opisthonotal shield in the deutonymph. But have more setae on the podonotal

shield of the protonymph and on the opisthonotal shield of the deutonymph than the Otopheidomenidae discussed above. These shields are also present in the immature stages of *Krantzoseius walteri* (Blattisociidae), closely related to Phytoseiidae, but has 4 pairs of sigillary platelets in between the podonotal shield and the pygidial shield of the protonymph (Seeman, 2012). None of the above authors have reported the presence of pharate female or pharate male in their collections. The mesonotal sclerites may be homologous with the sigillary platelets but different in shapes and size.

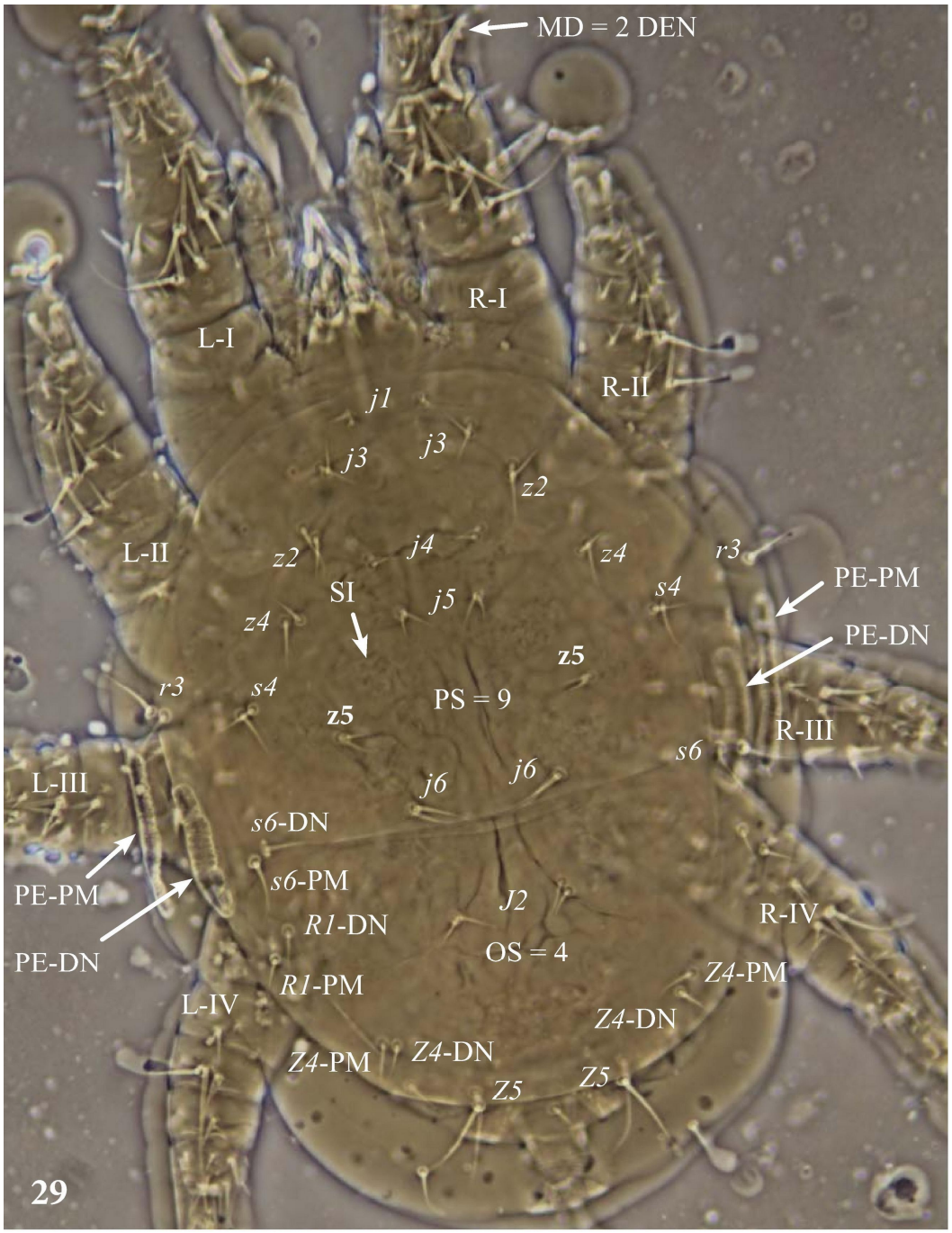


Figure 29. *Hemipteroseius indicus* (OSAL 0104177, TC, slide #7, pharate male inside a deutonymph #1-3, dorsal) – Duplicate setae *j1*, *j3*, *j4*, *j5*, *j6*, *z2*, *z4*, *z5*, and *s4* on podonotal shield; *s6* and *r3* on podosomal integument; *J2,* (*J5* not visible), *Z4, Z5* on opisthonotal shield; and *R1* on opisthosomal integument. Duplicate peritremes (PE) and sigilla (SI) also seen [original magnification = 200×].

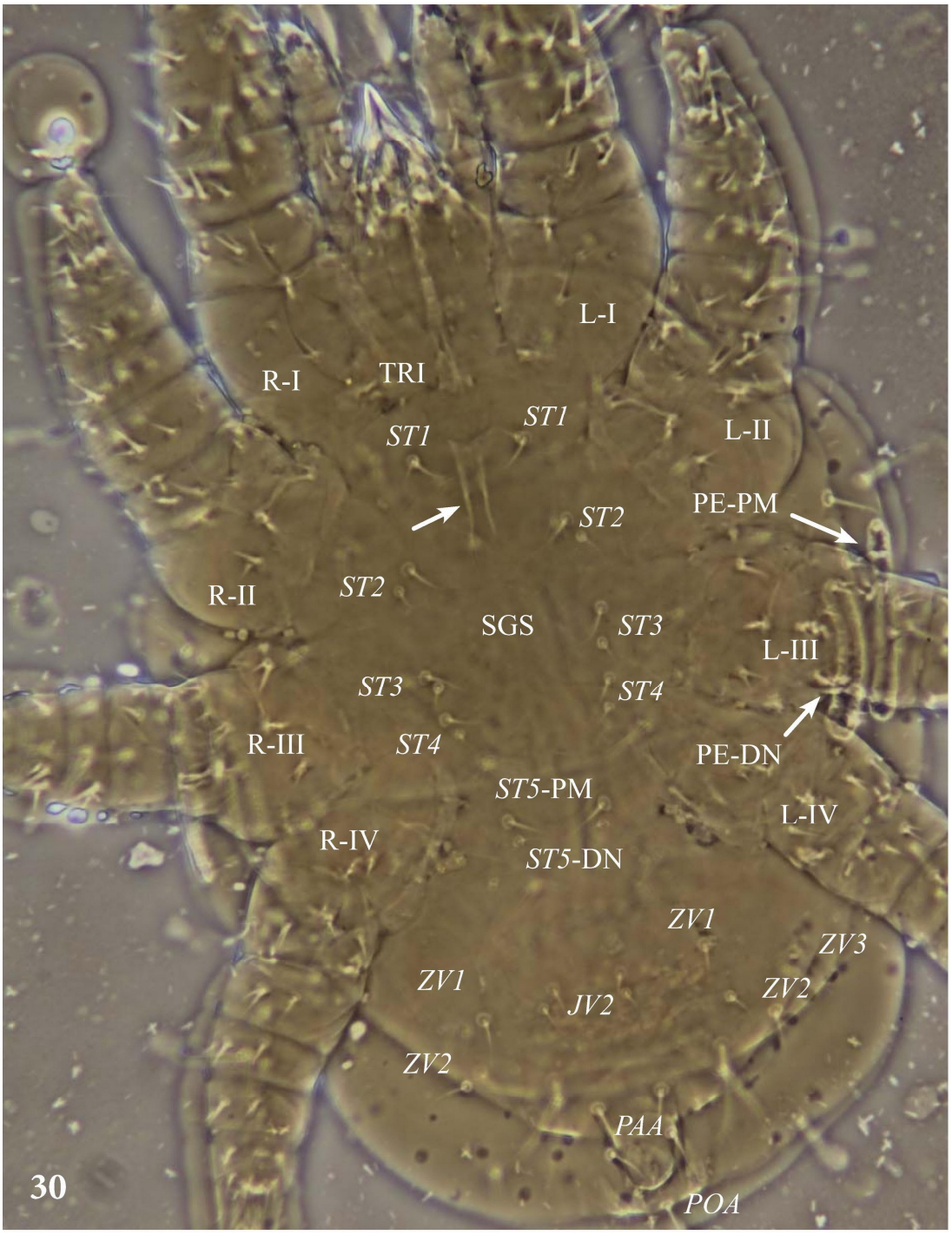


Figure 30. *Hemipteroseius indicus* (OSAL 0104177, TC, slide #7, pharate male inside a deutonymph #1-7, ventral) – Podosoma (PO) with duplicate sternal-genital setae *ST1*-*ST5* and tritosternum (TRI) on integument. Sternogenital shield (SGS), male genital opening, and duplicate opisthosomal setae barely seen [PE-DN = peritreme of deutonymph, PE-M = peritreme of male; original magnification = 200×].

Pygidial shield and opisthonotal shield – The term pygidial shield has been used in the larva and the protonymph and term opisthonotal shield in the deutonymph and the adult by most acarologists, including in several recent publications (Lindquist *et al*. 2009; Seeman 2012). This is the concept that has been followed in the present work.

According to one of the reviewers of PJA for this paper, the pygidial shield and the opisthonotal shield are not alternatives but are different forms of the same thing. It is not that the pygidial shield disappears and the opisthonotal shield magically appears. Term pygidial is used when the shield is relatively small and confined to the posterior part of the opisthosomal dorsum. When it gets bigger, it is called an opisthonotal shield. The difference is gradual and thus subject to interpretation.

Lindquist (pers. comm. October 2012) stated, "There is an implied distinction between the use of the terms "pygidial" and "opisthonotal". As indicated by Evans, among mesostigmatic mites, the dorsum of the larva and protonymph is generally provided with an anterior podonotal shield, one or more pairs of mesonotal scutellae, and a pygidial shield. In the deutonymph and adult, the mesonotal scutellae and pygidial shield expand and coalesce to form an opisthonotal shield (which may remain distinct or fuse with the podonotal shield). Rarely, the protonymphal condition persists throughout ontogeny, an example of paedomorphosis. Also, in some groups (families of Dermanyssoidea), the larva lacks a pygidial shield".

The term "pygidium" has been used in some oribatid mites and other arthropods for the posterior body part of the dorsum while the pygidial shield, an adjective of pygidium, has been used in acarology specifically for this posterior shield of larva and the protonymph in the Mesostigmata (Krantz *in* Krantz and Walter, ed., 2009: 37; Seeman, 2012). Evans and Till (1965: 262–264) discussed and illustrated the ontogenetic development of the sclerotization of the dorsum of the idiosoma in the free-living and nest-inhabiting dermanyssid representing the facultative ectoparasites of Gamasina in which this follows a definite and constant pattern. In a few larvae examined, they found only the anteriorly located shield called the podonotal shield and not the posteriorly located shield. At the protonymphal stage, they always found both anteriorly located large podonotal shield and a posteriorly located small pygidial shield. They also found variable numbers of mesonotal scutellae on soft cuticle of the protonymphal stage present in between the podonotal shield and the pygidial shield. They assumed 3 steps in this process: (a) First, these scutellae coalesced at the deutonymphal stage, presumably the mesonotal scutellae uniting with the pygidial shield, resulting in the formation of a single opisthonotal shield. Thus, having 2 dorsal shields in some protonymphs (with sternal shield having *ST1-ST3*). (b) Second, this opisthonotal shield, fusing with the podonotal shield except at its lateral margins and, thus, forming a single, large dorsal shield having lateral incisions and covering, most of dorsum in some deutonymphs (with sternal shield having *ST1-ST4* and absent genital shield). (c) Third, finally, the pair of lateral incisions disappear forming a single, very large dorsal shield without lateral incisions in the adult stage (with sternal shield having *ST1-ST3* and genital shield). They indicated further that in genus *Liponyssoides* (Dermanyssidae) the extremely small pygidial shield is either retained by the deutonymph and female as a separate scute or fused with the remainder of the dorsal shield whilst in *Dermanyssus* (Dermanyssidae) the pygidial shield is lacking (Evans and Till 1965: 262–264, Fig. 7). Thus, since the work of Evans and Till (1965), use of terms podonotal shield, pygidial shield, and mesonotal scutellae have been followed for larvae, protonymphs, and deutonymphs, as applied, by many subsequent acarologists. Similar to above, some excellent figures are provided for the ontogenetic development of *Gaeolaelaps aculeifer* (Laelapidae) by Lindquist *et al*. (2009: 168).

It should be noted that the pair of mesonotal sclerites are present in the larva and the protonymph, but not in the deutonymph, of *H. indicus* and *H. womersleyi* but are absent in the larva and the protonymph of *N. duplicisetus.* Thus, scutellae are species specific features. In addition, although the pygidial shield is commonly seen in the larva, it may not be discernible in some specimens of same species in some populations as observed in the present work.

The case of adult *Noctuiseius treati* is very interesting in relation to the opisthonotal shield which is very small, similar to the pygidial shield of the larva and the protonymph, but having 2 pairs of setae on it (*J5* and *Z5*) as in the protonymph and the deutonymph of this species (Prasad, 1968 and 1969). In this species, there is paedomorphosis in which the immature stage morphology of the

protonymph and the deutonymph is present in the adult stage. Thus, other than paedomorphosis of *N. treati*, sexual dimorphism of *P. pholusis* is also present in the mites of subfamily Otopheidomeninae that infest Noctuidae and Sphingidae. These conditions are not known in other subfamilies of Otopheidomeninae.

(i) Setae on dorsal shields and central integument – As stated before, the podonotal shield, opisthonotal shield, or the dorsal shield are considered present in the protonymph, deutonymph and the adult. Following patterns of setae are evident on these shields:

(1) There are 9 pairs of setae on the podonotal shield (*j1*, *j3*, *j4*, *j5*, *j6*, *z2*, *z4*, *z5*, and *s4*) in the larva, the protonymph, the deutonymph, and the female-male (including the pharate female-male). This pattern is present in *H. adleri, H. indicus, H. womersleyi,* and *Nabiseius duplicisetus* all of which parasitize hemipterous insects that have smooth abdominal-thoracic surface.

(2) There are 9 pairs of setae on the podonotal shield in the larva as above but there are 10 pairs of setae in the protonymph, the deutonymph, and the female-male of *Noctuiseius treati*. This species infests noctuid insects that have very hairy abdominal-thoracic surface. In this case, seta *s6* (which is absent in larva) is added on the podonotal shield of the protonymph which is carried to the deutonymph and to the female-male. Note that seta *s6* is located on the integument of the protonymph, the deutonymph, and the adult in *H. adleri, H. indicus, H. womersleyi,* and *Nabiseius duplicisetus* but it is present on the podonotal shield of the protonymph, the deutonymph, and the adult in *Noctuiseius treati* indicating migration of this seta from the integument to the podonotal shield of the protonymph.

(3) Setae *J1* are present on the integument of the protonymph but present on the opisthonotal shield of the deutonymph and the adult of *H. womersleyi* and *Nabiseius duplicisetus.* Contrary to this, setae *J1* are absent in all stages of *H. adleri, H. indicus,* and *Noctuiseius treati.*

(4) Setae *J2* are present on the integument of the protonymph of 5 species: *H. adleri, H. indicus, H. womersleyi, Nabiseius duplicisetus,* and *Noctuiseius treati.*

(5) Setae *J2* are present on the opisthonotal shield of only 4 species: *H. adleri, H. indicus, H. womersleyi,* and *Nabiseius duplicisetus.*

(6) Unusually, setae *J2* are present on the integument of the protonymph, the deutonymph, and the adult of *Noctuiseius treati.* Thus, seta *J1* is a variable seta, which may be present or absent in different stages, but seta *J2* is always present either on the integument or the opisthonotal shield.

(7) Seta *J1* is absent but *J2* always present on the dorsal shield in the adult females of 8 species of *Prasadiseius* (*achlora, aporodes, cocytes, donahuei, incanus, indicus, kayosiekeri,* and *pholusis*).

(8) Uniquely, in *P. pholusis* which has the dimorphism of the dorsal shield being single in the female but 2 separate shields in the male*,* seta *J2* is present on the dorsal shield of the female but it is present on the dorsal integument of the opisthosoma in the male.

(9) Another dimorphism is present in *P. incanus* in which seta *J2* is present on the dorsal shield in the female but absent on this shield in the male (Prasad *et al*. 2011) indicating that, similar to *J1*, seta *J2* is also a variable seta in the Otopheidomenidae.

(ii) Setae on pygidial shield - As stated before, pygidial shield is considered present in the larva and the protonymph. It may be lightly sclerotized and not discernible in some larvae but clearly seen in other larvae and the protonymphs. Following patterns of setae are evident on this shield in the larvae: (1) No setae evident (*Nabiseius duplicisetus, Noctuiseius treati,* and *Prasadiseius cocytes*). (2) One pair present - Possibly *Z4* but referred to as *Z3* by Evans, 1963 (*H. indicus* and *H. womersleyi*). (3) Two pairs present - *J5* and possibly *Z4* (*H. adleri*).

Following patterns of setae are seen on the pygidial shield in the protonymphs: (1) Two pairs present; *J5* and possibly *Z4* or *Z5* (*N. treati* and *Prasadiseius cocytes*) - Both infesting Lepidoptera. (2) Three pairs present; *J5, Z4,* and *Z5*; later 2 referred to as *Z3* and *S5* by Evans, 1963, (*H. adleri, H. indicus, H. womersleyi,* and *Nabiseius duplicisetus*) - all infesting Hemiptera.

Ventral seta *ST5* or *JV1* – Pair of genital seta *ST5* are present on integument beside and very close to the lateral margin of the genital shield in the female of *H. indicus* (Fig. 23). These are absent

in larva (Fig. 4) and present as minute setae on integument of the protonymph (Fig. 14) but as long, similar to that of female, on integument of the deutonymph (Fig. 19). The question is if these are pair of *JV1,* and not *ST5,* as former (*JV1*) are absent in the female as anteriormost opisthosomal setal pair is considered *ZV1* by the present author (Fig. 23). This interpretation will change if these are considered *JV1* and not *ZV1.* Evans and Till (1965) indicated absence of genital setae (*ST5*) and presence of *JV1* in larva but presence of genital setae (*ST5*) and *JV1* in protonymph and deutonymph of *Hypoaspis* (*Gaeolaelaps*) *aculifer* and *Ornithonyssus bacoti* (Gamasina). Prasad (2012) described immature stages of *Prasadiseius cocytes* and indicated presence of *ST5* and *JV1* in larva, protonymph, and deutonymph, as present in female and male in which *JV2* is absent (Prasad, 2011d). But, Lindquist (pers. comm., June 2011) indicated that these are *JV1* and *JV2,* respectively.

Rate of increase in length and width in the dorsal shields between different stages – This kind of study has not been done in the Otopheidomenidae and is worth examining which may be of benefit for future studies. Looking at the measurements given in Table 1, followings are evident:

(a) Podonotal shield – (1) The increase in the length of this shield from the larva (148) to the protonymph (154) was slight (+ 6 µm). This length decreased (− 14 µm) from the protonymph (154) to the deutonymph (140) the reason for which is not clear. Measurements of more specimens may be necessary to confirm this finding. Comparing the length from the deutonymph (140) to the female (146), small increase (+ 6 µm) is noted. (2) Comparing the width of this podonotal shield, it is evident that increase from the larva (124) to the protonymph (138) was more than twice (+ 14 µm) than increase in the length (+ 6 µm). Similar trend of more increase in the width from protonymph (138) to the deutonymph (148) and to the adult female (177) than the length of these stages discussed above. This indicates that there was a large increase in the width (+ 29 µm) of the podonotal shield than increase in the length (+ 6 µm) from the deutonymph to the female.

(b) Opisthonotal shield – (1) The increase in the length of this shield from the deutonymph (97) to the adult female (125) was also large (+ 28 µm). But, increase in the width of this shield from the deutonymph (138) to the adult female (179) was much more (+ 41 µm) than increase in the length (+ 28 µm) indicating rate of increase in width much more than the length of the opisthonotal shield. Same trend also seen in the increase of the podonotal shield but less than the opisthonotal shield.

The significant difference in the increase of the dorsal shields may be due to increased feeding of the deutonymph than the larva or the protonymph.

Rate of increase in the length of dorsal setae in different stages - Looking at the measurements for all dorsal idiosomal setae given in Table 1, followings are evident: (1) Average increase in the length of these setae from the larva to the protonymph was 3 µm and increase from the protonymph to the deutonymph was also 3 µm. (2) But, there was a large increase of 6 µm from the deutonymph to the adult. This significant difference may be due to increased feeding of the deutonymph than the larva or the protonymph.

Rate of increase in transverse and vertical distances of setal pairs on dorsal shields between different stages – Looking at the measurements given in Table 2, following are evident: (1) Transverse distance - Average increase in the transverse distance from larva to the protonymph was 5 µm, protonymph to deutonymph was 4 µm, and deutonymph to adult female was 10 µm. This indicates that the rate of growth in the transverse distance from larva to the protonymph was almost same (4-5 µm) but from the deutonymph to adult female was more than twice (10 µm) than in the larva or the protonymph. This increase, again, may be due to increased feeding of the deutonymph than the larva or the protonymph. (2) Vertical distance - Average increase in the vertical distance from larva to the protonymph was 3 µm, protonymph to deutonymph was 4 µm, and deutonymph to adult female was 10 µm, all almost being same as the increase in the transverse distance. This indicates that the rate of growth in the transverse distance from larva to the adult female was almost same (4–10 µm) as the rate of growth in the vertical distance (3–10 µm).

Rate of increase in ventral setae in different stages – As seen in Table 3, following are evident: (1) Length of sternal setae - Rate of increase in setae *ST1-ST3* from larva to deutonymph is very little (1-3 μm) but much more (11-15 μm) from the deutonymph to the adult female. (2) Transverse distance between sternal setal pairs - Rate of increase between *ST1-ST1* from larva to protonymph is much less (3 μm) than from protonymph to deutonymph (8 μm) and from deutonymph to adult female (14 μm). This rate of increase between *ST2-ST2* from larva to protonymph is much less (8 μm) than from protonymph to deutonymph (12 μm) but almost no increase from deutonymph to adult female (11 μm). This rate of increase between *ST3-ST3* from larva to protonymph is much less (10 μm) than from protonymph to deutonymph (14 μm) and from deutonymph to adult female (39 μm). Thus, increase in the transverse distance between *ST3-ST3* from deutonymph to adult female is the greatest of all (39 μm). (3) Vertical distance between sternal setal pairs - Rate of increase from larva to adult female between *ST1-ST2* (from 34–35 μm) is almost none (0–1 μm) and *ST2-ST3* (from 29–-32 μm) is none to very little (0–3 μm). These results indicate that the increase in the transverse distance, indicating the width between the paired setae, is much more than the vertical distance, indicating the length between the paired setae. These data are very similar to measurements of the podonotal and opisthonotal shields that indicate also that the width of these shields increase much more than the length of these shields.

Rate of increase in the peritreme in between different stages – As shown in Table 3, peritreme is absent in larva and is very small in the protonymph (24 μm) which becomes large in the deutonymph (69 μm) and remains of almost same length in the adult female (68 μm). This indicates great increase in length of peritreme from the protonymph to the deutonymph (45 μm). This increase may be related to the increase of the body size from increased rate of feeding requiring increased rate of respiration.

Pharatism – It is a condition in which a mite (or an insect) will have completed the metamorphosis or transformation from the larva to the protonymph and then to the deutonymph (or pupa of the insect) having the adult stage within its body. Thus, this deutonymph will have duplicate setae, duplicate peritremes, and duplicate other features of both the deutonymph and the adult. Once this adult emerges, it leaves the molt or exuvia of the deutonymph behind.

Many species of insects and some species of mites diapause during the deutonymphal or the pupal phase, often to avoid unsuitable environmental conditions. Once the condition is suitable, the pharate female or male emerges or ecloses from the deutonymphal stage for feeding and reproduction.

Evans (1963), noting absence of deutonymphs but protonymphs having characteristics of the males in his series of *Hemipteroseius womersleyi,* suggested that the deutonymphal stage may be suppressed in the development of the males. Treat (1965) mentioned presence of a pharate male in the deutonymphal cuticle of a *Hemipteroseius indicus* he had received (as *Treatia indica* Krantz and Khot, 1962) from Dr. G.W. Krantz. He also reported a pharate male in a protonymphal cuticle of noctuid ear infesting true ectoparasitic mite *Dicrocheles phalaenodectes* Treat, 1954 (described as *Myrmonyssus phalaenodectes,* Laelapidae) indicating suppression of the deutonymphal stage in the males. In addition, Treat (1965) also reported presence of a pharate protonymph in *Treatia dysderci* Evans, 1963, he collected from *Dysdercus discolor.* Neither Krantz and Khot (1962), nor Costa (1968), or Menon *et al.* (2011) reported this condition in their many specimens of *Hemipteroseius indicus* collected from different countries.

In the present study, both pharate female and pharate male inside the deutonymphs along with the normal protonymphs, normal deutonymphs, and normal females and males were observed in *H. indicus*. Treat (1965) had similar observation of having a pharate male in this species. Thus, the deutonymphal stage may or may not be suppressed. If suppressed, must have some reasons to do so. No detail study on this aspect of a large population of this or other species of Otopheidomenidae is done and may be required to answer this question. The other question about this stage is if there is an increased rate of pharatism in other species of Otopheidomenidae, especially those that infest the

lepidopterous insects in families Noctuidae and Sphingidae. It is clear from the present study that this condition is not as prevalent in the species that infest the hemipterous insects.

CONCLUSIONS

Immature stages of only a few species of Otopheidomenidae are reported in published literatures. Therefore, it is not possible to reach any conclusion about the evolutionary or phylogenetic relationships between different genera and species within each genus. Therefore, future studies are needed.

The condition of pharatism is present in the female and male of *Hemipteroseius indicus*. It is not possible to state with certainty if these truly represent pharatism or simple case of a developing female and male inside the cuticles of the nymphs ready to emerge from the respective molts when fully grown. No larvae or protonymphs with the duplicate setae have been reported before or found in the present study of *H. indicus*. Study of more motile immature stages of this and other species may be necessary to answer this question. Many cases of adult male waiting near the molting deutonymphs are known in the Phytoseiidae. It is possible that such adult males may be recognizing the pharate females or the molting females and waiting for emergence from the cuticle to fertilize the female.

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توصیف مراحل نابالغ متحرک *Hemipteroseius indicus* (Krantz & Khot) (Acari: Otopheidomenidae)

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چکیده

لارو، پوره‌های سن یکم و دوم *Hemipteroseius indicus* (Krantz & Khot, 1962) از نمونه‌های جمع‌آوری شده از روی سن سرخ پنبه، *Dysdercus* sp. (Hemiptera: Pyrrhocoridae) در هند و جمهوری دمکراتیک کنگو توصیف شدند. ویژگی‌های این مراحل با کنهٔ ماده بالغ مقایسه شدند. افزون بر این، کتوتاکسی کامل سطوح پشتی و شکمی ایدیوزوما و برخی جزییات گناتوزوما و پاها ارایه شده است. ویژگی‌های این گونه با *Hemipteroseius adleri*، *H. womersleyi*، *Nabiseius duplicisetus*، *Noctuiseius treati* و *Prasadiseius cocytes* به عنوان نمایندگان چهار جنس و شش گونه Otopheidomenidae از مقایسه شدند. پنج جدول و شمار زیادی از تصاویر رنگی با جزییات، شامل مادهٔ فاریت و نر فاریت آورده شده است.

واژگان کلیدی: مراحل نابالغ؛ میان‌استیگمایان؛ متحرک؛ فاریت؛ Pyrrhocoridae ؛ سن سرخ پنبه.

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