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DESCRIPTIONS OF PHYTOSEIID MITE, *NEOSEIULUS BARAKI* (ATHIAS-HENRIOT) (ACARI: MESOSTIGMATA: PHYTOSEIIDAE), A PREDATOR OF COCONUT ERIOPHYID MITE, *ACERIA GUERRERONIS* KEIFER

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ABSTRACT

The present study was conducted in the year 2017-18 and 2018-19 to explore the fauna of natural enemies of coconut eriophyid mite, *A. guerreronis* at five different locations *viz*., Navsari, Jalalpore, Gandevi, Bilimora and Chikhli talukas of Navsari district**.** The collected mite species was reported as *Neoseiulus baraki* Athias-Henriot which belonging to Superorder - Parasitiformes, Order - Mesostigmata, Subrorder - Monogynaspida, Cohort - Gamasina and Subcohort - Dermanyssiae were identified. Morphometrics studies revealed that the length and width of adult female idiosoma were 350.91 and 159.83 µm, respectively; while male idiosoma measures 344.20 and 152.05 µm, respectively. Dorsal chaetotaxy found that the total of 33 pairs of setae present in idiosoma, among which 19 pairs inserted in dorsal side and 14 pairs on ventral side. Dorsal shield with seven pairs setae of j-J series, six pairs of z-Z series, four pairs of s-S series and two pairs of r-R series. The length of j3 setae was much longer than j1 setae, while length of S4 setae was slightly longer than S5 setae. Whereas, Z5 setae was the longest dorsal setae as compare to other setae. Presence of one pair of lateral stigmata posterior to the coxae and it extending upto j1 setae, the larger number of teeth on fixed and movable cheliceral digits and the shallower cup-shaped spermathecal calyx was present. The preanal pores on the female ventrianal shield were narrowly separated.

Keywords: Coconut, *N. baraki*, eriophyid mite, description, taxonomy

INTRODUCTION

Coconut (*Cocos nucifera* L.) is one of the most important commercial crops in Indian coastal states, covering an area of 2.08 million hectare, production of 23904.10 million nuts and productivity of 11481 nuts/ha, whereas in Gujarat covering an total area of 24.44 thousand hectare, production of 336.65 million nuts and productivity of 13775 nuts/ha, which holds 7th rank in India (Anonymous, 2017a). In Navsari district, the total coconut growing area were 554 hectare with an production of 46.65 lakh nuts and productivity of 8421 nuts/ha (Anonymous, 2016). Nowadays, coconut is severely attacked by the coconut mite, *Aceria guerreronis* Keifer, which causes necrosis and malformation of nuts, as well as premature nut fall. This damage reduces yield and quality of copra, leading to substantial economic losses (Haq and Sobha, 2010). This mite was first described in 1965 from the state of Guerrero, Mexico (Keifer, 1965). In India, first time reported at Ernakulam district of Kerala in 1998, later onwards, it has attained a major pest status in the three peninsular states of India namely Kerala, Karnataka and Tamil Nadu and it has spread northwards menacingly and it has drawn national attention as a threat to the coconut plantation (Sathiamma *et al.,* 1998). An outbreak of eriophyid mite in South Gujarat was observed; around 84 per cent of the palms were infested. This was thought to be first report of eriophyid mite infestation in Gujarat (Desai *et al*., 2003).

Classical biological control, involving the search for effective natural enemies in the place of origin of the pest and their ultimate introduction in the new environment would seem most appropriate, but the possible management of native natural enemies already present in the new area have also been

considered pertinent. In both cases, a prior identification of the natural enemies of the pest in the new environment is a pre-requisite. The taxonomy and distribution of phytoseiid mites have been extensively studied in different parts of India, as summarized by Gupta (1986). Phytoseiid predatory mites have been generally considered the most promising group of predators of pest mites on different crops (Gerson *et al*., 2003). The distance between the distal end of the bracts and the fruit surface of coconut is large enough for *A. guerreronis* penetration into the perianth but not large enough for the access of other mites (Lima *et al*., 2012), including most of the predatory mites. *Neoseiulus baraki* are the species that stand out among the predatory mites frequently found in association with *A. guerreronis* in the perianth of coconut fruit in Asia (Moraes *et al*., 2004). These *Neoseiulus* species have reduced size, a short legs and mainly flattened body (Chant and McMurtry 2003; Moraes *et al*., 2004) when compared with other predatory mite species that are also found in association with *A. guerreronis.* Thus, species of this group should naturally be some of the first to be considered for use in the control of *A. guerreronis*. Phytoseiid mites are conventionally identified based on morphological characters such as body size, length of dorsal setae, leg chaetotaxy, shape and size of spermatheca, cheliceral length and dentition have been used to describe species in this family (Chant and McMurtry 1994). The accurate identification of natural enemies is essential for biological control. *Neoseiulus baraki* (Athias-Henriot) predatory mites are considered to be potential candidates for biological control of the coconut eriophyid mite *A. guerreronis*, a serious pest of the coconut palm in Africa, Americas and part of Asia (Moore 2000). Whether differences between populations or cryptic species are relevant to achieve improvements in biological control remains to be seen, but to assess its relevance accurate identification is required (Moraes 1987).

The objective of this study was to describe the phytoseiids mite, *N.baraki* on the basis of its morphological characters for quick identification.

MATERIAL AND METHODS

Collection of nuts. Nuts examined in this study were collected from the coconut fields of Navsari, Jalalpore, Gandevi, Bilimora and Chikhli talukas of Navsari district. The collected nuts were brought into the laboratory and mites of all mobile life stages from each nut were collected separately using fine camel hair brushes and put into vials containing 10 ml of 70 per cent ethyl alcohol for future identification purpose. The collected mite species mounted on glass slides by using Hoyer's medium. After mounting, slides were kept in hot air oven at 45°C for one week for proper drying; later slides were sent for identification to Network Coordinator, All India Network Project on Agricultural Acarology, University of Agricultural Science, Bangalore, Karnataka.

Morphometric study of predatory mite, *N. baraki.* Morphometric studies were carried out with the help of Axico Zeiss (Scope A1 Phase Contrast Microscope) fitted with ProgRes CT5 camera having ProgRes® CapturePro 2.10.0.1 Jenoptic Optical System GmbH software. Measurements of different body parts of predatory mite, *N. baraki* were taken in micrometer (µm) at 40X resolution with the help of Scope A1 Phase Contrast Microscope. For present study morphological characters were studied as given below:

1. **Idiosoma:** The next to gnathosoma upto a caudal end of body, the part is called as idiosoma
2. **Length:** Measured from anterior most part of idiosoma and posterior most part of idiosoma
3. **Breadth:** Measured from middle of idiosoma, where it is having maximum width
4. **Setae count:** The total setae present in dorsal and ventral idiosoma and their length
5. **Other parameters:** Sternal, genital and ventrianal shield size (both male and female) and there setae position, portion of legs and position of stigmata were taken.

RESULTS AND DISCUSSION

From the present investigation collected species was belonging to Superorder - Parasitiformes, Order - Mesostigmata, Subrorder - Monogynaspida, Cohort - Gamasina and Subcohort - Dermanyssiae, Order - Mesostigmata, Superfamily - Phytoseioidea and Family - Phytoseiidae were identified. These species were belonging to Genera: *Neoseiulus* and Species: *baraki* (Acari: Phytoseiidae) were identified.

Keys to the superorder, order, suborder, cohort, subcohort, family, subfamily, tribe, genus and species of *N. baraki*

The following taxonomic characters of *N. baraki* were referred from the training manual given by Anonymous (2017b) and their keys (Plate I) were denoted in alphabetical series (from a to af) as follows:

i. Presence of one pair of lateral stigmata posterior to the coxae II (a); coxae of legs free, usually movable (b); tarsus of leg 1 with dense dorsal cluster of solenidiform setae sub-distally (c)… **Superorder - Parasitiformes.**

ii. Tarsus of palp with a tined subterminal apotelic claw (d); opisthosoma with one pair of ventrolateral stigmata in lateral to coxae II-IV. Subcapitulum with a pair of horn like, setiform corniculi (e); stigmata with elongate peritremes extending anteriorly (f). Venter of subcapitulum with maximum of 4 pairs of setae (g); tritosternum usually present, with distinctive base and 1 to 2 setulose laciniae (h); anal valves with 1 pair of setae (i)… **Order - Mesostigmata.**

iii. Genital shield single with 1 pair seate (j); tarsus of leg IV of deutonymph and adults with a maximum of 18 setae (k) …. **Subrorder - Monogynaspida.**

iv. Epigynal shield of female flask shaped and bearing setae ST5 (l); femur IV of deutonymph and adult typically with 3 pair setae (m)…. **Cohort - Gamasina.**

v. Female with sterna setae ST4 inserted on small metasternal of sterna shield (n); female sperm access system opening by pair of small solenostomes in region of coxae IV (o). Male chelicerae with a spermatodactyl, a sperm holding process that project distally, usually free from movable digit (p) …. **Subcohort - Dermanyssiae**.

vi. Male: Dorsal chaetotaxy similar to that of female except that the sublateral setae (setae of r-R series) are inserted on the lateral margin of the dorsal shield (q). Female with genitiventral shield narrowly separated from ventrianal shield (r); male with separate sternitigenital and ventrianal shield (s). Female with 3 pairs of sternal setae on the sternal shield (t), opisthonotum with caudal setae J5 (u) and usually with one marginal R - setae (u).

vii. Female with epigynal shield truncate (v) and narrowly separated from an anal shield that is oval in shape (v). Adults with less than 20 pairs of dorsal shield setae. Fixed and movable chelicerae digits normally developed (w); anal opening posteroventral, usually in ventrianal shield (x) … **Family - Phytoseiidae.**

vii. Setae j3, z2, z4 and s4 present (y)….**Subfamily - Amblyseiinae**.

ix. Deutosternal groove narrower and less than 5 μm in width (z); setae JV1 usually inserted near the anterior margin of the ventrianal shield (aa); preanal setae JV2 and ZV2 without forward migration (ab); preanal setae in males usually arranged in a triangular pattern.

x. Setae S4, Z4 and J2 setae always present (ac).

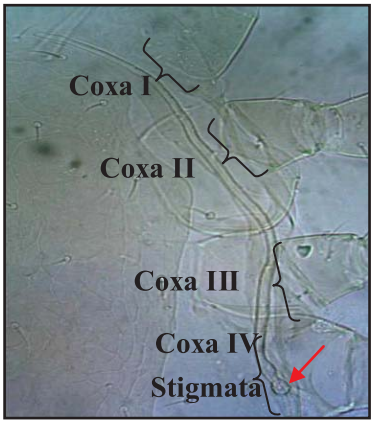
xi. Genu II without and genu III with a macrosetae; fixed digit of chelicerae with fewer than six teeth…. **Tribe-Neoseiulini, Genus-*Neoseiulus***.

xii. Setae j3 much longer than j1 (ad); S4 longer than S5 (ae); Z5 <2 times the length of macrosetae on basitarsus IV; preanal pores on the female ventrianal shield narrowly separated (af) …. **Species - *baraki*.**

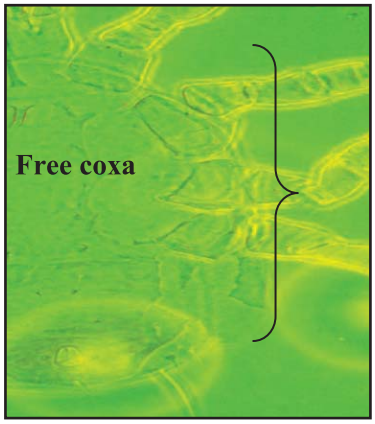
Idiosoma. The measurements of length and width of dorsal and ventral idiosoma were presented in Table 1.

Dorsal idiosoma. Dorsal shield well sclerotized, narrow and elongated much longer than wide. The length of adult female idiosoma was 350.91 ± 1.95 μm (Plate IIa), whereas in male it was 344.20 ± 2.42 μm (Plate IIb). Whereas, Width of female and male idiosoma were 159.83 ± 1.20 μm (Plate IIa) and 152.05 ± 1.69 μm (Plate IIb), respectively.

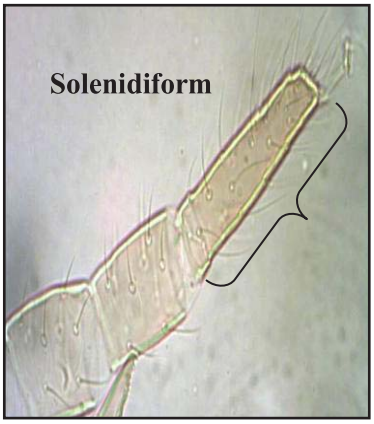
Ventral idiosoma. Ventral idiosoma of female consisting of sternal shield, genital shield and ventrianal shield, whereas in male it consisting of sternitigenital shield and ventrianal shield.



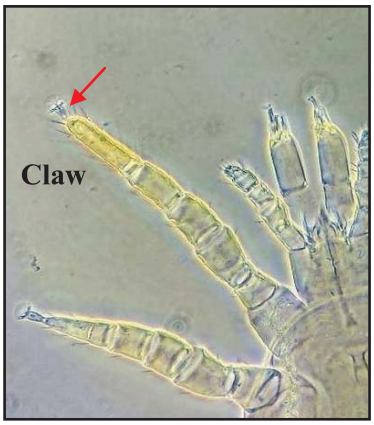
a. Lateral stigmata



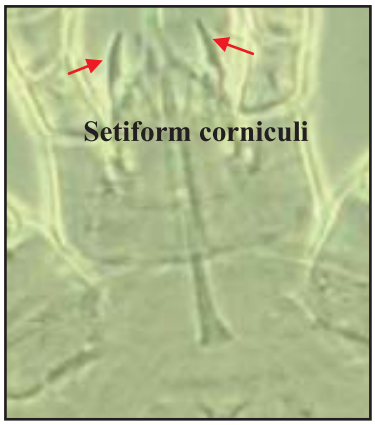
b. Coxae of legs free



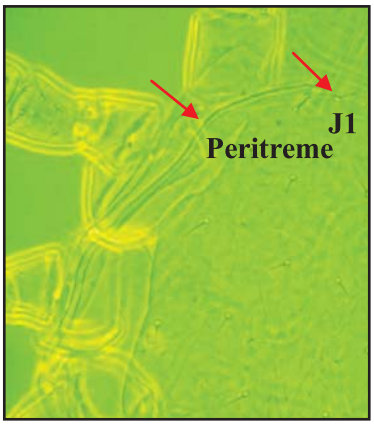
c. Solenidiform setae



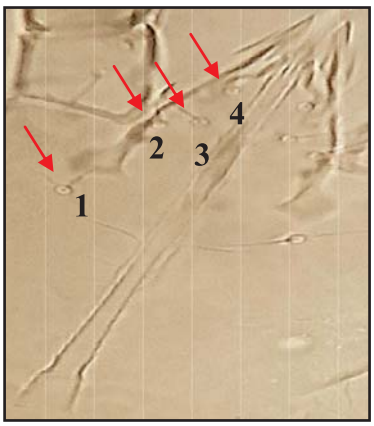
d. Apotelic claw



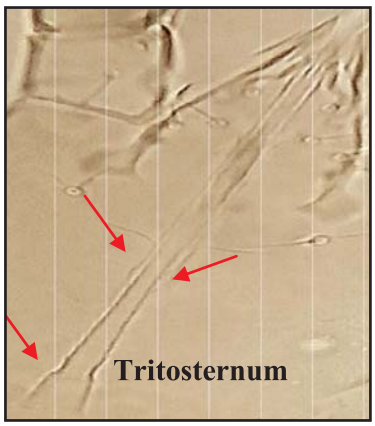
e. Subcapitulum with setiform corniculi



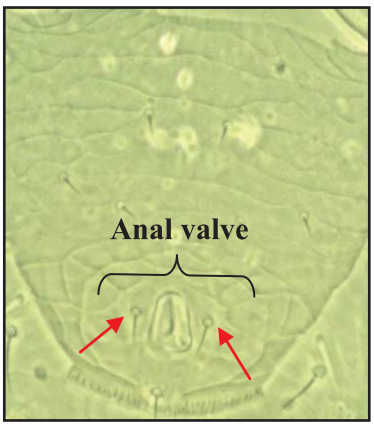
f. Peritremes extending upto J1 setae



g. Subcapitulum with four pairs of setae

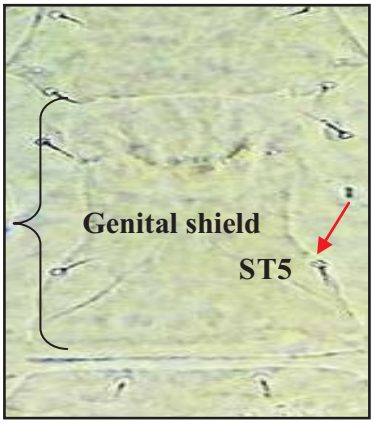


h. Tritosternum with one pair setulose laciniae

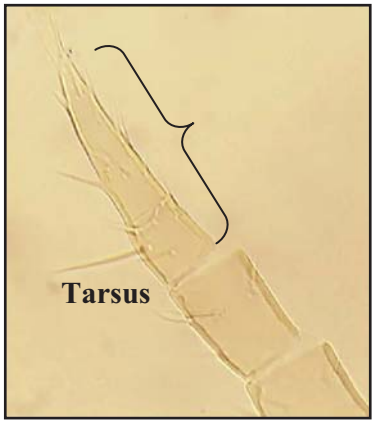


i. Anal valves with one pair of setae

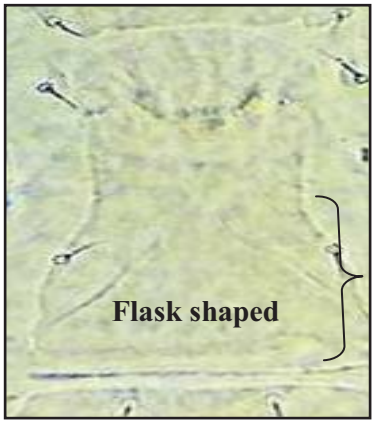
Plate 1. Continued.,...



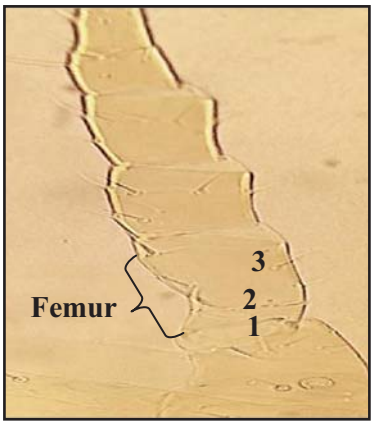
j. Genital shield with 1 pair seate



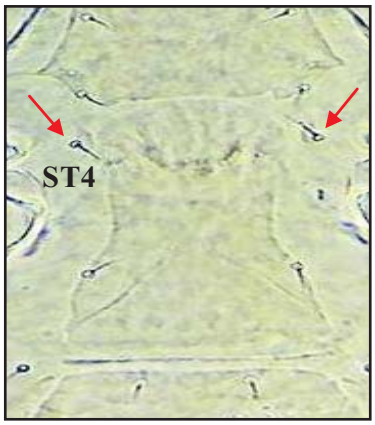
k. Tarsus of leg IV with a maximum of 18 setae



l. Epigynal shield flask shaped

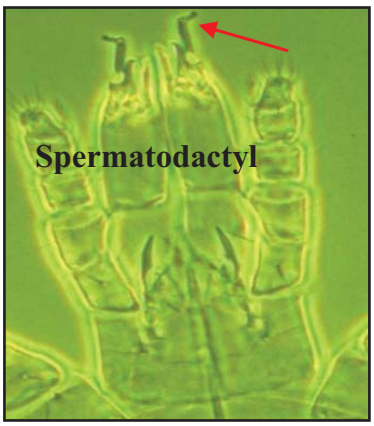


m. Femur IV typically with six setae

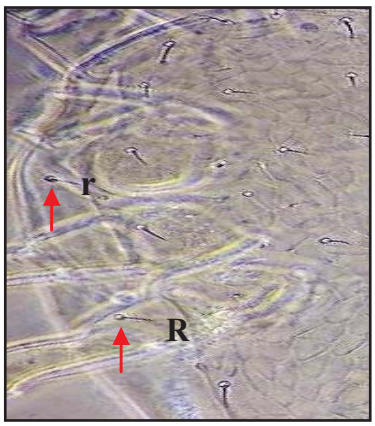


n. Setae ST4 inserted on small metasternal shield

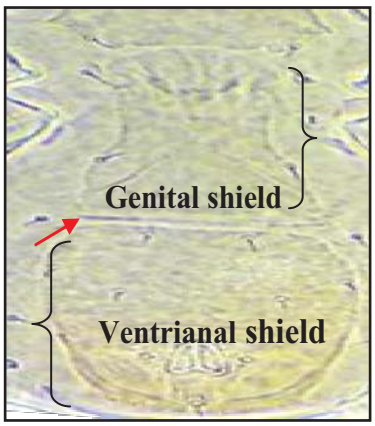
o. Female sperm access system opening by in coxae IV



p. Male chelicerae with a spermatodactyl

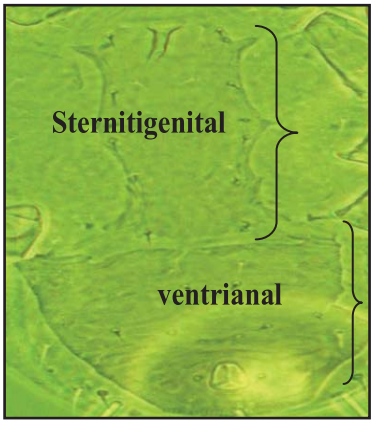


q. Setae r-R series inserted on the lateral margin of the dorsal shield

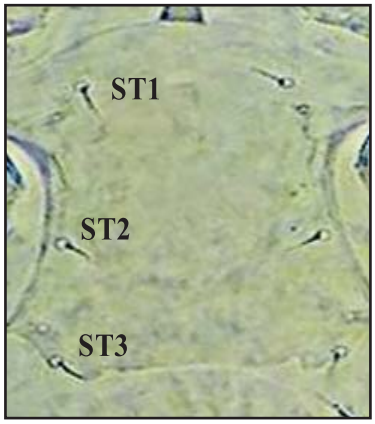


r. Genitiventral shield narrowly separated from ventrianal shield

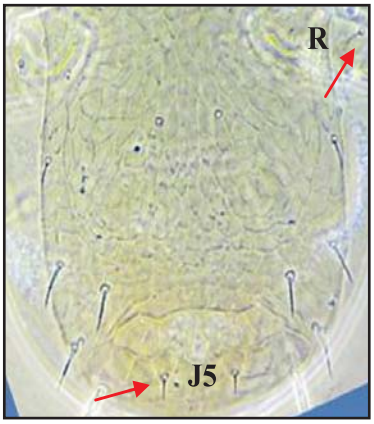
Plate 1. Continued.,...



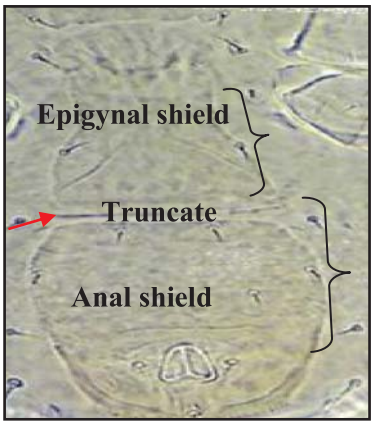
s. Male with sternitigenital and ventrianal shield



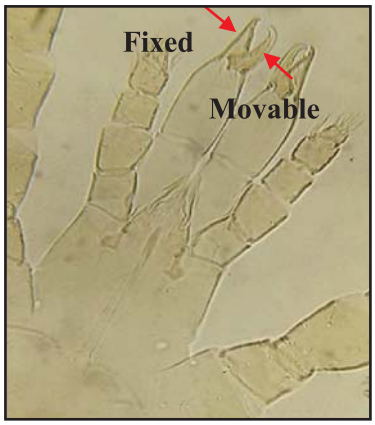
t. Female with three pairs of sternal setae



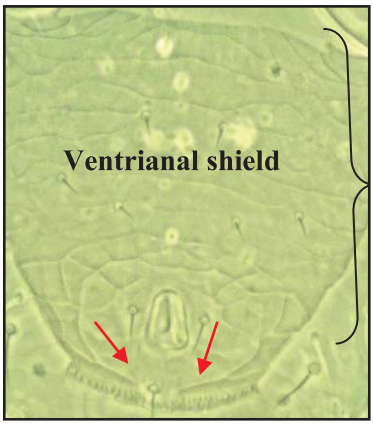
u. Opisthonotum with J5 and R-setae



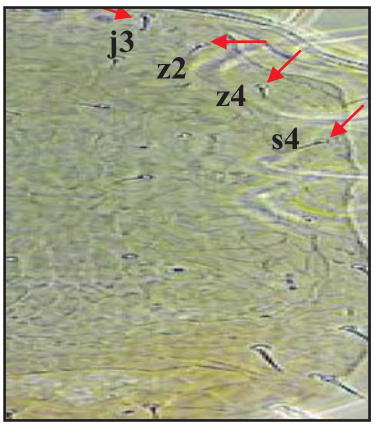
v. Epigynal shield truncate anal shield oval shape



w. Fixed and movable chelicerae

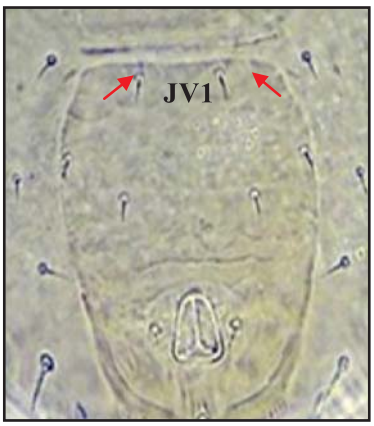


x. Anal opening in ventrianal shield



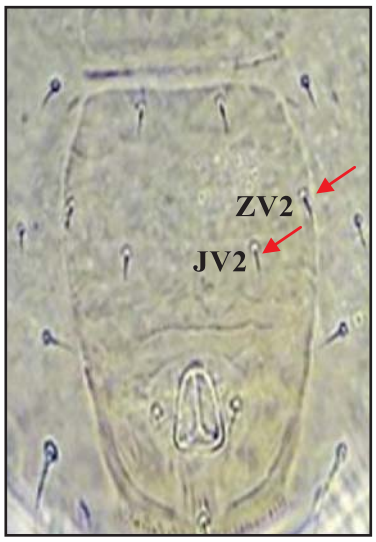
y. Setae j3, z2, z4 and S4 present

z. Deutosternal groove narrower < 5 µm in width

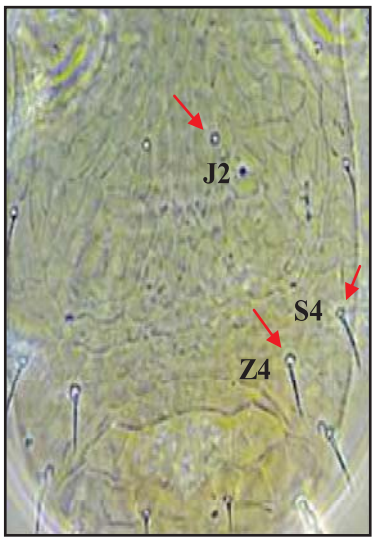


aa. JV1 usually inserted near the anterior margin of the ventrianal

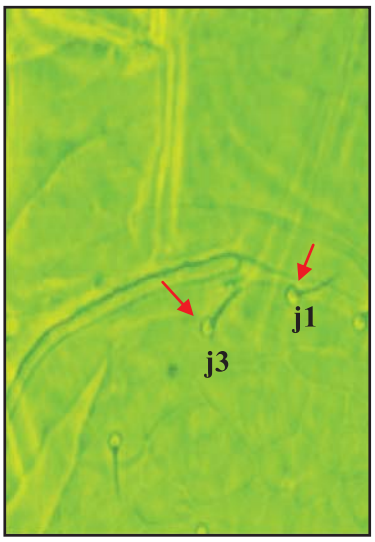
Plate 1. Continued.,...



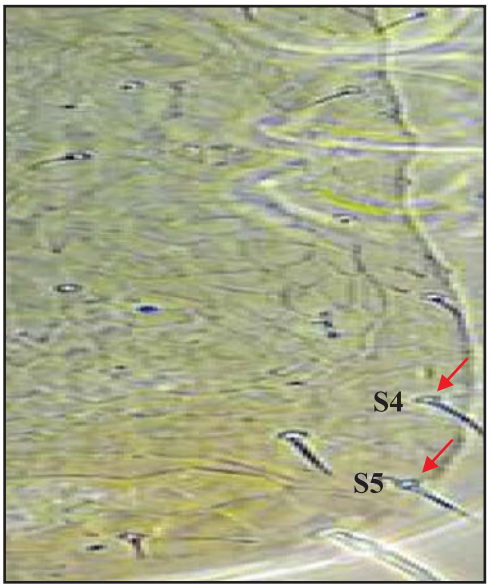
ab. Preanal setae JV2 and ZV2 without forward migration



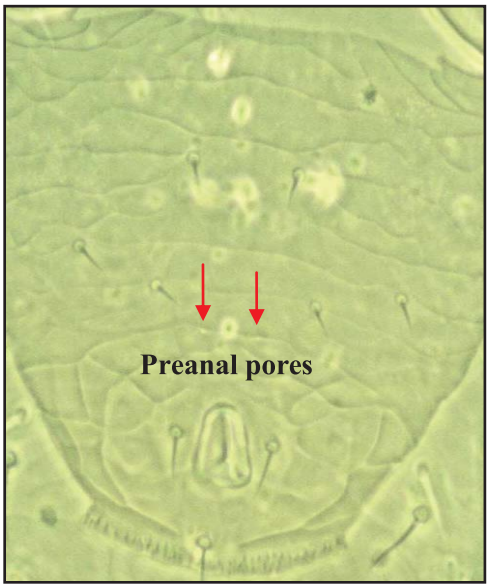
ac. Setae S4, Z4 and setae J2 always present



ad. Setae j3 much longer than j1



ae. S4 longer than S5



af. Preanal pores on the female ventrianal shield narrowly separate. Species – baraki

Plate 1. Taxonomic keys to the super order, order, suborder, cohort, subcohort, family, subfamily, tribe, genus and species of *N. baraki*

Sternal shield. The length of sternal shield from ST1 setae to ST3 setae of adult female was 83.83 ± 0.88 µm (Plate IIIa), whereas in male sternitigenital shield was 120.97 ± 1.35 µm (Plate IIIb), while width at ST3 setae to ST3 setae in female and male were 59.02 ± 0.99 µm (Plate IIIa) and 58.62 ± 0.79 µm (Plate IIIb).

Genital shield. Genital shield narrower than ventrianal shield with few longitudinal striations were present. The length of adult female genital

Table 1. Morphometrics of adult male and female *N. baraki* (N = 25)

	Stage (Adult)		Length (μ m)			Width (μ m)		
			Min.	Max.	Av. ± SD	Min.	Max.	Av. ± SD
Dorsal idiosoma	Female		347.50	354.00	350.91 ± 1.95	156.80	161.05	159.83 ± 1.20
	Male		341.00	347.50	344.20 ± 2.42	150.00	154.50	152.05 ± 1.69
Ventral idiosoma	Female	Sternal shield	82.50	86.00	83.83 ± 0.88	57.00	61.00	59.02 ± 0.99
		Genital shield	118.00	123.00	120.23 ± 1.39	57.80	62.50	60.51 ± 1.31
		Ventrianal shield	110.00	118.00	114.78 ± 1.81	92.00	96.75	94.74 ±1.20
	Male	Sternitigenital shield	119.00	124.00	120.97 ± 1.35	57.00	60.50	58.62 ± 0.79
		Ventrianal shield	111.00	115.50	113.15 ± 1.30	91.00	94.75	92.68 ± 1.06

shield measured about 120.23 ± 1.39 μm (Plate IIIa) and width at ST5 setae to ST5 setae was 60.51± 1.31 μm (Plate IIIa).

Ventrianal shield. Ventrianal shield longer than wide, lightly reticulated, lateral margins rounded with three pairs of preanal setae arranged in triangular pattern and pair of prominent preanal pores which were separated narrowly in between JV2 setae. The length of venrtianal shield of adult female was 114.78 ± 1.81 μm and width at widest point of ZV2 setae level was 94.74 ± 1.20 μm (Plate IIIa), whereas in male the length and width measured about 113.15 ± 1.30 and 92.68 ± 1.06 μm (Plate IIIb), respectively.

Dorsal chaetotaxy of *N. baraki.* The length of dorsal setae present on idiosoma of both female and male were varied slightly. There were total of 33 pairs of setae present in idiosoma, among which 19 pairs inserted in dorsal side (Plate IVa) and 14 pairs on ventral side (Plate IVb). Dorsal shield with seven pairs setae of j-J series, six pairs of z-Z series, four pairs of s-S series and two pairs of r-R series. These dorsal setae were very short in length, smooth and setiform except Z5 setae which longer than all and slightly serrated.

Female dorsal chaetotaxy. The measurements of dorsal setae length were given in micrometer (μm) with minimum, maximum and average length was as follows (Table 2): j1 13.80 to 14.80 (14.18 ± 0.31), j3 16.50 to 18.10 (17.38 ± 0.58), j4 10.80 to 12.20 (11.54 ± 0.51), j5 11.20 to 12.00 (11.65 ± 0.29), j6 13.10 to

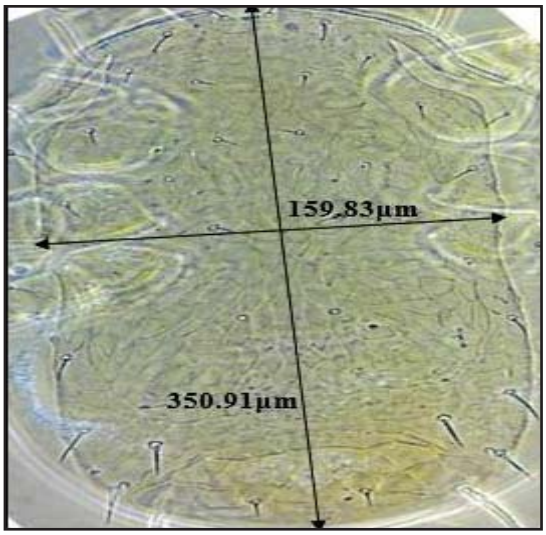


Plate IIa: Female

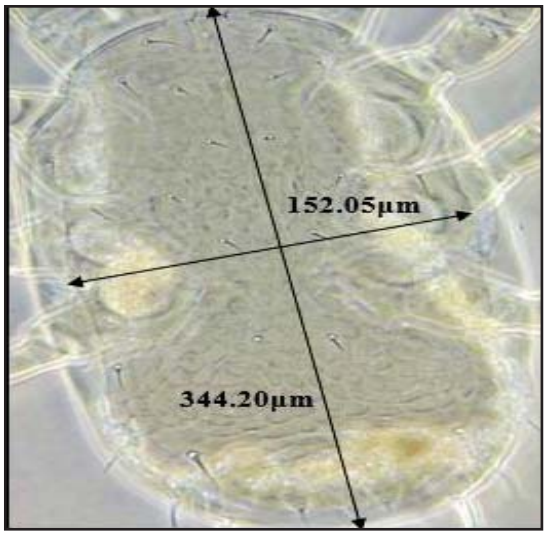


Plate IIb: Male

Plate II: Dorsal idiosoma

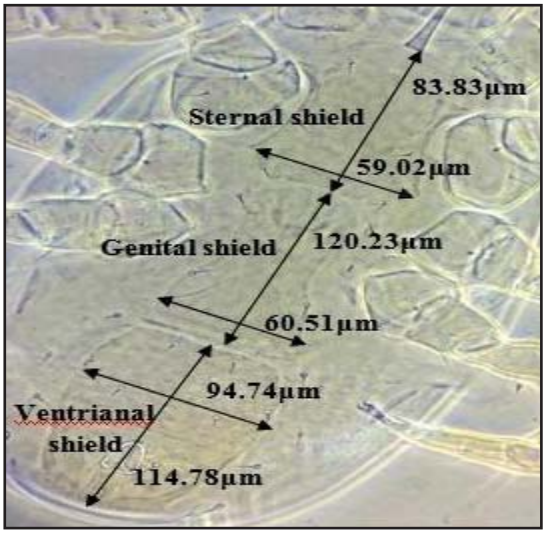


Plate IIIa: Female

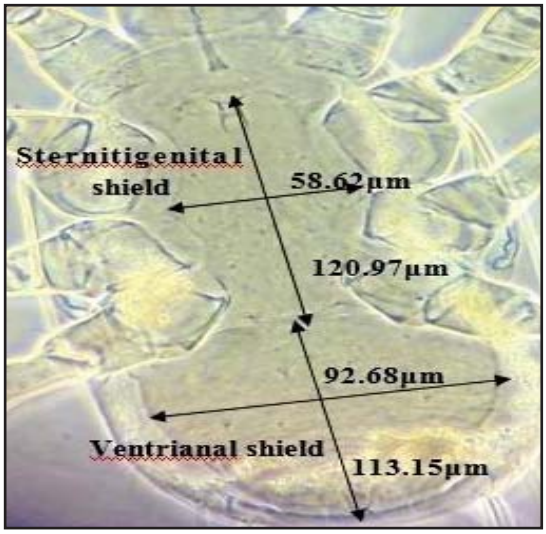


Plate IIIb: Male

Plate III: Ventral idiosoma

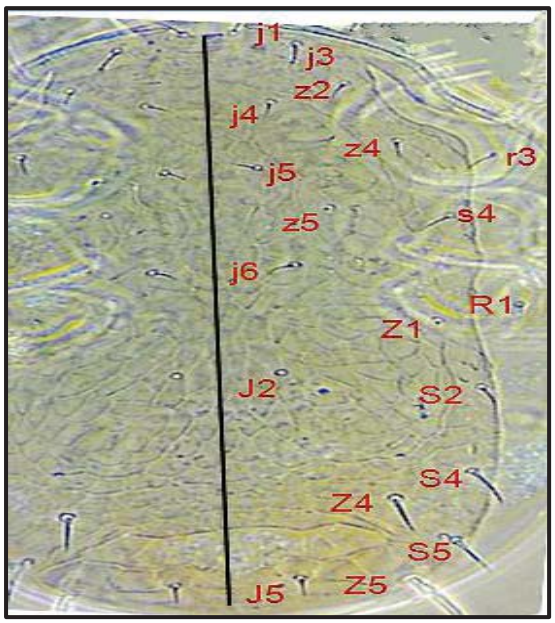


Plate IVa: Dorsal chaetotaxy of *N. baraki*

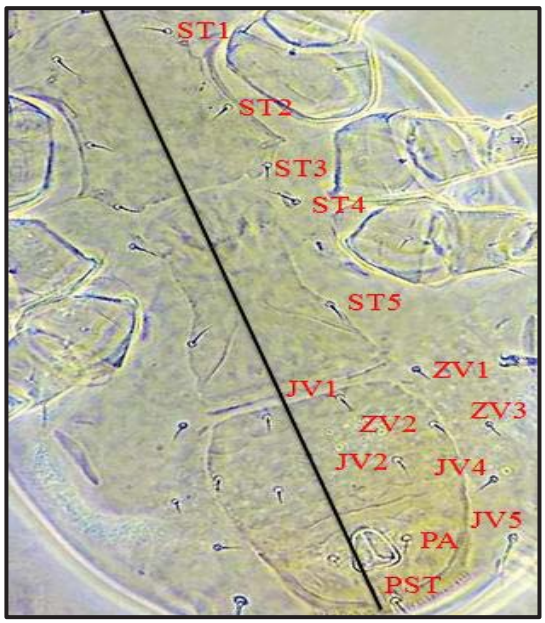


Plate IVb: Ventral chaetotaxy of *N. baraki*

13.80 (13.45 ± 0.23), J2 12.00 to 14.00 (13.21 ± 0.65), J5 11.00 to 11.60 (11.33 ± 0.18), z2 10.00 to 12.00 (11.48 ± 0.69), z4 13.00 to 14.20 (13.59 ± 0.42), z5 10.50 to 11.50 (11.04 ± 0.28), Z1 12.20 to 14.50 (13.17 ± 0.73), Z4 18.90 to 23.00 (21.08 ± 1.18), Z5 65.20 to 69.70 (67.33 ± 1.43), s4 15.20 to 17.00 (16.15 ± 0.57), S2 15.20 to 16.90 (16.18 ± 0.54), S4 25.00 to 26.00 (25.66 ± 0.34), S5 23.00 to 25.10 (24.33 ± 0.82), r3 15.00 to 16.50 (15.90 ± 0.50), R1 14.00 to 14.50 (14.27 ± 0.21) and macro setae in 4th leg 39.00 to 41.00 (39.84 ± 0.69).

Male. The measurements of dorsal setae length were given in µm with minimum, maximum and average length was as follows (Table 2): j1 13.90 to 14.50 (14.13 ± 0.25), j3 16.40 to 17.80 (17.06 ± 0.44), j4 10.00 to 12.00 (11.03 ± 0.58), j5 14.40 to 12.00 (11.72 ± 0.20), j6 13.20 to 14.10 (13.66 ± 0.30), J2 12.00 to 14.00 (13.44 ± 0.58), J5 11.10 to 12.00 (11.48 ± 0.30), z2 10.20 to 12.60 (11.72 ± 0.62), z4 13.30 to 14.70 (13.84 ± 0.40), z5 10.50 to 11.00 (10.94 ± 0.15), Z1 12.00 to 15.00 (13.20 ± 1.17), Z4 18.30 to 22.00 (21.11 ± 1.41), Z5 63.92 to 69.50 (66.56 ± 1.61), s4

Table 2. Dorsal cheatotaxy of *N. baraki* (N = 25)

Sex	Female			Male		
Name of stage	Min.	Max.	Av. ± SD	Min.	Max.	Av. ± SD
j1	13.80	14.80	14.18 ± 0.31	13.90	14.50	14.13 ± 0.25
j3	16.50	18.10	17.38 ± 0.58	16.40	17.80	17.06 ± 0.44
j4	10.80	12.20	11.54 ± 0.51	10.00	12.00	11.03 ± 0.58
j5	11.20	12.00	11.65 ± 0.29	11.40	12.00	11.72 ± 0.20
j6	13.10	13.80	13.45 ± 0.23	13.20	14.10	13.66 ± 0.30
J2	12.00	14.00	13.21 ± 0.65	12.00	14.00	13.44 ± 0.58
J5	11.00	11.60	11.33 ± 0.18	11.10	12.00	11.48 ± 0.30
z2	10.00	12.00	11.48 ± 0.69	10.20	12.60	11.72 ± 0.62
z4	13.00	14.20	13.59 ± 0.42	13.30	14.70	13.84 ± 0.40
z5	10.50	11.50	11.04 ± 0.28	10.50	11.00	10.94 ± 0.15
Z1	12.20	14.50	13.17 ± 0.73	12.00	15.00	13.20 ± 1.17
Z4	18.90	23.00	21.08 ± 1.18	18.30	22.00	21.11 ± 1.41
Z5	65.20	69.70	67.33 ± 1.43	63.92	69.50	66.56 ± 1.61
s4	15.20	17.00	16.15 ± 0.57	15.00	16.80	16.01 ± 0.64
S2	15.20	16.90	16.18 ± 0.54	15.50	17.00	16.01 ± 0.43
S4	25.00	26.00	25.66 ± 0.34	24.00	26.00	25.13 ± 0.71
S5	23.00	25.10	24.33 ± 0.82	22.00	24.20	23.11 ± 0.79
r3	15.00	16.50	15.90 ± 0.50	15.80	17.00	16.18 ± 0.42
R1	14.00	14.50	14.27 ± 0.21	13.70	15.00	14.16 ± 0.41
Macro setae in 4th leg	39.00	41.00	39.84 ± 0.69	39.20	41.50	40.30 ± 0.86

15.00 to 16.80 (16.01 ± 0.64), S2 15.50 to 17.00 (16.01 ± 0.43), S4 24.00 to 26.00 (25.13 ± 0.71), S5 22.00 to 24.20 (23.11 ± 0.79), r3 15.80 to 17.00 (16.18 ± 0.42), R1 13.70 to 15.00 (14.16 ± 0.41) and macro setae in 4th leg 39.20 to 41.50 (40.30 ± 0.86).

The present results were more or less in agreement with past findings of Moraes *et al*. (2004), who studied the taxonomy of *N. baraki* adult female and measurements were given in average, minimum and maximum micrometer. The dorsal shield length 350 (330-375), width at level of s4 160 (146-175); length of setae on dorsal shield were j1 14 (13-16), j3 17 (13-19), j4 11 (9-12), j5 11 (10-18), j6 13 (11-15), J2 12 (10-13), J5 11 (10-13), z2 11 (10-13), z4 14 (10-15), z5 10 (9-15), Z1 12 (11-14), Z4 21 (19-25), Z5 69 (60-73), s4 16 (14-17), S2 15 (14-16), S4 25 (23-27), S5 25 (21-28), r3 15 (13-16) and R1 13 (12-15). Similarly, Gowda (2009) worked on taxonomy of *N. baraki* and measurements were given in average, minimum and maximum in µm. The dorsal shield length 349 (340-358) at R1 setae level, width at point (S2) level 159 (155-167). Idiosoma with total 33 pairs of setae (19 pairs inserted in dorsal and 14 pairs on ventral shield). The measurements of dorsal setae: j1 14 (13- 15), j3 18 (16-19), j4 11 (10-12), j5 11 (11-12), j6 13 (13-14), J2 13 (12-14), J5 11 (11-12), z2 11 (10-13), z4 14 (13-15), z5 11 (10-11), Z1 12 (11-15), Z4 21 (18-23), Z5 69 (65-70), s4 16 (14-17), S2 16 (15-17), S4 26 (25-26), S5 24 (23-26), r3 16 (15-17) and R1 14 (13-15), macro setae on leg IV 40 (39-42). Slight variation in length and width of dorsal and ventral idiosoma as well as setae length might be due to geographic variation of species.

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