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Article

Hemipteroseius vikrami Menon: a junior synonym of *H. indicus* (Krantz & Khot) (Acari: Otopheidomenidae) with comments on the sigilla of the dorsal shield

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ABSTRACT

Hemipteroseius vikrami Menon, 2011 (Acari: Otopheidomenidae: Treatinae) has been considered a junior synonym of *Hemipteroseius indicus* (Krantz & Khot, 1962). Both species were described from India from the red cotton bugs *Dysdercus koenigii* (F.) and *Dysdercus cingulatus* (F.), the latter is widely distributed in India and some other countries. The sigilla of the podonotum and opisthonotum are also described for the first time in this mite.

KEY WORDS: Otopheidomenidae; Pyrrhocoridae; red cotton bugs; sigilla; Treatiinae.

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INTRODUCTION

Hemipteroseius vikrami Menon (Acari: Otopheidomeninae: Treatiinae) was described from specimens collected from *Dysdercus koenigii* (F.) in New Delhi and from *Dysdercus cingulatus* (F.) in Varanasi, India (Menon *et al.* 2011). Both hosts belong to the true bugs of the family Pyrrhocoridae (Hemiptera). The former is commonly known as the red cotton stainer and latter as the red cotton bug. Sometimes, both species have been called as the red cotton bug.

Krantz and Khot (1962) described *Treatia indica* collected from the red cotton bug, *D. cingulatus* (F.), in New Delhi, India. Evans (1963) described the new genus *Hemipteroseius* having palpal chaetotaxy in adults as 1-3-0-8-12 which represented the setae from trochanter to tarsus and differentiated it from *Treatia* Krantz and Khot which has the palpal chaetotaxy in adults as 2-5-6-14-15. He transferred *Treatia indica* to his new genus as *Hemipteroseius indicus* (Krantz & Khot). In addition, he mentioned that the palp genu of *Hemipteroseius* is usually without setae (and at most may have a single seta indicating variation) and genu and tibia of leg I each have only 6 or 7 setae. In comparison, palp genu of *Treatia* has 6 setae and genu and tibia of leg I each have 10 setae. Both genera parasitize species of the family Pyrrhocoridae.

Treat (1965) described the following 4 species in the genus *Hemipteroseius* as: *H. ageneius, H. antilleus, H. parvulus,* and *H. sabbaticus.* These mites were collected from different species of Pyrrhocoridae [*Dysdercus: D. andreae* (L.), *D. discolor* Walker = *D. howardi* Ballou, *D. mimulus* Hussey, *D. mimus* (Say), and *splendidus* Distant = *D. concinnus* Stal] that were collected in Antigua, Cuba, Culebra, Guadeloupe, Haiti, Jamaica, Martinique, Mexico, Mona Island, Panama, and Puerto Rico and deposited in the collection of the American Museum of Natural History, New York. He also collected *Hemipteroseius indicus* from 3 specimens of *Dysdercus* (species undetermined) collected in Faradje, a town in the Haut-Uele district, in Democratic Republic of Congo (DRC). In addition, he reported one specimen of *Dysdercus* (species undetermined) collected in Thysville, DRC. Costa (1968) described a new species, *Hemipteroseius adleri,* parasitic on *Pyrrhocoris apterus* (L.) and *Scanthius* [*sic* for *Scantius*] *aegyptius* (L.) (both Hemiptera: Pyrrhocoridae) in Israel. He also collected *Hemipteroseius indicus* in Israel from a new insect host *Caenocoris nerii* Germ. (Hemiptera: Lygaeidae). Thus, *Hemipteroseius indicus* is known from Democratic Republic of Congo, India, and Israel on different hosts, mostly belonging to Pyrrhocoridae. Treat (1965) and Costa (1968) mentioned extensive variation in the morphological structures of *Hemipteroseius* in different species. Former author clearly mentioned these variations in certain setae present even in the individual members of the same colony, and even to the opposite sides of the same mite. The latter author presented these variations extensively as Evans (1963) discussed. Prasad (1975) reported *H. indicus* on *Dysdercus koenigii* infesting cotton and hollyhock plants in Ludhiana, Punjab state, India. Shahi and Krishna (1981) reported *H. indicus* effectively reducing the nymphal and adult population of *Dysdercus koenigii* infesting cotton plants in India.

Menon *et al.* (2011) mentioned some of the above variations in their new species *Hemipteroseius vikrami.* They described their species as new, however without studying the type specimens of *Hemipteroseius indicus*, described originally also from New Delhi*,* and, without giving the species specific diagnostic features. In their key to different species of *Hemipteroseius*, they separated the above two species on the basis of two characters as follow: (1) All dorsal setae simple and macrosetae of legs spine-like in *H. indicus* but dorsal setae j6, s6, and Z5, and (2) all macrosetae of legs having spatulate or bulbose endings in *H. vikrami*. In the remarks, they mentioned separating these two species using those two species specific features but also using some features of the subfamily Treatiinae, genus *Hemipteroseius*, and its other species, some given by Zhang (1995).

As Menon *et al.* (2011) had not studied the types of *H. indicus,* the present author studied all of the holotype and paratype specimens of *H. vikrami* from Dr. Menon and several type and non-type specimens of *H. indicus* borrowed from the Museum of Biological Diversity, The Ohio State University, Columbus. In additions, some specimens from the Philippines and many from Ludhiana (Punjab state, India), where this author (Prasad 1975) had studied the biology of *H. indicus*. Other specimens of this species collected in May 2013 and July 2014 on the campus of Bidhan Chandra Krishi Viswavidyalaya (BCKV), Kalyani, West Bengal, from *Dysdercus cingulatus* and sent to the author of the present paper by Dr. K. Karmakar, were also studied. The results of this study are presented in this paper which indicates that *H. vikrami* is the junior synonym of *H. indicus.*

MATERIAL AND METHODS

The details of the specimens of *H. indicus* studies from different collections are as follow:

- (A) From the Museum of Biological Diversity, The Ohio State University, 1315 Kinnear Road, Columbus, OH 43212, USA (borrowed in February 2014 and returned in March 2014): **Slide #1** - *Treatia indica* from *Dysdercus cingulatus,* PARATYPE, AL#2153, deposited in the Acarology Collection (then Institute of Acarology, Wooster, Ohio), The Ohio State University, Columbus, Ohio, USA, by Dr. G. W. Krantz.

Following slides # 2–7 are from "Treat Collection" marked as paratypes and located in the Museum of Biological Diversity, The Ohio State University, Columbus with the following details: **Slide #2** (OSAL, #0104178) - *Treatia indica* from *Dysdercus cingulatus*. **Slide #3** (OSAL, #0104179) - *Treatia indica* from *Dysdercus cingulatus.* **Slide #4** (OSAL, #0104180) - *Treatia indica* from *Dysdercus cingulatus*. **Slide #5** (OSAL, #0104169) - *Hemipteroseius indicus* from Thysville, Congo, June 3, 1915. **Slide #6** (OSAL, #0104170) - *Hemipteroseius indicus* from Faradje, Congo. **Slide #7** (OSAL, #0104177) - *Hemipteroseius indicus* from a pyrrhocorid from Faradje, Congo.

- **(B)** The holotype female and 10 paratype females and 3 paratype males of *Hemipteroseius vikrami* from *Dysdercus cingulatus* on 7 microscopic slide preparations (slides #1-7), collected on December 15, 2009 in Varanasi, India were examined. In addition, 2 paratype females from

Dysdercus koenigii on 2 microscopic slide preparations (slides #8-9), collected on December 5, 2007 in New Delhi, India were also studied. These were sent to this author by Dr. P. Menon, Division of Entomology, Indian Agricultural Research Institute, New Delhi 110012, India. All specimens were returned in March 2014 to Dr. V.V. Ramamurthy, in charge of National Pusa Collection, Division of Entomology, Indian Agricultural Research Institute, New Delhi 110012, India, keeping slide #8 in this author's collection. The study of these 9 slides is as follow: **Slide #1** - With 1 male, 4 eggs, 1 larva, and 1 deutonymph. **Slide #2** - With 1 female, 1 male, and 1 larva. **Slide #3** - With 1 female (holotype). **Slide #4** - With 1 female. **Slide #5** - With 1 female and 1 egg. **Slide #6** - With 1 female, 1 male, and 1 nymph. **Slide #7** - With 1 female, 2 protonymphs, and 2 deutonymphs. **Slide #8** - With 8 females, 1 male, 6 eggs, 1 protonymph, and 2 deutonymphs. **Slide #9** - With 1 female.

- (C) From the specimens in this author's collection as follow: Several slides with many females, males, and immature stages collected by this author from the red cotton bugs, *Dysdercus koenigii* (F.), feeding on the cotton and hollyhock plants in Ludhiana (Punjab state), India, during 1974 (VP74-43, VP74-54, VP74-63). In addition: 2 slides with 16 females and 3 eggs collected by unidentified collector from the red cotton bug in July 1974 in Jorhat (Assam state), India, identified by this author in 1974 (VP74-69); several slides with females collected from the red cotton bugs, *Dysdercus koenigii* (F.), feeding on the cotton plants, in Kalyani (West Bengal state), India, during May 2013, and sent to this author by Dr. K. Karmakar, BCKV, Kalyani 741235; and 1 slide with 1 female collected in Luzon, Philippines from the red cotton bug, *Dysdercus cingulatus,* in April 1981, identified in 1984 by Dr. L. Corpuz-Raros and sent to the present author.

The above mites were examined under 100× using a Accu-Scope 3000 phase-contrast microscope (Accu-Scope, New York, USA) to locate the mites on the slides and then under 200×-400×, or 1000× under the oil immersion lens as necessary, to study the details. Photographs were taken using a Canon™ EOS 550D (Canon USA Inc., Melville, NY 11747, USA) camera after mounting on the microscope and saved in Photoshop CS5™ (Adobe Systems Inc., San Jose, CA 95110-2704, USA). The photographs were placed in InDesign™ (Adobe Inc.) program to label the structures. The original magnification of the photos was 200-400x 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.

RESULTS

From the study of many females and some males from different collections and locations mentioned in the Material and Methods and shown in different figures (Figs. 1–6: *H. vikrami* and Figs. 7–14: *H. indicus*), followings are evident.

Dorsal idiosoma, shields, and setae – As seen in Figs. 1–4 and 6, the idiosoma is almost entirely covered by 2 separate and sculptured dorsal shields: a shield-shaped podonotal shield (PS) with anteriorly located large bi-lateral incision or cleavage (CLE) between setae z2 and *z4* and 9 pairs of setae: *j1*, *j3*, *j4*, *j5*, *j6*, *z2*, *z4*, *z5*, and s4. Posterior to this shield, a rectangular opisthonotal shield (OS) with minor lateral indentations and 4 pairs of setae: *J2*, *J5*, *Z4*, and *Z5*, are present. Two pairs of setae *r3* and *s6* are present on integument beside the podonotal shield and 1 pair of setae *R1* are present on integument beside the opisthonotal shield. Thus, 16 pairs of setae are seen on the dorsal idiosoma of which 13 pairs are on both the shields and 3 pairs are on the integument. Of these setae, *J5* are minute and *Z5* are the longest of all. Seta *s6* is on the integument, and is almost always, located in between and lateral to podonotal shield and opisthonotal shield. A short peritreme (PE) is present along the left and right margin and is usually located lateral to setae *r3* and *s6* and under leg III. Under high magnification, the tips of setae *j6* and *Z5* can be seen having hyaline knobs which, occasionally, may not be seen clearly.

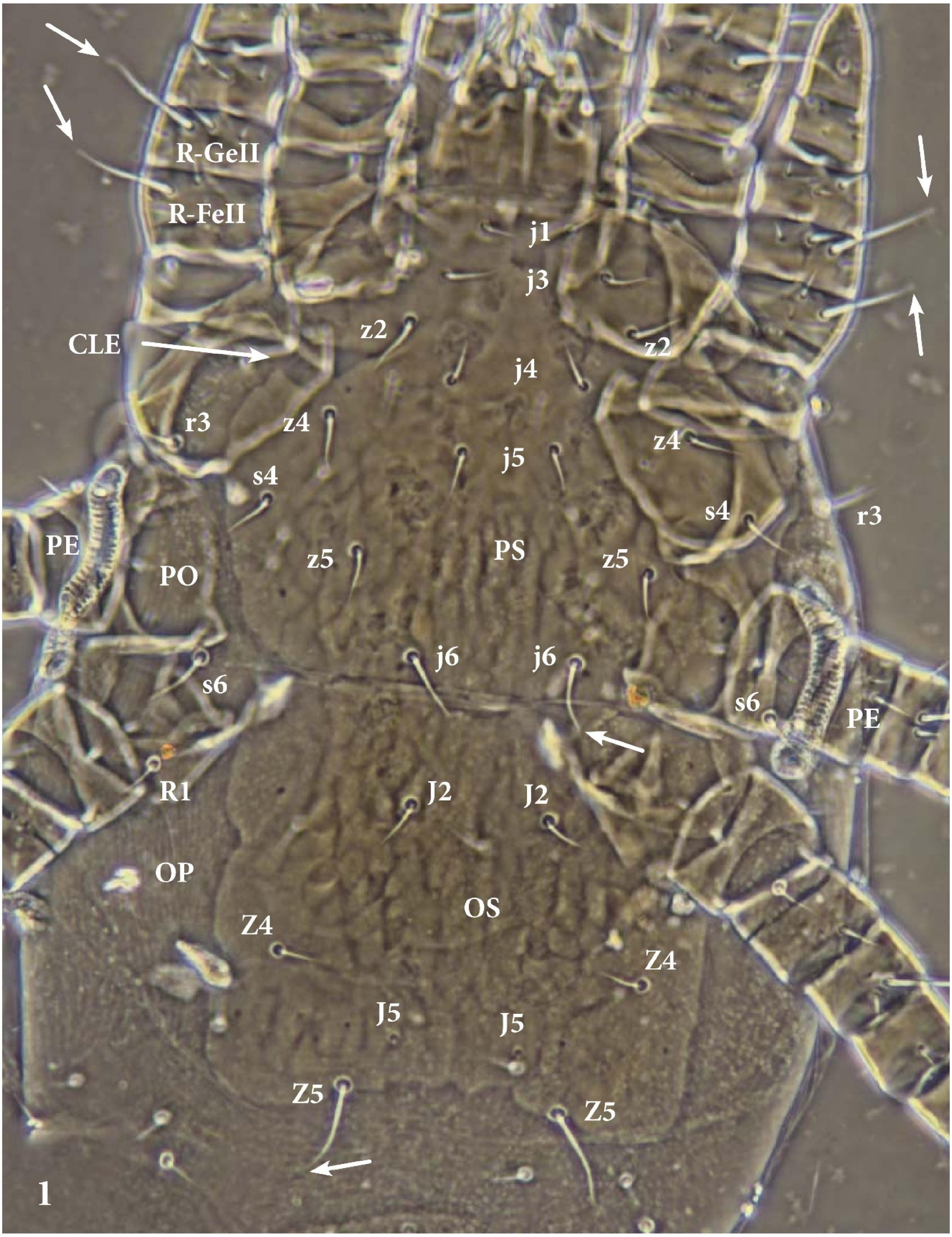


Figure 1. *Hemipteroseius vikrami* (female, slide #6 - Menon) – Macrosetae of femur and genu of left and right legs II seen with distinct knobbs even in this low magnification. Setae j6 and Z5 with barely showing knob on each but not seen on s6 even in high magnification [CLE = cleavage, OS = opisthonotal shield, PE = peritreme, PS = podonotal shield; original magnification = 200×].

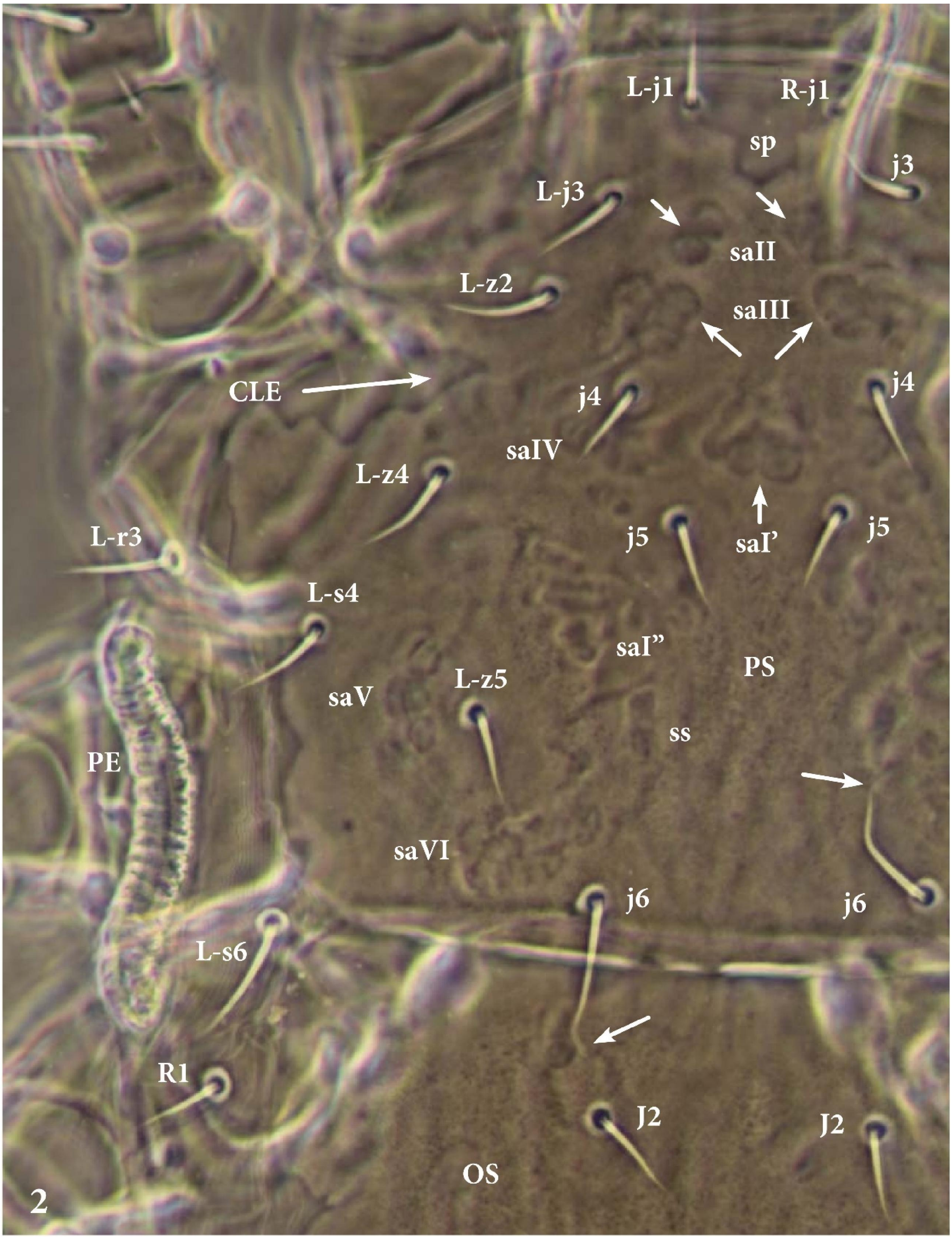
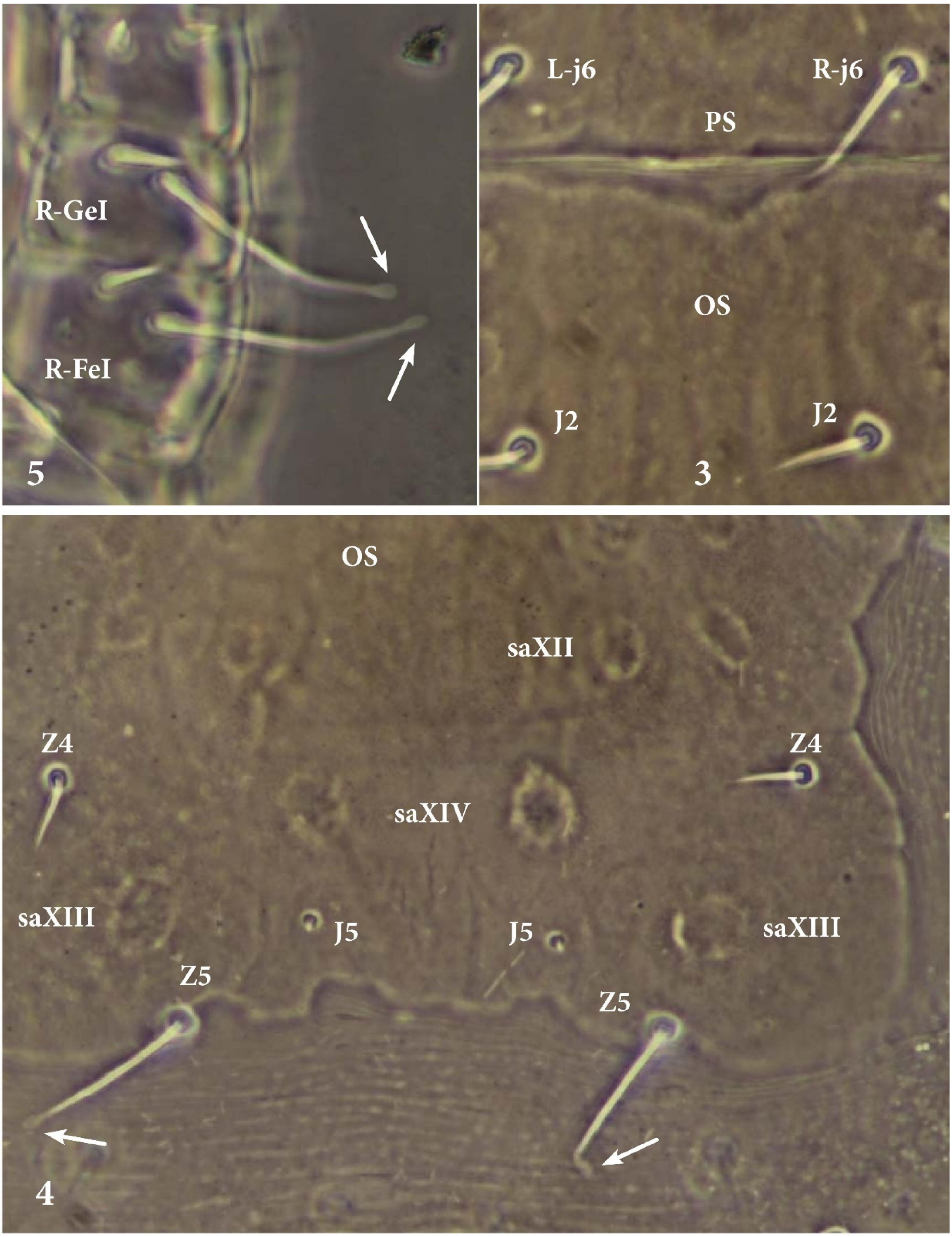


Figure 2. *Hemipteroseius vikrami* (female, slide #3 - Menon) – Setae j6 and s6 with barely showing knob on each. Sigilla sp, saI', saI", saII, saIII, saIV, saV, saVI also seen on podonotal shield [CLE = cleavage, OS = opisthonotal shield, PE = peritreme, PS = podonotal shield; original magnification = 400×].

Sigilla on dorsal shields – As seen in Figs. 2, 4, and 6, the podonotal shield (PS) has following 9 pairs of sigilla (all in pair except saI' but counted as a pair): sp in between *j1*, saI' in between *j4*, saI" posterolateral to *j5*, ss medial to *z5*, saII posteromedial to *j3*, saIII medial to *z2*, saIV posterior to *j4*, saV lateral to *z5*, and saVI posterior to *z5*. Of these, 4 pairs of sigilla saV, saVI, ss, and saI" surround seta *z5*. In comparison to above, the opisthonotal shield (OS) has following 7 pairs of sigilla (all in pair): The landmark sigilla sg is located anterior to *J2* just posterior to anterior margin of opisthonotal shield (Fig. 6). Others as saIX and saX located lateral to *J2*, saXI and saXII posterior to *J2*, saXIII lateral to *Z5*, and saXIV anterior to *J5*.



Figures 3–5. *Hemipteroseius vikrami*– 3. Right seta j6 with barely showing knob (female, slide #2 - Menon); 4. Setae Z5 showing knobbs. Sigilla saXII-saXIV also seen (female, slide #2 - Menon); 5. Femur and genu of right leg I (R-FeI and R-GeI) with knobbed macrosetae (male, slide #1 - Menon) [OS = opisthonotal shield, PS = podonotal shield; original magnification = 400×].

Legs – Legs I–IV are seen having a long macroseta on each femur and genu. Even at low magnification, they show a hyaline knobbed tip. These are also seen clearly on leg I in the enlarged view (Fig. 5, male).

As mentioned above for *H. vikrami* (Figs. 1–6), these characteristics are also seen in mites identified as *H. indicus* (Figs. 7–14). The ventral idiosomal, gnathosomal, and leg details are also similar. Thus, both species have the same species specific characteristics and no other differences were found to distinguish them from each other.

DISCUSSION AND CONCLUSION

Dorsal shield – The dorsal shield (DS) consists of a single plate in 3 species of *Hemipteroseius: H. ageneius* Treat, 1965; *H. parvulus* Treat, 1965; and *H. sabbaticus* Treat, 1965. It is divided into 2 separate shields as podonotal shield (PS) and opisthonotal shield (OS) in 5 species of this genus: *H. adleri* Costa, 1968; *H. antilleus* Treat, 1965; *H. indicus* (Krantz and Khot, 1962); *H. vikrami* Menon, 2011; and *H. womersleyi* Evans, 1963. In addition to above, each side of the podonotal shield in adults has an incision leading to a deep cleavage anterolaterally in between z2 and z4. Krantz and Khot (1962: 536, Fig. 2: 539) clearly illustrated these and mentioned in the description of their new species. Menon *et al.* (2011) illustrated and described these in the description of *H. vikrami.* These 2 characteristics of the dorsal shields are not significantly different in *H. indicus* and *H. vikrami*.

In Phytoseiidae, the presence of single dorsal shield and its division into 2 separate podonotal and opisthonotal shields is only known to occur in *Macroseius biscutatus* Chant, Denmark, and Baker, 1959 and is considered to be a characteristic used to separate the tribe Macroseiini from other tribes. Denmark and Evans (2011) considered the feature of divided dorsal shield into 2 separate shields as a subfamily characteristic (e.g. Macroseiinae Denmark and Evans, 2011: 40, 287). Chant and McMurtry (2003b) considered presence of a notch or incision on lateral margin of the dorsal shield at level of seta s4 a subtribe characteristic (e.g. Paraphytoseiina Chant and McMurtry, 2003b: 21, 189, 211) which was accepted by Chant and McMurtry (2007: 47).

Chant and McMurtry (2006a) suggested that the separation of the podonotal and opisthonotal shields on the adults of *Macroseius biscutatus* as an example of paedomorphosis in the Amblyseiinae. Larvae, protonymphs, and some deutonymphs in Phytoseiidae have these 2 shields separated.

The examination of 8 species of *Hemipteroseius* having a single dorsal shield in 3 species [*H. ageneius* Treat; *H. parvulus* Treat; and *H. sabbaticus* Treat] and lateral incision and the presence of 2 separate dorsal shields in remaining 5 species [*H. adleri* Costa, *H. antilleus* Treat, *H. indicus* (Krantz and Khot), *H. vikrami* Menon, and *H. womersleyi* Evans], is a challenge. For now, these are considered characteristics separating 2 groups or 2 subgenera within the genus *Hemipteroseius.*

Dorsal setae – In the 5 species of *Hemipteroseius* that have 2 separate dorsal shields [*adleri* Costa, *antilleus* Treat, *indicus* (Krantz and Khot), *vikrami* Menon, and *womersleyi* Evans], the following is noted. (1) There are 16 pairs of setae on the dorsal idiosoma in 4 species: *adleri* (*JV5* is illustrated on dorsal opisthosoma in Fig. 5 of Costa, 1968: 6), *antilleus* [Treat, 1965: 3, Fig. 5: 11; setae *j6* shown absent but his description says 9 pairs of setae present on the podonotum (and 4 pairs on the opisthonotum). Therefore, *j6*, a very stable seta, is considered present], *indicus,* and *vikrami* (*JV5* is illustrated on dorsal opisthosoma in Fig. 1 of Menon *et al.*, 2011: 55). Of these 16 pairs, there are 9 pairs of setae on the podonotum: *j1*, *j3*, *j4*, *j5*, *j6*, *z2*, *z4*, *z5*, and *s4*; 4 pairs of setae on the opisthonotum: *J2*, *J5*, *Z4*, and *Z5*; and 3 pairs of setae on the integument: 2 pairs *r3* and *s6* beside the podonotal shield and 1 pair *R1* beside the opisthonotal shield. Thus, there are 13 pairs of setae (9 pairs + 4 pairs) on both the shields and 3 pairs on the integument (= 16 pairs on the dorsal idiosoma). (2) But in *womersleyi* Evans, 17 pairs of setae are illustrated (Evans, 1963, Fig. 8: 11613; additional setae J1 shown present) on the dorsal idiosoma in which there are 9 pairs of setae on the podonotum: *j1*, *j3*, *j4*, *j5*, *j6*, *z2*, *z4*, *z5*, and *s4*; 5 pairs of setae on the opisthonotum: additional J1, J2, J5, Z4, and Z5;

and 3 pairs of setae on the integument: 2 pairs (*r3* and *s6*) beside the podonotal shield and 1 pair R1 beside the opisthonotal shield. Thus, there are 14 pairs of setae (9 pairs + 5 pairs) are on both the shields and 3 pairs are on the integument (= 17 pairs on the dorsal idiosoma).

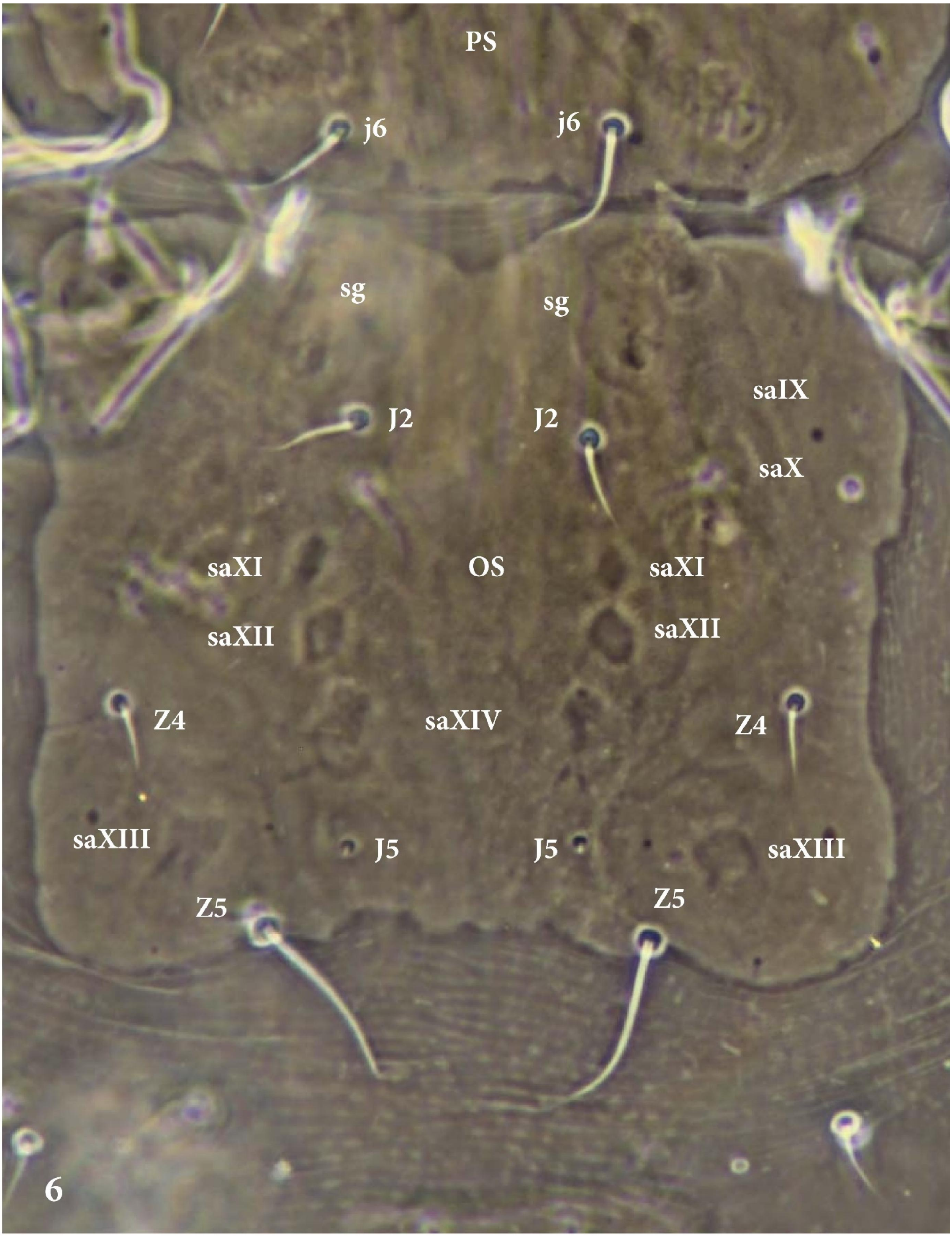
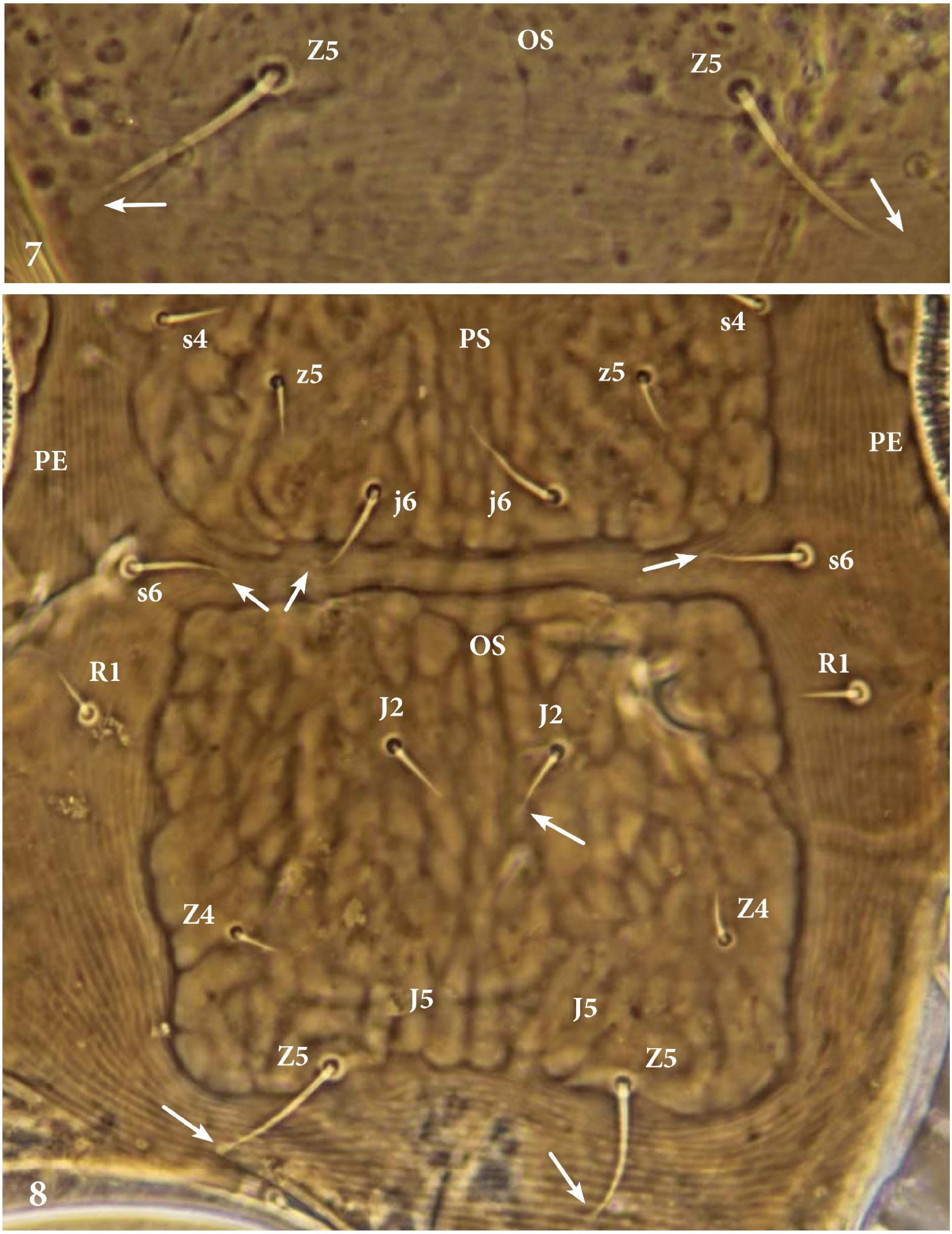


Figure 6. *Hemipteroseius vikrami* (female, slide #5 - Menon) – Sigilla sg, barely seen saIX and saX, and clearly seen saXI-saXIV. Setae j6, J2, J5, Z4, and Z5 also seen [OS = opisthonotal shield, PS = podonotal shield; original magnification = 200×].



Figures 7–8. *Hemipteroseius indicus* – 7. Setae Z5 with distinct knobb on each (female, Philippines); 8. Setae j6 and s6 with barely showing knobbs but Z5 with distinct knobb on each (female, Assam, India) [OS = opisthonotal shield, PE = peritreme, PS = podonotal shield; original magnification, both = 200×].

It is evident from above that number of setae in 5 species of *Hemipteroseius* that have 2 separate dorsal shields [*H. adleri* Costa, *H. antilleus* Treat, *H. indicus* (Krantz & Khot), *H. vikrami* Menon, and *H. womersleyi* Evans], the total number of setae on dorsal idiosoma varies from 16 to 17 pairs. In these species, seta *J1* is added only in *H. womersleyi* and considered a variable seta in *Hemipteroseius*. It is also evident that the number of dorsal idiosomal setae and the chaetotaxy in *H. indicus* and *H. vikrami* are identical.

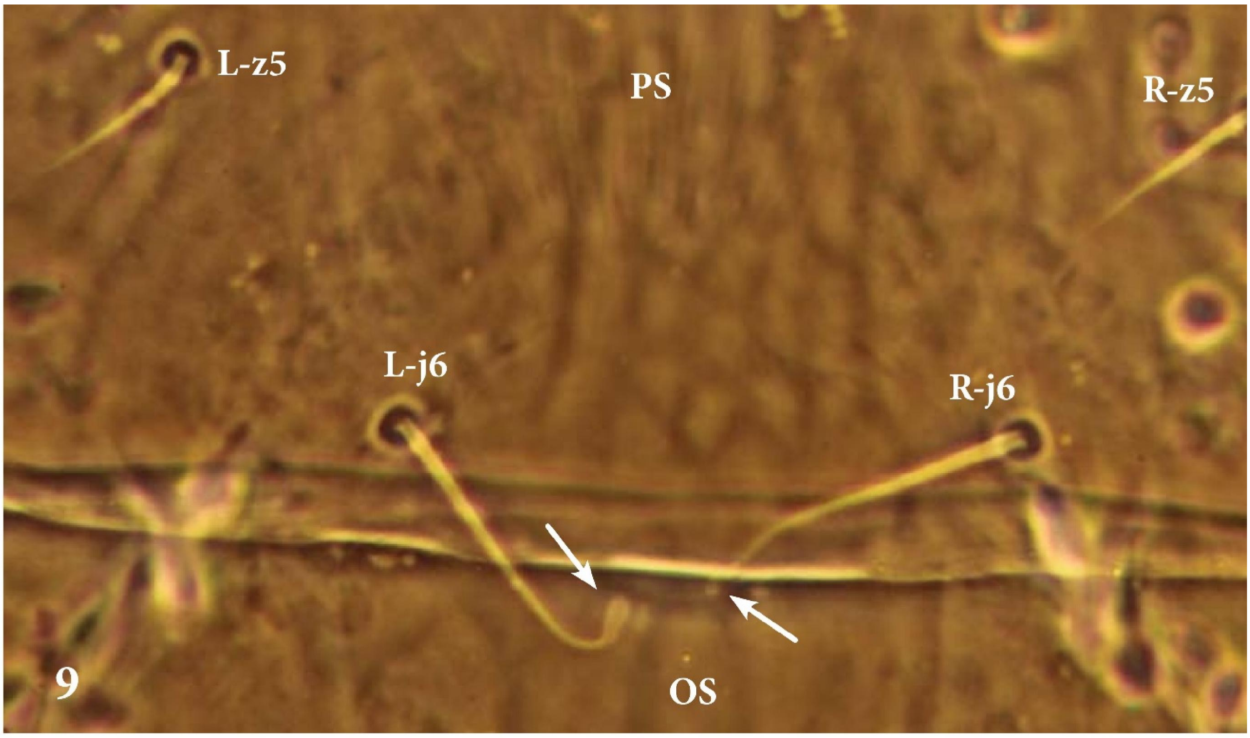
Regarding the dorsal chaetotaxy of idiosoma in remaining 3 species of *Hemipteroseius* [*H. ageneius* Treat, 1965; *H. parvulus* Treat, 1965; and *H. sabbaticus* Treat, 1965], showing single dorsal shield, is examined, following is evident: **(1)** In *parvulus* [seta *JV5* is shown on integument close to posterior end of dorsal shield in Treat, 1965, Fig. 6: 11], there are 15 pairs of setae on the dorsal idiosoma of which 9 pairs of setae are on the podonotum: *j1*, *j3*, *j4*, *j5*, *j6*, *z2*, *z4*, *z5*, and *s4*; 4 pairs of setae on the opisthonotum: *J2, J5*, *Z4*, and *Z5*; and only 2 pairs of setae on the integument: 1 pair *r3* beside the podonotal shield and 1 pair *R1* beside the opisthonotal shield. Thus, there are 13 pairs of setae (9 pairs + 4 pairs) on single dorsal shield and 2 pairs are on the integument (= 15 pairs on the dorsal idiosoma). **(2)** There are 16 pairs of setae on the dorsal idiosoma in 2 species: *H. ageneius* and *H. sabbaticus* of which 10 pairs of setae are on the podonotum: *j1*, *j3*, *j4*, *j5*, *j6*, *z2*, *z4, z5*, *s4*, and *s6* (added); 4 pairs of setae on the opisthonotum: *J2*, *J5*, *Z4*, and *Z5*; and 2 pairs of setae on the integument: 1 pairs *r3* beside the podonotal shield and 1 pair R1 beside the opisthonotal shield. Thus, there are 14 pairs of setae (10 pairs + 4 pairs) on the single dorsal shield and 2 pairs on the integument (= 16 pairs on the dorsal idiosoma). It is evident that seta s6 may be present on the dorsal shield (as in *H. ageneius* and *H. sabbaticus*) or absent (as in *parvulus*). Thus, seta s6 is considered a variable seta in *Hemipteroseius*.

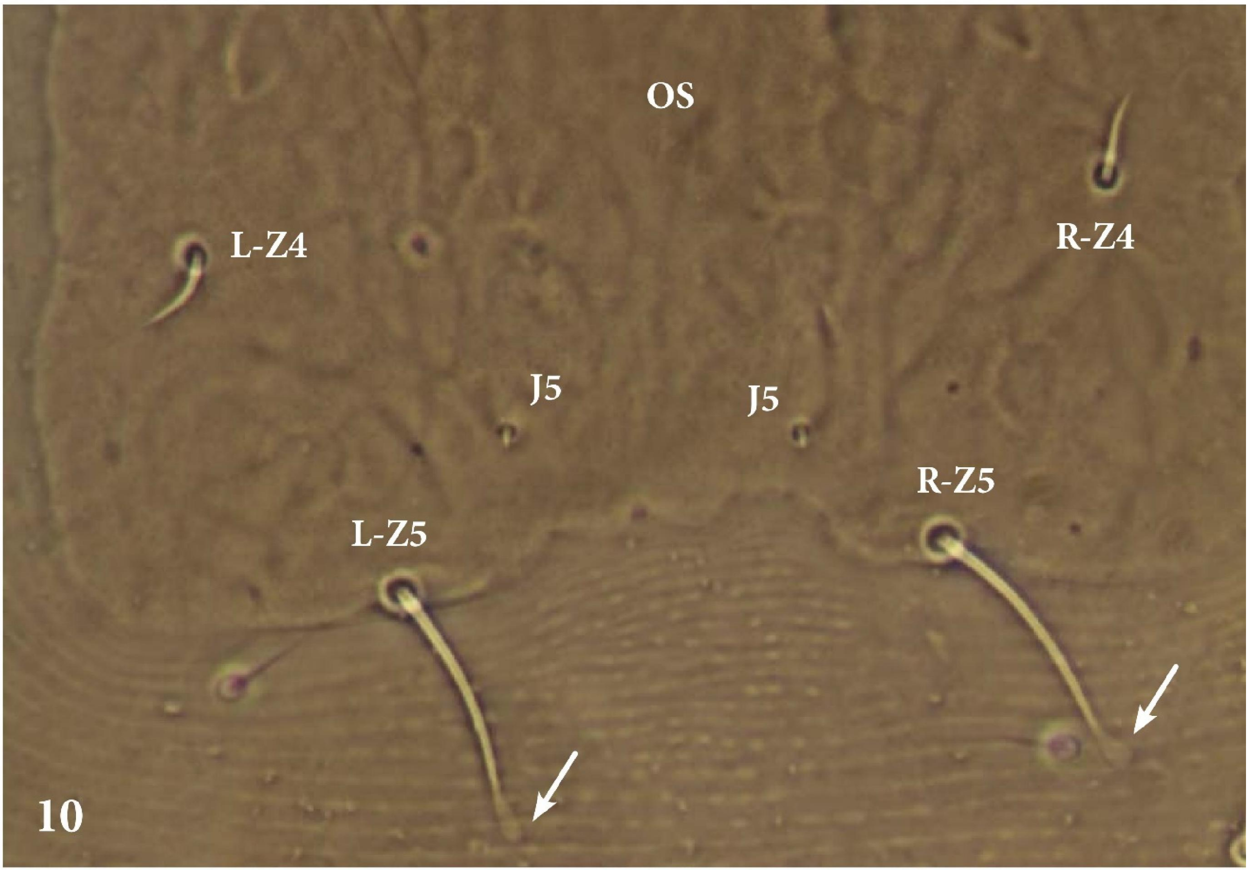
Comparing the dorsal idiosomal setae discussed above, whether present on a single or 2 separate dorsal shields, the following is clear: **(1)** Dorsal idiosoma in *Hemipteroseius* has a total of 16–17 pairs of setae. **(2)** Of all the 16-17 pairs of setae, 8–9 pairs are present on the podonotum, 4–5 pairs are present on the opisthonotum, and 2–3 pairs are present on the lateral integument. Of these setae, 2 pairs of setae: *s6* and *J1* are most variable and remaining 9 pairs of setae (*j1*, *j3*, *j4*, *j5*, *j6*, *z2*, *z4*, *z5*, and *s4*) in the podonotal area; 4 pairs of setae (*J2*, *J5*, *Z4*, and *Z5*) in the opisthonotal area; and 2 pairs of setae (*r3* and *R1*) on the lateral integument are most stable.

The hypotrichy of the free-living predatory mite family Phytoseiidae is well known in Mesostigmata. It has a maximum of 23 pairs of setae on dorsal idiosoma (e.g. *Australiseiulus angophorae*) and a minimum of 14 pairs of setae on dorsal idiosoma (e.g. *Afroseiulus robertsi*). Also, the fixed digit of chelicera is well developed. In comparison to Phytoseiidae, species of family Otopheidomenidae are also hypotrichous but are ectoparasitic and have a reduced fixed digit of chelicera. The 8 species of *Hemipteroseius,* representing Otopheidomenidae, are also hypotrichous and have only 16–17 pairs of setae on dorsal idiosoma. Therefore, there is some overlap in the number of dorsal setae in Phytoseiidae and Otopheidomenidae.

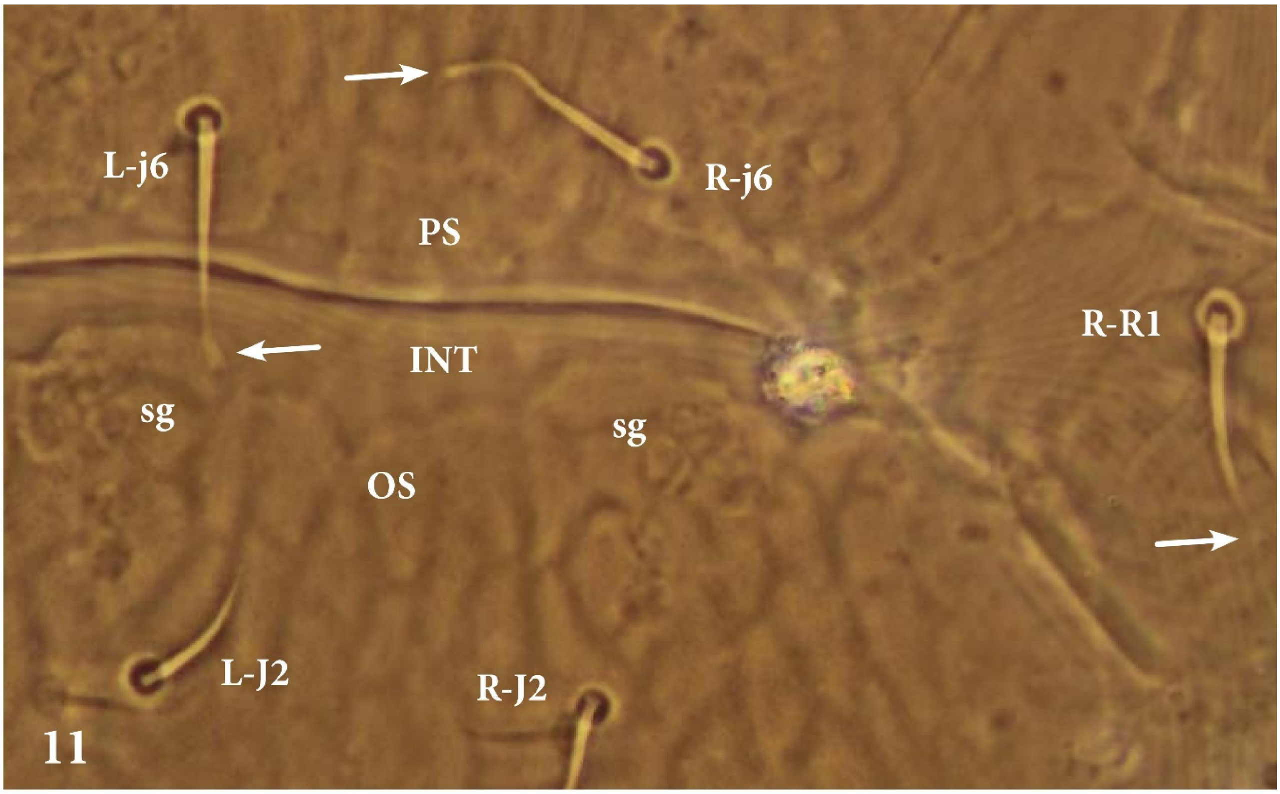
Another pattern in the chaetotaxy of the dorsal shield is evident in species of *Hemipteroseius* in which the loss of setae on the podonotal region is much less than that of the opisthonotal region. Thus, the number of setae on the podosomal region is almost twice the number as that of the opisthonotal region. This kind of pattern is also present in the species of Phytoseiidae. Thus, in many cases, more setae have been lost on the opisthonotal region than the podosomal region due to adaptive changes by the mites under different bio-ecological pressures.

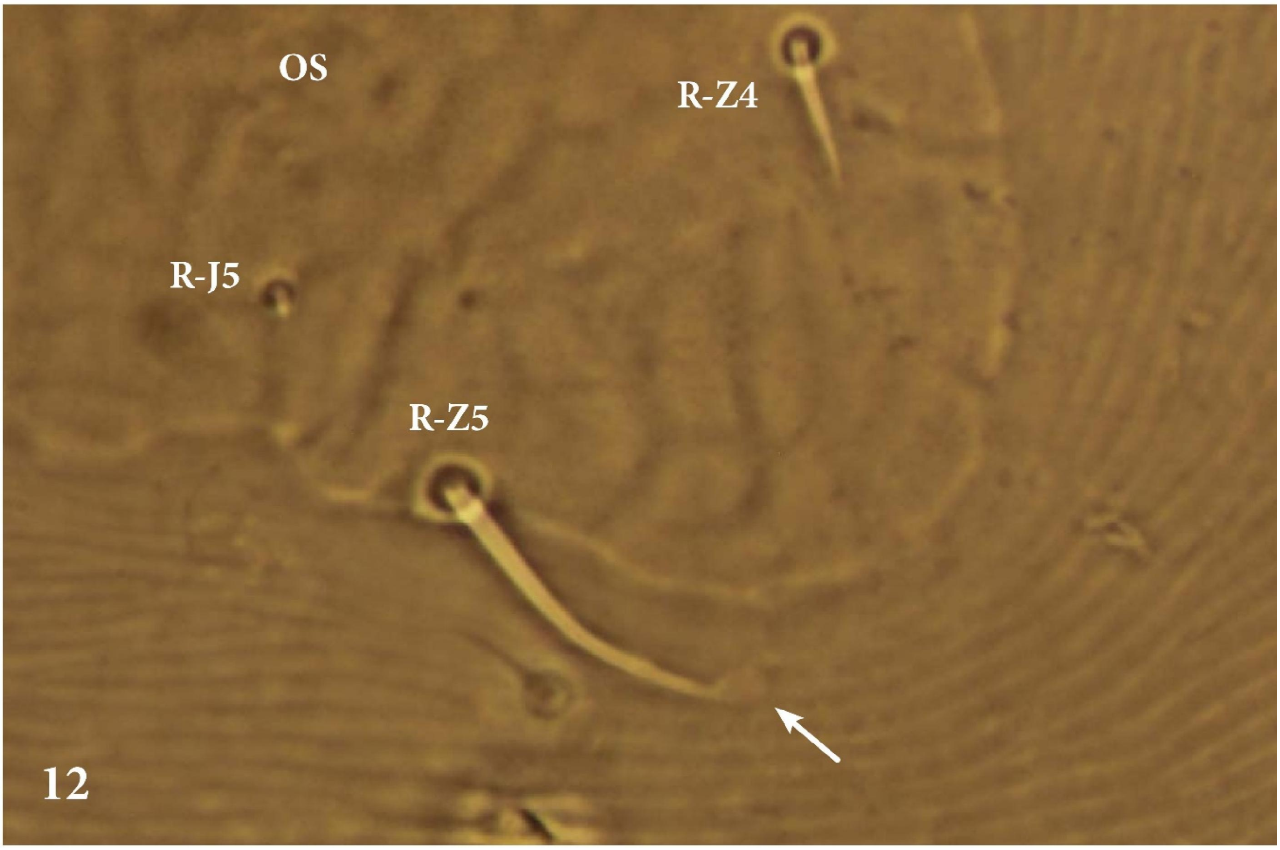
Knobbed dorsal idiosomal and leg setae – Evans (1963) illustrated *Hemipteroseius womersleyi* having the *Z5* seta on the left side being knobbed, whereas that of the right not so in the female. He did not give any significance to this feature. Krantz and Khot (1962), Treat (1963), Costa (1968) described the remaining species of this genus and did not mention this feature in their species. However, Menon *et al.* (2011) considered this character of significance in separating their new species (*H. vikrami*) from *H. indicus.* Based on the examination of numerous specimens, this feature was seen present also in *indicus* and found variable. Detailed examination of the mites at very high magnification (400–1,000×), showed that the knobbed hyaline tips of setae *j6*, *Z5*, *s6*, and macrosetae on femur and genu of legs, appear to have some secretory material at the tip which may or may not be of any taxonomic significance.





Figures 9–10. *Hemipteroseius indicus* – 9. Left seta j6 with distinct knob but right barely showing the knob (female #4, Punjab, India); 10. Both left and right setae Z5 with distinct knob on each. Setae z5 and Z4 without knobbs (female #1, Punjab, India) [OS = opisthonotal shield, PS = podonotal shield; original magnification, both = 400×].





Figures 11–12. *Hemipteroseius indicus* – 11. Left seta j6 with distinct knob but right barely showing the knob. Sigilla sg also seen (slide #7, female #2, Treat Collection); 12. Both left and right setae Z5 with distinct knob on each. Setae z5 and Z4 without knobbs (slide #7, female #2, Treat Collection) [INT = integument, OS = opisthonotal shield, PS = podonotal shield; original magnification, both = 400×].

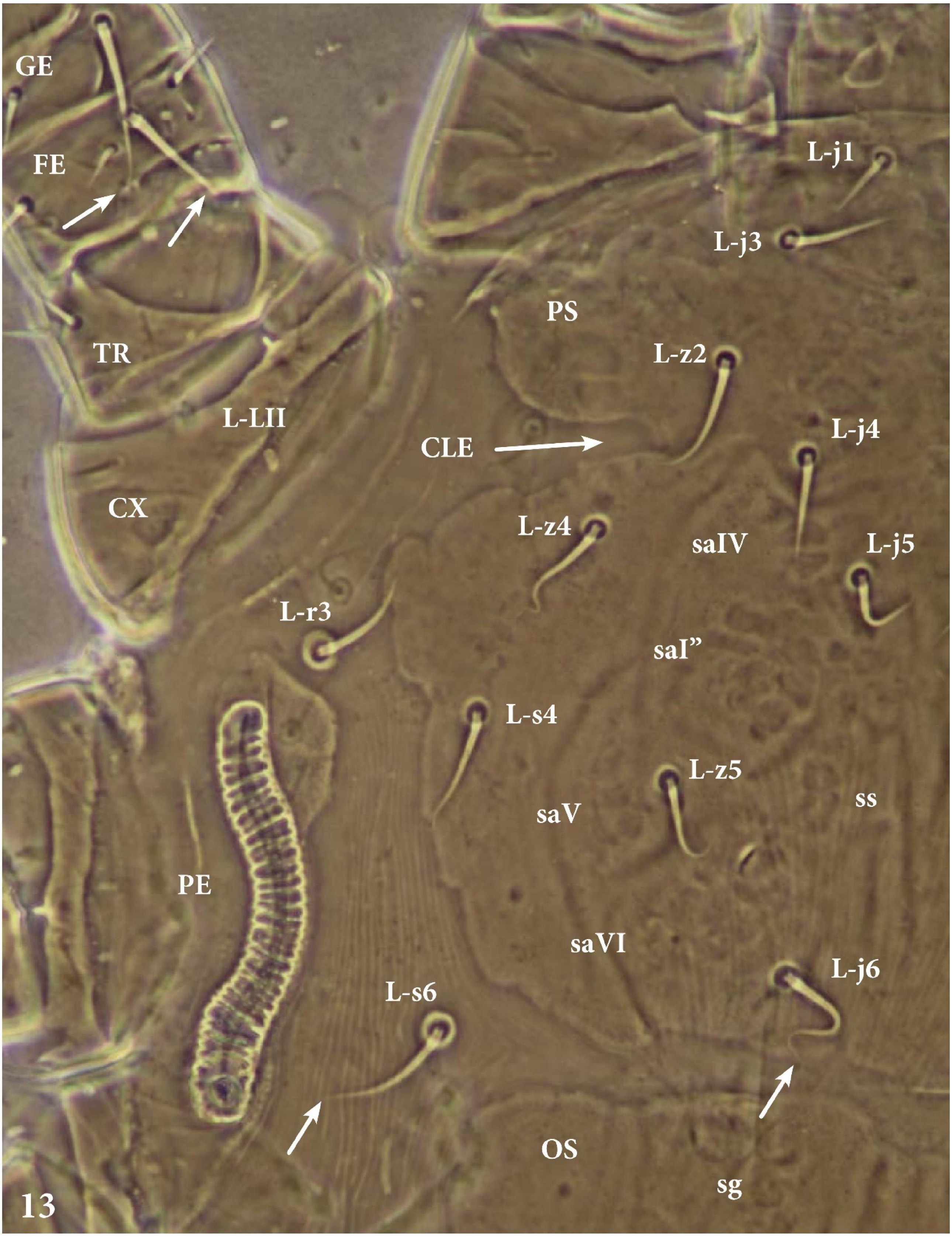


Figure 13. *Hemipteroseius indicus* (slide #4, female #1, Treat Collection) – Macroseta on left femur II and genu II with barely visible knobb on each. Setae j6 and s6 without knobbs. Several sigilla also seen [CLE = cleavage, CX = coxa, F = femur, Ge = genu, OS = opisthonotal shield, PE = peritreme, PS = podonotal shield, TR = trochanter; original magnification = 400×].

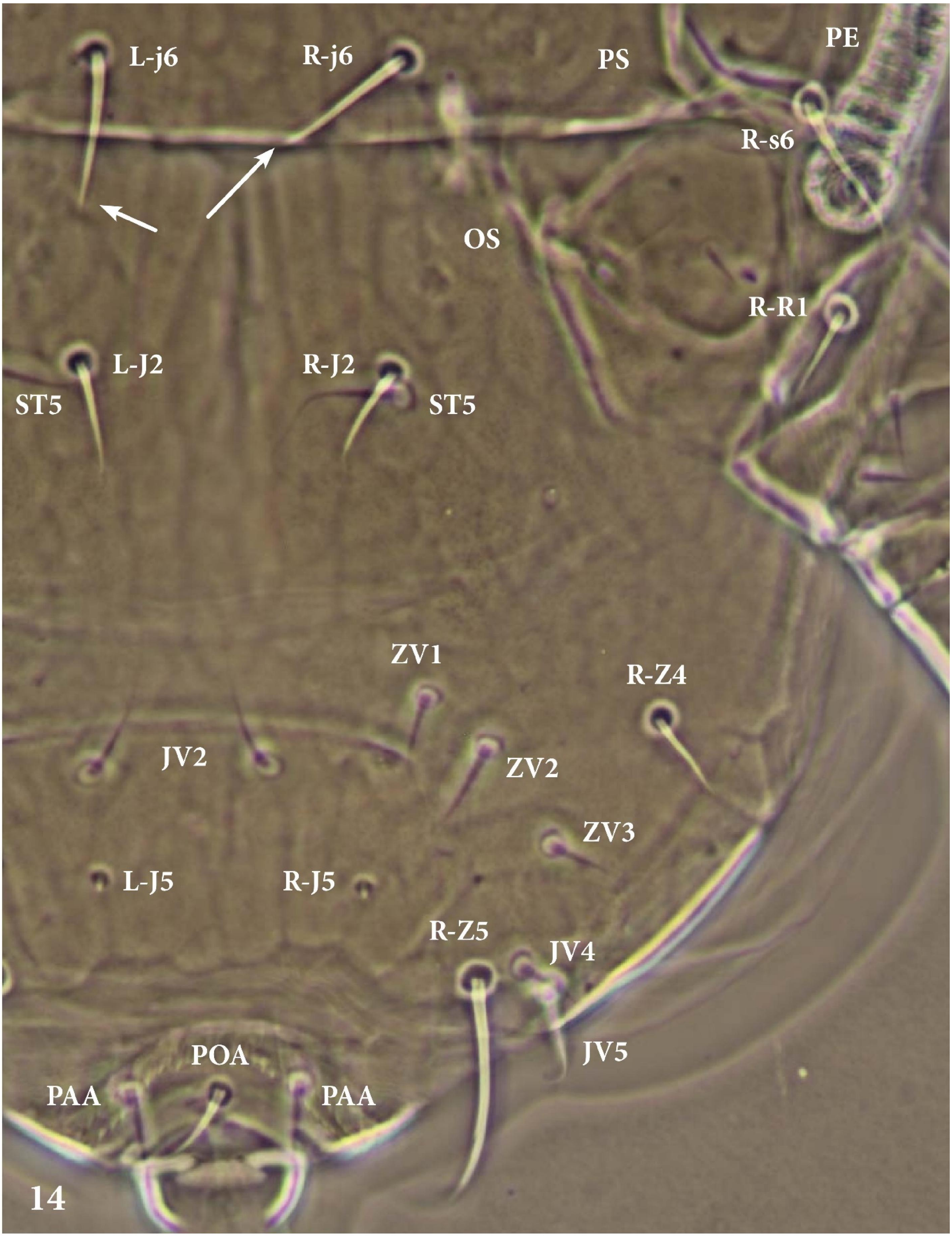


Figure 14. *Hemipteroseius indicus* (slide #1, female #1, Oregon State University) – Setae j6 with barely showing knob at the tip and others without knobbs (s6, J2, Z4, and Z5). Some ventral setae (ST5, JV2, JV4, JV5, ZV1, ZV2, ZV3, PAA, and POA) also seen [OS = opisthonotal shield, PE = peritreme, PS = podonotal shield; original magnification = 400×].

Different kinds of setae on the idiosoma, including having pointed, clavate, knobbed, or spatulate tips have been reported and illustrated in several species of Phytoseiidae (as given in Chant and McMurtry, 2007). Some of these setae may have specific tactile and chemoreceptive functions while others, especially those with tiny hyaline knobs on a few setae and found variable, may be of no taxonomic significance.

Sigilla on dorsal shield – Athias-Henriot (1975) described and illustrated 9 pairs (sp, saI', saI'', saII, saIII, saIV, saV, saVI, and ss) of sigilla on the podonotal region (counting single saI' as a pair) and 7 pairs (sg, saIX, saX, saXI, saXII, XIII, and saIV) of sigilla on the opisthonotal region of the single dorsal shield in the adult female of Amblyseiini (Phytoseiidae). Prasad (2015) described these in 4 species of *Paraphytoseius* (Phytoseiidae). All sigilla were very similar to those described by Athias-Henriot (1975) except that their shape was slightly different on the opisthonotum. He also discussed the difficulty in the identification of 4 pairs of closely present sigilla (saI'', ss, saV, and saVI) surrounding the bases of setae *z5* and significance of sigilla sg present on each side just anteromedial to seta *Z1* on the single dorsal shield anterior to which the podonotal region is present.

In contrast to that of *Paraphytoseius*, the single dorsal shield in the species of *Prasadiseius* (Otopheidomenidae) is partially incised bilaterally and each invagination stops medial to sigilla sg posterior to which the opisthonotal region is present and setae *Z1* are absent. In both genera of 2 different families of mites in which many opisthonotal setae are absent but present in many species of Phytoseiidae, all opisthonotal sigilla (sg, saIX, saX, saXI, saXII, XIII, and saIV) could still be identified.

In comparison to *Paraphytoseius* and *Prasadiseius*, the single dorsal shield of *Hemipteroseius indicus* [= *H. vikrami*] is divided into 2 separate dorsal shields. In spite of this, all 9 pairs of sigilla (sp, saI', saI'', saII, saIII, saIV, saV, saVI, and ss) are present on the podonotum and 7 pairs of sigilla (sg, saIX, saX, saXI, saXII, XIII, and saIV) are present on the opisthonotum. Thus, pattern of sigilla in 3 different genera in 2 different families are alike. The pattern of sigilla in *Hemipteroseius indicus* [= *H. vikrami*] in the present study revealed these to be very similar. In fact, without naming, Menon *et al.* (2011) illustrated these crudely on Fig. 2 of their new species *H. vikrami* which agree to the present finding (e.g. they illustrated saI' in between *j4-j4*, saII and saIII medial to *j3-j3* and *z2-z2*, and saVI lateral to *j6-j6*, etc.).

It is evident from the study of Prasad (2015) and the present study that the shape of some sigilla on opisthonotum is different in different species and may be a group specific characteristic. Unfortunately, the study of sigilla has not received much attention by taxonomic acarologists as they have not been found to be species specific. Also, correct identification of these has been difficult. Voucher photos presented by Prasad (2015) and in the present study are worth examining and using giving the photographic evidence as they may prove important in some species, especially on the opisthonotum. Swirski, Ragusa di Chiara, and Tsolakis (1998) and many other taxonomic acarologists have clearly drawn them, without notations, for many phytoseiid mites.

Significance of *Hemipteroseius indicus* as a parasitic mite and research tool – Of all the known species of Otopheidomenidae from 9 genera [*Eickwortius, Hemipteroseius, Katydiseius, Nabiseius, Noctuiseius, Orthopteroseius, Otopheidomenis, Prasadiseius,* and *Treatia* (= *Entomoseius*)] in 3 subfamilies (Katydiseiinae, Otopheidomeninae, and Treatiinae), only *Otopheidomenis incanus* Prasad and Guanilo was collected and described from live sphingid moths; all other species were described from specimens collected from dead insects.

Treat (1954) was the first one to describe *Dicrocheles* (= *Myrmonyssus*) *phalaenodectes* (Laelapidae) from dead noctuid moths and study its biology in detail on live moths in Tyringham, MA, USA. This included his observations feeding on some material in punctured tympanic cavity showing some feeding scars. Prasad (1975) studied the biology of *Hemipteroseius indicus* on live red cotton bugs. This mite was found to be easy to rear and study its biology on live red cotton bugs but, unfortunately, many aspects of its parasitism have never been studied. It is not known with certainty if the mites feed by scraping the cuticle or on some fluid coming out of the pierced cuticle. Punctate, pale to colorless spots are seen on the glistening and smooth dorsal abdominal cuticle of the red cotton bug where the adults and immatures are clustered together. The use of fecal material to study the contents for possible hemolymph or other cellular material, such as fungal hyphae, has not been studied. The parasitic effects on the host, including mortality and morbidity, have not been studied in detail. However, Shahi and Krishna (1981) have reported *H. indicus* effectively reducing the nymphal and adult population of *Dysdercus koenigii* infesting cotton plants in India. Do these mites develop parthenogenetically also? Where are these mites present when the bugs are not seen in those locations? No DNA studies have been done on this family of mites. Based on the morphology of having only the movable digit of chelicera with the recurved teeth, this author believes that these mites feed on the host by scraping the epicuticle. No proof of piercing the cuticle or feeding on the exudate of the body has ever been observed in *H. indicus* or any other otopheidomenid mite.

The otopheidomenids infesting the lepidopterous hosts, Sphingidae in particular, are only known from Ethiopian and Neotropical countries. These hosts are very hairy and the study of biology-ecology or parasitic aspect of these mites is difficult. In addition, the lack of trained acarologists in most areas where they occur has hindered our understanding of them.

One or both species of the red cotton bugs (*Dysdercus cingulatus* and *D. koenigii*) mainly infest cash crops such as cotton and okra and, sometimes, citrus, hibiscus, hollyhock, jute, kapok, maize, musk mallow, okra, portia, teak, and other plants as well, in many countries of Asia (Bangladesh, Borneo, northeastern India, Papua New Guinea, Philippines, Sri Lanka, Sumatra, Thailand) and northern Australia. It is also known from Democratic Republic of Congo and Israel. As *H. indicus* is reported from both of these insect hosts, it is believed that this mite must be present in those areas affecting the morbidity and mortality of these bugs which often are very heavily infested by these mites. Since otopheidomenid species are obligatory ectoparasitic mites, that have a short egg to adult maturity period, and are very easy to rear and study, they may play an important role in the ecology of certain agroecosystems and prove to be very beneficial.

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گونهٔ *Hemipteroseius vikrami* Menon: مترادف کم‌سابقهٔ *H. indicus* (Krantz & Khot) (Acari: Otopheidomenidae) همراه با تفسیرهایی در مورد سجیلای صفحهٔ پشتی

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چکیده

گونهٔ *Hemipteroseius vikrami* Menon, 2011 (Acari: Otopheidomenidae: Treatinae) به عنوان مترادف کم‌سابقهٔ *Hemipteroseius indicus* (Krantz & Khot, 1962) در نظر گرفته شده است. هر دو گونه از روی سن‌های سرخ پنبه *Dysdercus koenigii* (F.) و *Dysdercus cingulatus* (F.) توصیف شده‌اند که گونهٔ دوم در هند و برخی کشورهای دیگر پراکنگی گسترده دارد. سجیلای پودونوتوم و اپیستونوتوم نیز برای نخستین بار در این کنه توصیف شده‌اند.

واژگان کلیدی: Otopheidomenidae؛ Pyrrhocoridae؛ سن‌های سرخ پنبه؛ سجیلا؛ Treatiinae.

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