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Morphology of adult and tritonymph of *Afronothrus arboreus* Ramani & Haq, 1992

(Acari: Oribatida: Trhypochthoniidae)

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Afronothrus arboreus Ramani & Haq, 1992 (Oribatida, Trhypochthoniidae) is an arboreal oribatid mite species known from the Oriental region. The present study is based on the adult and tritonymphal instars of *A. arboreus* collected from branches and bark of the *Haldina cardifolia* and *Dipterocarpus alatus* trees in the Cat Tien National Park, southern Vietnam. A supplementary description of the adult is presented along with summarized diagnostic morphological traits. The tritonymph is described.

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Introduction

The genus *Afronothrus* (Acari, Oribatida, Trhypochthoniidae) was described by Wallwork (1961), with *Afronothrus incisivus* Wallwork, 1961 as type species. Presently, the genus comprises two species. The first species (*A. incisivus*) is widely distributed in the Afrotropical, Australasian, Neotropical, and Oriental biogeographical regions, and can be considered circumglobal at tropical and perhaps subtropical latitudes. The species inhabits litter-soil, different terrestrial substrates, and arboreal microhabitats (Wang et al. 1999, Corpuz-Raros & Ermilov 2019, 2020, Revelo-Tobar et al. 2024). The second species (*A. arboreus* Ramani & Haq, 1992) was described from leaves of a coconut palm in India (Ramani & Haq 1992). Ermilov and Salavatulin (2025) recorded *A. arboreus* from tree branches and bark of the *Haldina cardifolia* and *Dipterocarpus alatus* trees in Vietnam.

The main goals of the paper are to present a supplementary description of adult and to describe the tritonymphal instar of *A. arboreus*, based on the Vietnamese specimens. The original description of the adult (Ramani & Haq 1992) was incomplete; in particular, it lacks the morphology of the subcapitulum, the morphology and setation of the legs (except leg I), and the length of many setae of the body. Juvenile instars (larva, proto-, deuto-, and tritonymphs) were described in *A. incisivus* by Wang et al. (1999), but remain unknown in *A. arboreus*.

Methods

Sampling. Samples of tree branches and bark were collected via climbing *Haldina cardifolia* and *Dipterocarpus alatus* (using climbing spikes and other special equipment) at a height of 8–20 m above ground in the Cat Tien National Park, southern Vietnam. Mites were subsequently extracted by high-pressure flushing and further by heptane flotation in laboratory conditions. Detailed descriptions of arboreal acarofauna collection and extraction techniques are presented in Salavatulin (2019). The collection locality is given in the Material section.

Observation and documentation. For measurement and illustration, specimens were mounted in lactic acid on temporary cavity slides. All measurements are in micrometers (μm). Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the notogaster (in adult)/gastronotic region

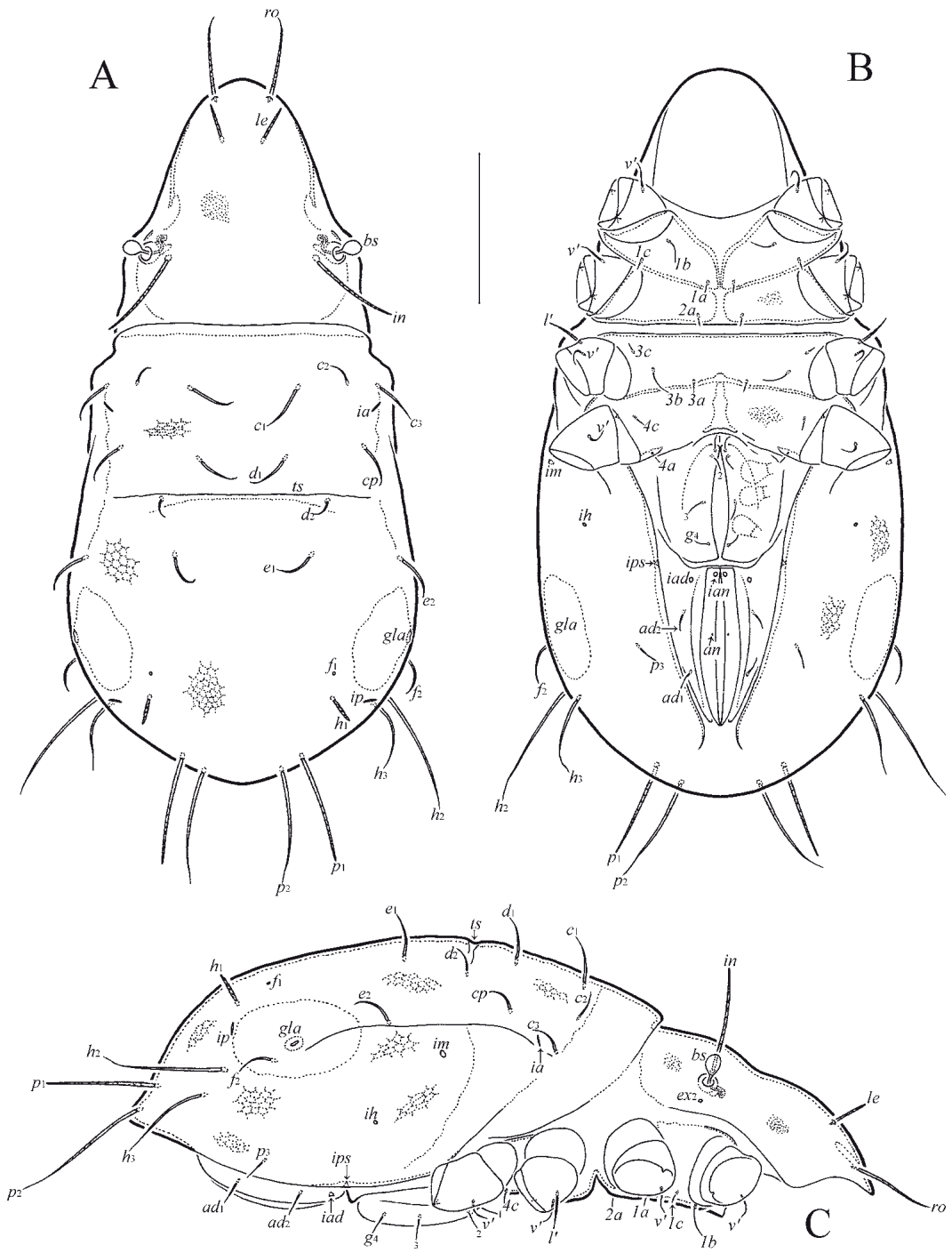

Fig. 1. *Afronothrus arboreus* Ramani & Haq, 1992, adult (gnathosoma and legs except trochanters omitted): **A.** dorsal view; **B.** ventral view; **C.** right lateral view. Scale bar 100 µm.

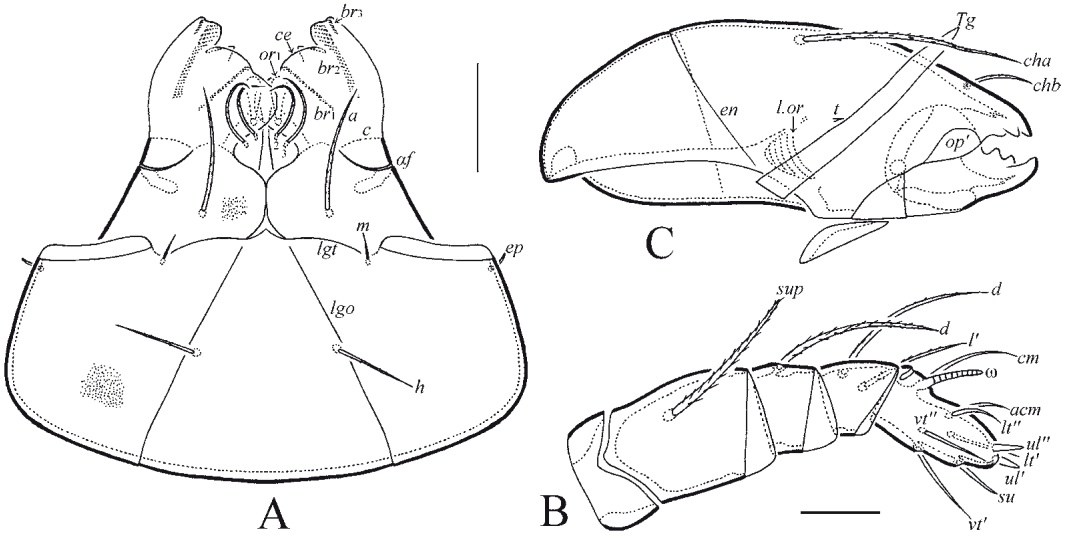

Fig. 2. *Afronothrus arboreus* Ramani & Haq, 1992, adult: **A.** subcapitulum, ventral view; **B.** palp, right, antiaxial view; **C.** chelicera, left, paraxial view. Scale bars 20 µm (A,C), 10 µm (B).

(in tritonymph). Notogastral (adult) /gastronotic (in tritonymph) width refers to the maximum width in dorsal aspect. Setal lengths were measured in lateral aspect. Formulas for leg setation are given in parentheses according to the sequence trochanter-femur-genu-tibia-tarsus (famulus included). Formulas for leg solenidia are given in square brackets, according to the sequence genu-tibia-tarsus. Drawings were made with a camera lucida using a Leica DM 2500 transmission light microscope. Images were obtained with an AxioCam ICc3 camera using a Carl Zeiss transmission light microscope Axio Lab.A. Sometimes image stacks were combined using the Helicon Focus Pro (v. 5.0) suite.

Terminology. Morphological terminology is mostly that of Grandjean (references in Travé & Vachon 1975). Fundamentals of leg setation were reviewed by Norton (1977) and partially supplemented by Norton and Ermilov (2024).

Abbreviations. Prodorsum: *ro*, *le*, *in*, *bs* = rostral, lamellar, interlamellar, and bothridial setae, respectively; *bo* = bothridium; ex_2 = alveolus of second exobothridial seta. Notogaster/gastronotic region: *ts* = partial transverse scissure; c_1–c_3, *cp*, d_1, d_2, e_1, e_2, f_2, h_1–h_3, p_1–p_3 = setae; f_1 = setal alveolus; *ia*, *im*, *ip*, *ih*, *ips* = lyrifissures/cupules; *gla* = opisthonotal gland opening. Gnathosoma: *lgt* = transverse labiogenal articulation; *lgo* = oblique labiogenal articulation; *ce* = distal cutting edge of rutellum; br_1–br_3 = rutellar brushes (comb); *c* = collum; αf = antiaxial manubrial fissure; *a*, *m*, *h* = subcapitular setae; or_1–or_3 = adoral setae; *d*, *sup*, *cm*, *acm*, *ul*, *su*, *vt*, *lt* = palp setae; ω = palp solenidion; *ep* = postpalpal seta; *cha*, *chb* = cheliceral setae; *Tg* = Trägårdh organ; *t* = tooth; *op'* = paraxial oncophysis; *l.or* = lamellated organ; *en* = line of attachment for cheliceral frame. Epimeral region: *ep1* = epimere 1; *ep3* = epimere 3; *1a*, *1b*, *1c*, *2a*, *3a*, *3b*, *3c*, *4a*, *4c* = setae. Anogenital region: g_1–g_4 = anal setae; *an* = alveolus of anal seta; ad_1, ad_2 = adanal setae; *ian* = anal lyrifissure/cupule; *iad* = adanal lyrifissure/cupule. Legs: ω, φ, σ = solenidia; σ_m = pore of second genual solenidion; *d*, *l*, *v*, *bv*, *ev*, *ft*, *tc*, *p*, *u*, *a*, *s*, *pv* = setae.

Notes. Tritonymphal specimens were associated with adults using criteria outlined by Norton and Ermilov (2014). In particular, they were found in the same samples and had appropriate size and proportions.

Paired structures are described in the singular, unless otherwise noted.

Taxonomy

Afronothrus arboreus Ramani & Haq, 1992
Figs 1–8

Material. Nine adults (females) and three tritonymphs: southern Vietnam, Dong Nai Province, Dong Nai Biosphere Reserve, Cat Tien National Park, 11°25'N, 107°25'E, about 130 m a.s.l., branches from *Haldina cardifolia* (height 15–20 m), November–December 2022 (V.M. Salavatulin). Three adults (females) and one tritonymph: same, but branches from *Dipterocarpus alatus*. Two adults (females) and one tritonymph: same, but bark from *D. alatus* (height 8–10 m).

All specimens (preserved in 70% solution of ethanol with a drop of glycerol) are in the personal collection of the author.

Fig. 3. *Afronothrus arboreus* Ramani & Haq, 1992, adult: **A.** leg I, right, antiaxial view; **B.** leg II, left, paraxial view; **C.** leg III, right, paraxial view; **D.** leg IV, left, antiaxial view. Scale bar 50 µm.

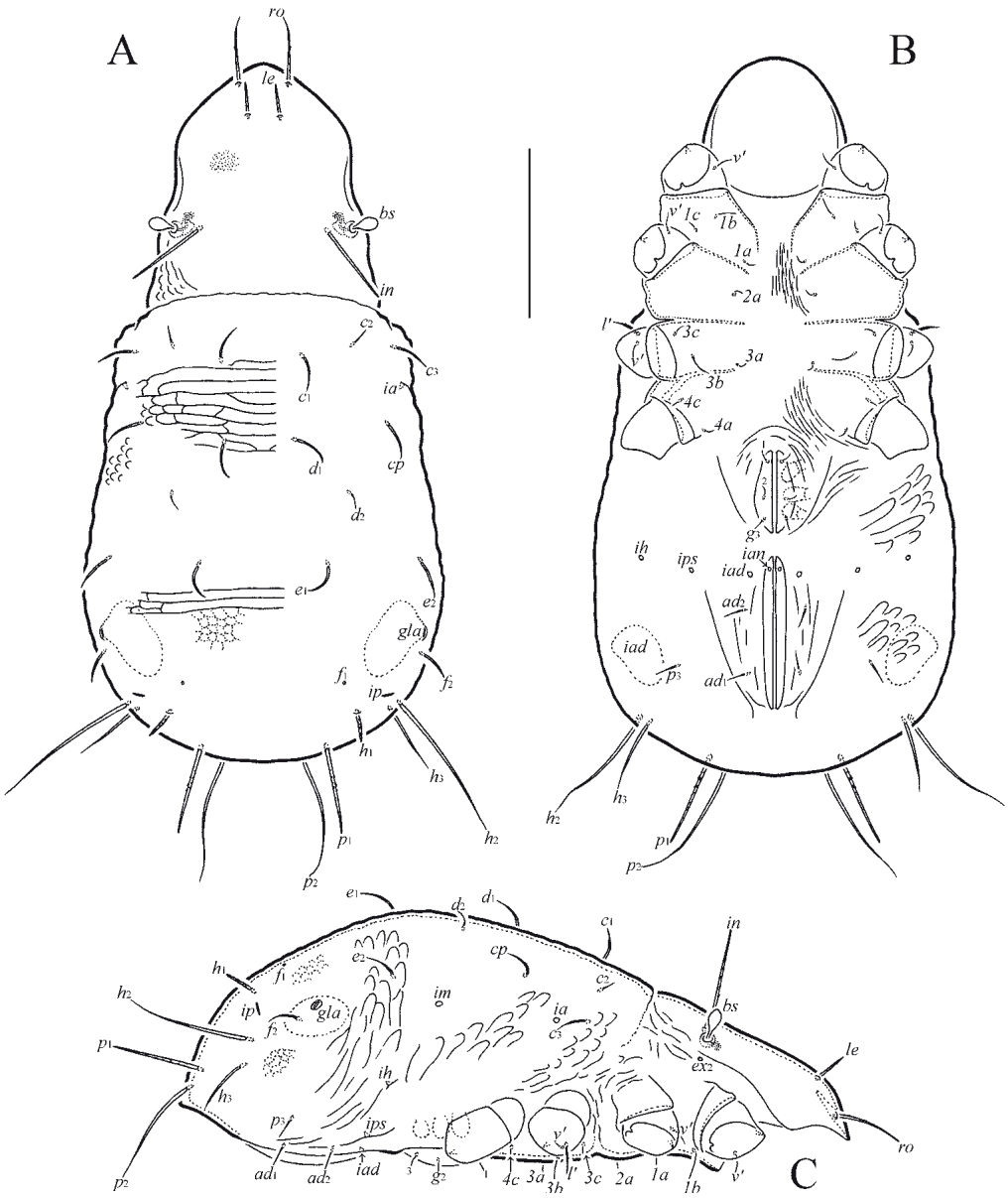

Fig. 4. *Afronothrus arboreus* Ramani & Haq, 1992, tritonymph (gnathosoma and legs except trochanters omitted): **A.** dorsal view; **B.** ventral view; **C.** right lateral view. Scale bar 100 µm.

Supplementary description of adult

Measurements. Body length 450–495; body width 225-247.

Integument. Body colour light brown (Fig. 6A), opisthonotal gland dark brown (Figs 6A, 7L). Body surface densely microporose (clearly visible under high magnification, ×1000). Notogaster with polygonate ornamentation (Figs 6A, 7D), cells transversely elongate and poorly visible in anterior part of notogaster before partial transverse band (Figs 6A, 7G).

Prodorsum (Figs 1A, C, 6A, 7A–C). Rostrum broadly rounded. Rostral seta (49–53) setiform, barbed. Lamellar (22–24) and interlamellar (79–82) setae rod-like, erect, barbed (Fig. 7A). Bothridial seta

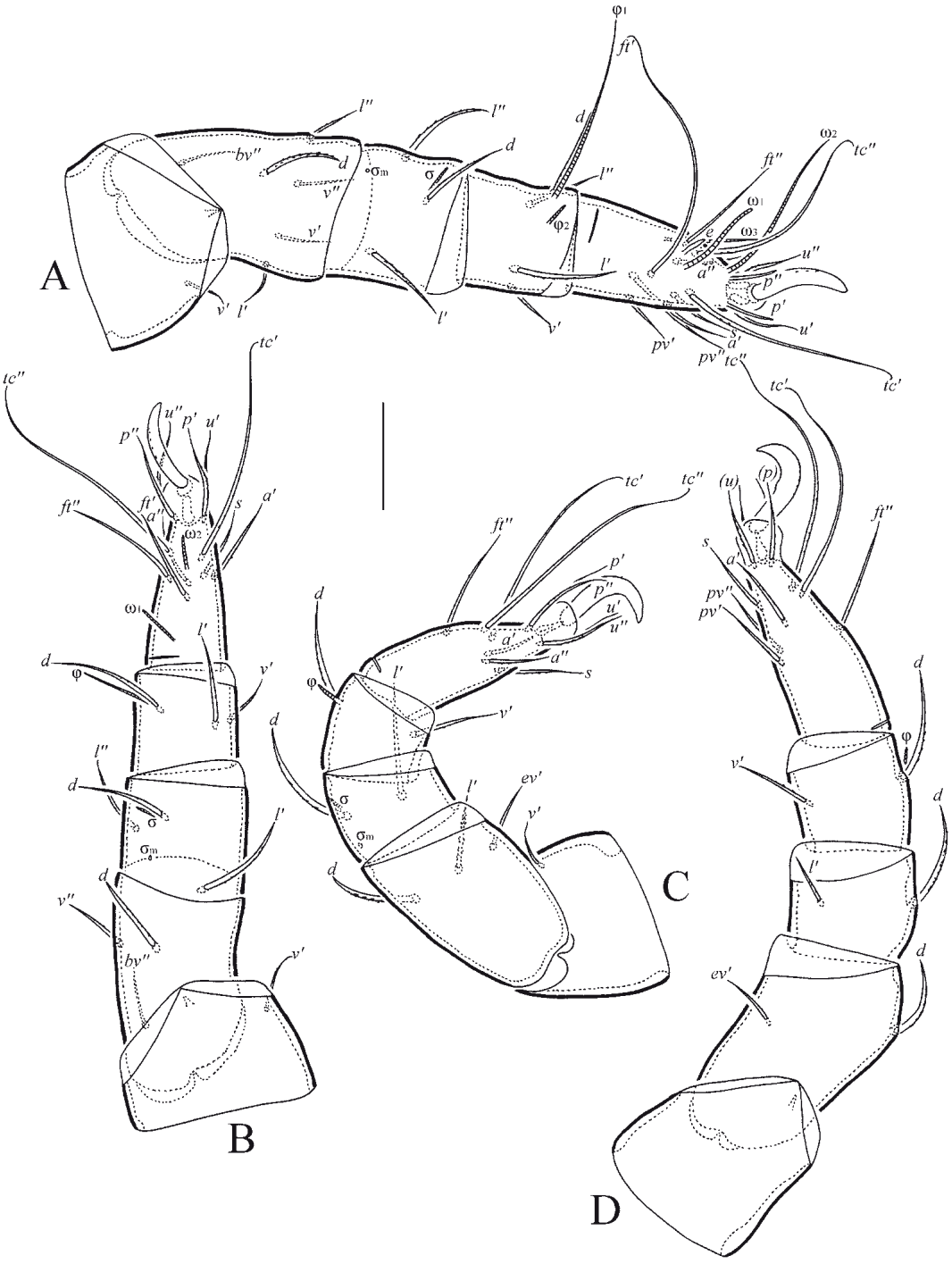

Fig. 5. *Afronothrus arboreus* Ramani & Haq, 1992, tritonymph: **A.** leg I, left, paraxial view; **B.** leg II, left, dorsal view; **C.** leg III, right, paraxial view; **D.** leg IV, left, antiaxial view. Scale bar 20 µm.

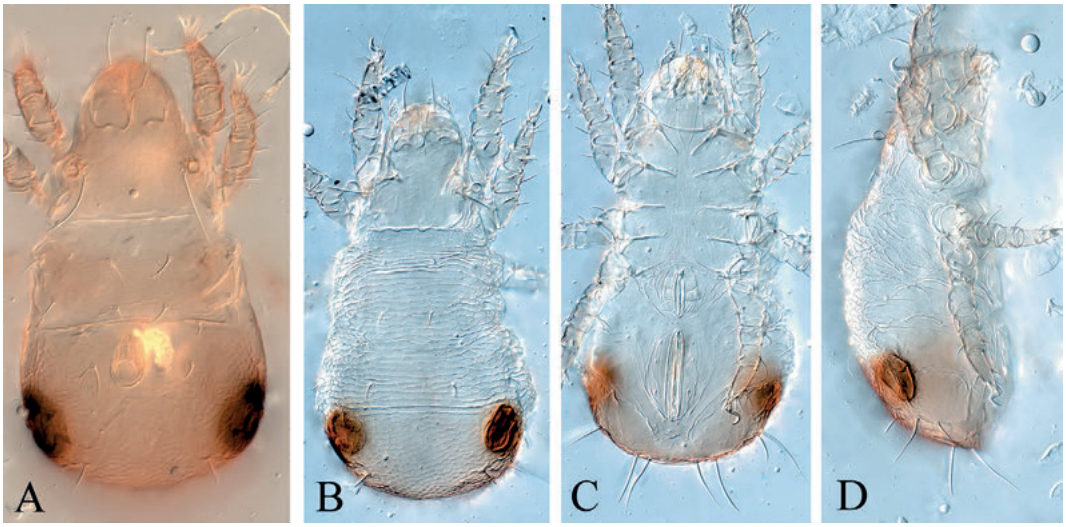

Fig. 6. *Afronothrus arboreus* Ramani & Haq, 1992, adult (A) and tritonymph (B–D), microscope images: **A**, **B.** dorsal view; **C.** ventral view; **D.** right lateral view.

(22–24) capitate, smooth (Fig. 7B). Alveolus of second exobothridial seta poorly visible.

Notogaster (Figs 1A–C, 6A, 7E–L). Partial transverse scissure well developed (Figs 1A, 6A, 7H). Fifteen pairs of setae: f_1 represented by alveolus (Figs 1A, 7I); h_1 (22–26) thickened, sometimes slightly dilated in medial part, heavily barbed (Figs 1A, 6A, 7I–K); p_1 (64–71) rod-like, erect, barbed (Figs 1A, 7E); h_2 and p_2 (90–94) subflagellate, roughened (Figs 1A, 7F); h_3 (64–67), c_2, d_2, p_3 (15–19), and c_1, c_3, d_1, *cp*, e_1, e_2, f_2 (34–37) setiform, roughened (Figs 1A, 7G, H). Opisthonotal gland opening and all lyrifissures distinct.

Gnathosoma (Figs 2A-C, 7M). Subcapitulum size 90–94 × 98–101. Transverse and oblique labiogenal articulations present, but frequently poorly visible. Rutellum with three rows of brushes, two rows (br_1, br_2) long, dorsal, and one row (br_3) short, ventral. Subcapitular setae *a* (22) and *h* (19) setiform, roughened, *m* (4) acicular. Adoral seta or_1 (13) leaf-shaped, dilated mediodistally, smooth, or_2 (19) and or_3 (19) setiform, roughened. Palp length 60. Palp setal formula 0-1-1-2-9 (+ ω). Postpalpal seta (4) spiniform. Chelicera length 86-94. Cheliceral setae (*cha* 41–45; *chb* 15) setiform, barbed.

Epimeral region (Fig. 1B, C). Epimeral setal formula 3-1-3-2. Epimeral setae (*1b*, *3b* 22–26, others 9–11) setiform, roughened.

Anogenital region (Figs 1B, C, 7N–P). Four pairs of genital (11–15) and two pairs of adanal (17–19) setae setiform, roughened. One pair of anal setae represented by alveoli. Anal and adanal lyrifissures well visible.

Table 1. Leg setation and solenidia of adult and tritonymph *Afronothrus arboreus* Ramani & Haq, 1992. TN = tritonymph; AD = adult; *Tr*, *Fe*, *Ge*, *Ti*, *Ta* = trochanter, femur, genu, tibia, and tarsus, respectively. Roman letters refer to normal setae. Greek letters to solenidia. Seta and solenidion coupled: *dφ* and *dσ*, respectively. Single prime (′) marks setae on the anterior and double prime (″) setae on the posterior side of a given leg segment. Parentheses refer to a pair of setae. * – seta usually present, but sometimes absent.

Leg/Instar	*Tr*	*Fe*	*Ge*	*Ti*	*Ta*
I/TN	*v′*	*d*, (*l*), *bv″*, (*v*)	*dσ*, (*l*), σ_m	*dφ*$_1$, (*l*), *v′*, *c″**, φ_2	(*ft*), (*tc*), (*p*), (*u*), (*a*), *s*, (*pv*), *e*, ω_1, ω_2, ω_3
I/AD	*v′*	*d*, (*l*), *bv″*, (*v*)	*dσ*, (*l*), σ_m	*dφ*$_1$, (*l*), *v′*, *c″**, φ_2	(*ft*), (*tc*), (*p*), (*u*), (*a*), *s*, (*pv*), *v′*, *l′*, *e*, ω_1, ω_2, ω_3
II/TN	*v′*	*d*, *l′**, *bv″*, *v″*	*dσ*, (*l*), σ_m	*dφ*, *l′*, *l″**, *v′*	(*ft*), (*tc*), (*p*), (*u*), (*a*), *s*, ω_1, ω_2
II/AD	*v′*	*d*, (*l*), *bv″*, (*v*)	*dσ*, (*l*), σ_m	*dφ*, (*l*), *v′*	(*ft*), (*tc*), (*p*), (*u*), (*a*), *s*, (*v*), ω_1, ω_2
III/TN	*v′*	*d*, *l′*, *ev′*	*dσ*, *l′*, σ_m	*dφ*, *v′*	*ft″*, (*tc*), (*p*), (*u*), (*a*), *s*
III/AD	*l′*, *v′*	*d*, *l′*, *ev′*	*dσ*, *l′*, σ_m	*dφ*, *l′*, *v′*	*ft″*, (*tc*), (*p*), (*u*), (*a*), *s*, *v′*
IV/TN	-	*d*, *ev′*	*d*, *l′**	*dφ*, *v′*	*ft″*, (*tc*), (*p*), (*u*), *a′*, *s*, (*pv*)
IV/AD	*v′*	*d*, *ev′*	*d*, *l′**, *v′*	*dφ*, *l′**, *v′*	*ft″*, (*tc*), (*p*), (*u*), *a′*, *s*, (*pv*), *v′*

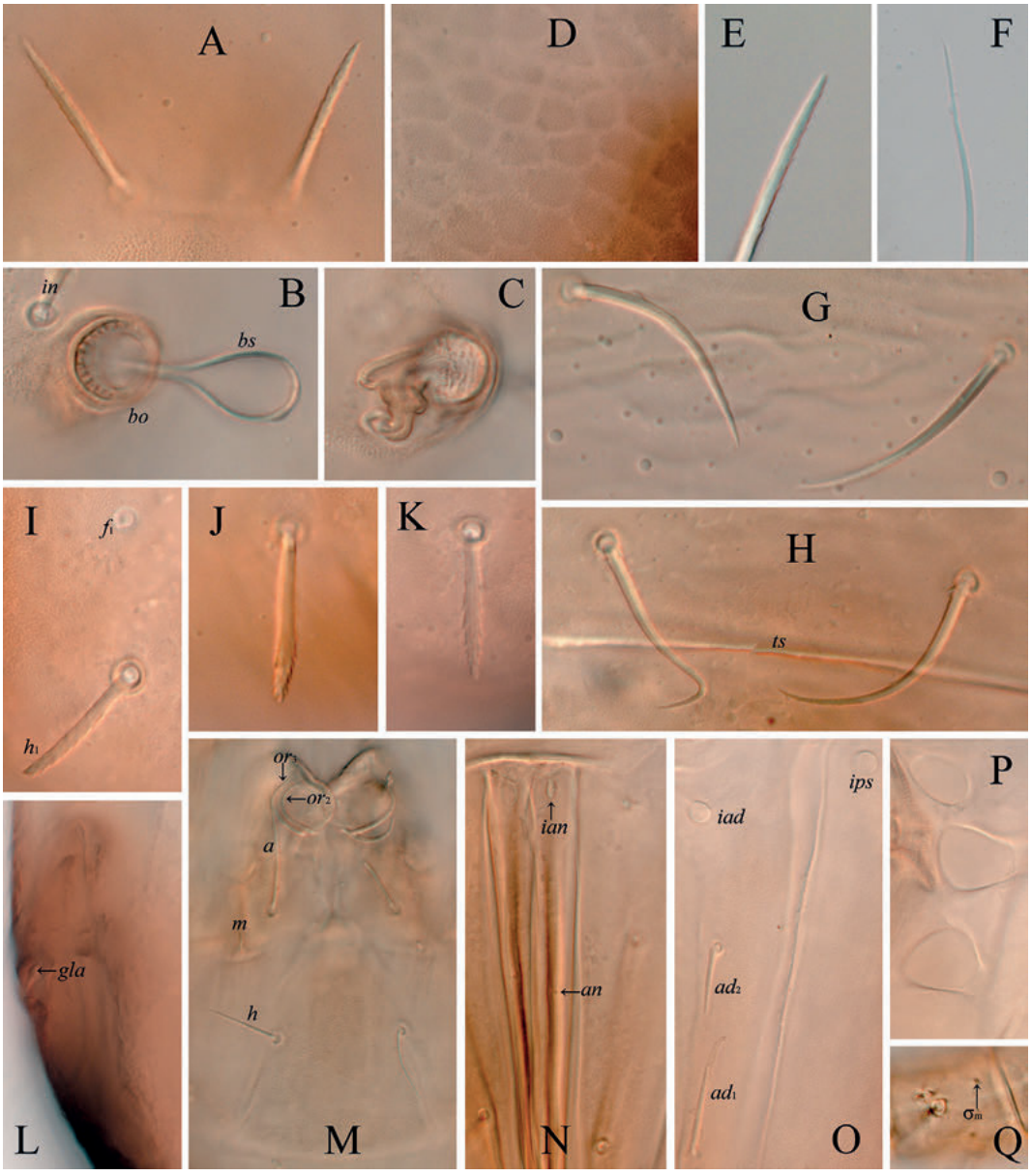

Fig. 7. *Afronothrus arboreus* Ramani & Haq, 1992, adult, microscope images: **A.** lamellar setae; **B.** bothridium and bothridial seta; **C.** bothridium, internal (lower) focus; **D.** ornamentation in posterior part of notogaster; **E**. distal part of notogastral seta p_1; **F.** distal part of notogastral seta p_2; **G.** notogastral setae c_1; **H.** notogastral setae d_1; **I-K.** notogastral setae h_1; **L.** opisthonotal gland; **M.** subcapitulum (lateral part omitted), ventral view; **N.** anal region; **O.** adanal region; **P.** genital papillae; **Q.** genual pore (solenidion σ_m) on genu III. Magnification: 1000.

Legs (Figs 3A–D, 7Q). Tridactylous, claws similar in thickness, slightly barbed on dorsal side. Formulas of leg setation and solenidia: I (1-6-3-5(4)-16) [2-2-3], II (1-6-3-4-13) [2-1-2], III (2-3-2-3-11) [2-1-0], IV (1-2-3(2)-3(2)-12) [0-1-0]. Homology of setae and solenidia indicated in Table 1. Solenidion σ_m on genua I–III represented by pore distanced from coupled seta *d* and solenidion σ.

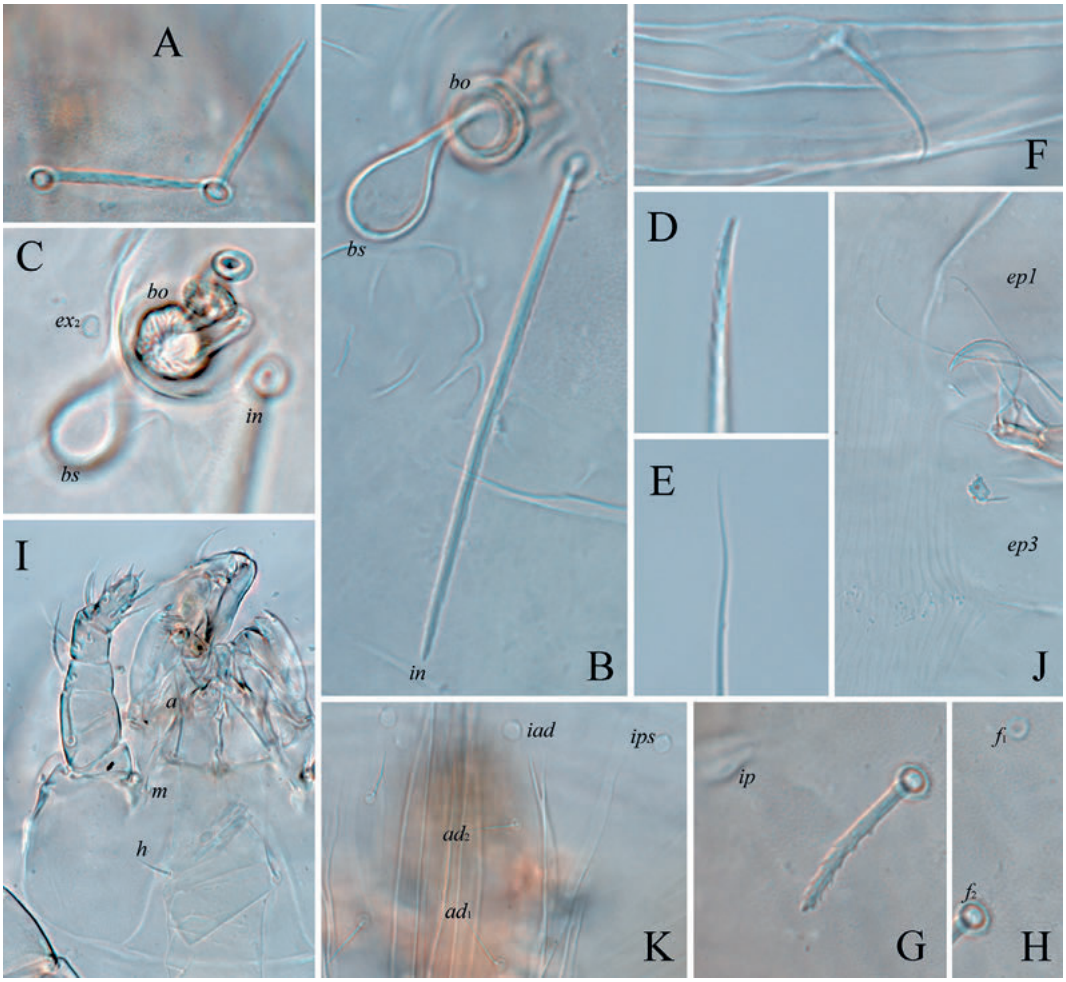

Fig. 8. *Afronothrus arboreus* Ramani & Haq, 1992, tritonymph, microscope images: **A.** lamellar setae; **B.** bothridium, bothridial and interlamellar setae; **C.** bothridium, internal (lower) focus, and alveolus of second exobothridial seta; **D.** distal part of notogastral seta p_1; **E.** distal part of notogastral seta p_2; **F.** notogastral ornamentation and notogastral seta e_1; **G.** notogastral setae h_1; **H.** alveolus of notogastral setae f_1; **I.** gnathosoma (partially), ventral view; **J.** medial epimeral region (partially) and distal part of bent leg tarsus III; **K.** anoadanal region (partially). Magnification: 1000.

Description of tritonymph

Measurements. Body length 390–405; body width 195–225.

Integument. Medioanterior part of body colourless to light yellow, posterior part of body (sometimes also dorsal side of prodorsum) light brown, opisthonotal gland dark brown (Fig. 6B-D). Body surface densely microporose (clearly visible under high magnification, ×1000). Gastronotum with polygonate ornamentation, cells transversely elongate, long, sometimes open forming simple folds in medioanterior and lateral parts of gastronotum (Figs 6B–D, 8F). Anogenital region partially folded. Sternal epimeral region densely folded (Figs 6C, 8J).

Prodorsum (Figs 4A,C, 6B–D, 8A–C). Rostrum broadly rounded. Rostral seta (41–43) setiform, barbed. Lamellar (17–19) and interlamellar (64–75) setae rod-like, erect, barbed (Fig. 8A, B). Bothridial seta (19) capitate, smooth (Fig. 8B). Alveolus of second exobothridial seta poorly visible (Fig. 8C).

Gastronotic region (Figs 4A–C, 6B–D, 8D–H). Partial transverse scissure absent. Fifteen pairs of setae: f_1 represented by alveolus (Figs 4A, 8H);

h_1 (19–22) thickened, sometimes slightly dilated in medial part, heavily barbed (Figs 4A, 8G); p_1 (52–56) rod-like, erect, barbed (Figs 4A, 8D); h_2 and p_2 (71–75) subflagellate, roughened (Figs 4A, 8E); h_3 (41), c_2, d_2, p_3 (11–13), and c_1, c_3, d_1, *cp*, e_1, e_2, f_2 (26–30) setiform, roughened (Figs 4A, 8F). Opisthonotal gland opening and all cupules distinct.

Gnathosoma (Fig. 8I). Generally, similar to adult, except sizes. Subcapitulum size 75 × 79–82. Length of seta *a* 19, *h* 13–15, *m* 4, or_1 11, or_2 and or_3 15. Palp length 45. Length of postpalpal seta 4. Chelicera length 75. Length of cheliceral seta *cha* 30–34, *chb* 11–13.

Epimeral region (Figs 4B, C, 8J). Epimeral setal formula 3-1-3-2. Epimeral setae (*1b*, *3b* 17–19, others 7) setiform, roughened.

Anogenital region (Figs 4B, C, 8K). Three pairs of genital (9) and two pairs of adanal (11–15) setae setiform, roughened. Alveoli of anal setae absent. Anal and adanal cupules well visible.

Legs (Figs 5A–D, 8J). Claws of all legs strong, slightly barbed on dorsal side. Formulas of leg setation and solenidia: I (1-6-3-5 (4)-14) [2-2-3], II (1-4(3)-3-4(3)-11) [2-1-2], III (1-3-2-2-10) [2-1-0], IV (0-2-2(1)-2-11) [0-1-0]. Homology of setae and solenidia indicated in Table 1. Solenidion σ_m on genua I–III represented by pore distanced from coupled seta *d* and solenidion σ.

General remarks

Adults of *A. arboreus* from Vietnam are morphologically similar to those from India described by Ramani and Haq (1992) except smaller body size (450–495 × 225–247 versus 525–587 × 293–306). This difference can be explained by the intraspecific variability.

Based on the supplementary description (above) and the original description (Ramani & Haq 1994) of adult *A. arboreus*, the following diagnostic morphological traits for this adult species can be taken into account:

Body length 450–587. Notogaster polygonate. Rostral seta setiform, barbed. Lamellar and interlamellar setae rod-like, erect, barbed. Relative length *in* > *ro* > *le*. Bothridial seta short, capitate, smooth. Notogastral seta f_1 represented by alveolus; h_1 thickened or slightly dilated in medial part, heavily barbed; p_1 rod-like, erect, barbed; h_2 and p_2 subflagellate, roughened; other setae setiform, roughened. Setae h_2 and p_2 longest, c_2, d_2, and p_3 shortest on notogaster. Epimeral and anogenital setae setiform, roughened. Leg genua I–III with setation 3-3-2 (*v*′ absent).

The adults of *A. arboreus* and *A. incisivus* can be easily distinguished by the morphology of the bothridial seta (capitate versus clavate) and notogastral seta h_1 (thickened or slightly dilated in medial part, heavily barbed versus simple). According to data on supplementary description above, these species differs also in setation of the leg genua I–III (3-3-2, with absence of seta *v*′ on segments versus 4-4-3, with presence of seta *v*′ on segments). The tritonymphs of *A. arboreus* and *A. incisivus* differ from each other in the same as the adults, e. g., by the morphology of the bothridial seta and notogastral seta h_1. Moreover, in *A. arboreus*, leg trochanter III with one seta (versus with two setae in *A. incisivus*), femur II with four (or three) setae (versus with five setae in *A. incisivus*).

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