

## Research Article

# New Species of *Rheotanytarsus* Thienemann and Bause (Diptera: Chironomidae: Tanytarsini) from Darjeeling–Sikkim, Himalaya, India, with Revised Keys to the Adult Males and Pupae of the Species of the Oriental Region

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Three new species of *Rheotanytarsus* Thienemann and Bause are described and illustrated from India. *R. nudicornus* n. sp. belonging to the *aquilus* species group is described as adult male and pupa, *R. spinicornus* n. sp. in the *musciola* group is described as adult male, pupa, and larva, and *R. caputimberus* in the *trivittatus* group is described as adult male with damaged pupa. A possible placement and inclusion of these three new species from India and other seven species recorded from the Oriental China in the key to males of genus *Rheotanytarsus* of Kyerematen et al. are proposed. A probable placement and inclusion of the 2 new species from India in the key to pupae of *Rheotanytarsus* of Kyerematen et al. are also stated. Diagnoses of the *musciola* group and *trivittatus* group are emended.

## 1. Introduction

The genus *Rheotanytarsus* Thienemann and Bause is a diverse predominant group occurring in nearly all lotic water recorded from all biogeographic regions except Antarctica comprising more than 100 nominal worldwide species [1]. The larvae of *Rheotanytarsus* are rheobiontic, filter feeding using nets stretching between the anterior “arms” of their characteristic cases. The silk mesh retains suspended detritus from the water flowing past the case. Detritus are utilized as food and for dwelling material by the larvae [1]. Most larvae live in moderately fast-to-slow flowing rivers, streams, and creeks and rarely in stagnant water—more likely in near-shore habitats in wind-driven currents on lakes [2]. The larvae may be phoretic on a number of other aquatic invertebrates including naiads of odonates, may flies, larvae of caddisflies, megalopteran insects, and gastropod molluscs [3].

Most species are described based on male adults including their distinctive genitalia; fewer are also known from their immature stages as Lehmann [4] described many western

European species with their pupae while Cranston [5] did for Australian ones. “Composition of tentative species groups” of the genus *Rheotanytarsus* based on both pupal exuviae and adult males made by Sæther and Kyerematen [6] has been followed here. Of the three new species, *R. nudicornus* n. sp. belongs to the *aquilus* species group described as adult male and pupa, *R. spinicornus* n. sp. in the *musciola* group as adult male, pupa, and larva, and *R. caputimberus* n. sp. in the *trivittatus* group as adult male and damaged pupa. A possible position and insertion of these three proposed Indian species and other seven species reported from Oriental China [7] including four species, namely, *R. bullus*, *R. liuae*, *R. polychaetus*, and *R. quadratus* described by Wang and Guo [7], *R. tamaterius* Sasa of Palaeartic Japan, *R. buculicaudus* Kyerematen, Andersen & Sæther of Ghana and *R. musciola* Thienemann of Holarctic Region including Palaeartic China in the key to known males of genus *Rheotanytarsus* of Kyerematen et al. [2] are proposed. A probable placement and inclusion of the 2 new species from India in the key to known pupae of *Rheotanytarsus* of Kyerematen et

al. [2] are also provided. Moubayed described *Rheotanytarsus orientalis* [8] and *Rheotanytarsus thailandensis* [9] from Thailand. Kyerematen et al. [2] made a review of the 26 species of Oriental *Rheotanytarsus*. Chaudhuri et al. [10] recorded four species of the genus from India. Later Wang & Guo [7] reviewed the genus from China stating seven species from Oriental China. With the addition of three new species here described, the number of species now increases to seven from India and thirty-six from the Oriental Region. Diagnoses of the *muscolola* group and *trivittatus* group are emended after examination of *Rheotanytarsus spinicornus* n. sp. and *Rheotanytarsus caputimberus* n. sp., respectively.

## 2. Material and Methods

The larvae collected from the streams of the Darjeeling–Sikkim, Himalaya, were reared in the glass vials containing substratum of the natural habitat plugged with cotton. The specimens were mounted on microslides following the method of Hazra et al. [11]. Morphological terminologies and abbreviations follow Sæther [12] and Epler et al. [1]. Measurements are expressed in micrometers ( $\mu\text{m}$ ) except the total length and wing length which are in millimetres (mm) with the ranges suffixed by “*n*” in parentheses denoting the number of specimens considered.

Types of the new species specimens now retained with the entomological collections of the Department of Zoology, University of Burdwan (India), will be deposited at the National Zoological Collections (NZC), Kolkata, in due course.

## 3. Results and Discussion

### 3.1. *The aquilus* Group [6]

*Rheotanytarsus nudicornus* n. sp. <http://zoobank.org/NomenclaturalActs/4A09B167-16BE-43E4-ACE8-432D832DDBDF> (Figures 1-2).

**3.1.1. Studied Specimens.** Holotype (male with pupal exuviae) (reared) (Type number B.U. Ent. 268), India, Sikkim, Jorethang (27°20'00"N; 88°35'00"E), 31/iii/1996, N. Hazra leg. Paratype (1 male), as holotype.

**3.1.2. Etymology.** From the Latin *nudus*, bare, and *cornus*, horn, referring to the bare thoracic horn of the pupa.

### 3.1.3. Description

**Adult Male** ( $n = 2$ ) (Figure 1). Total length 2.40–2.5 mm. Wing length 1.56 mm. Total length/wing length 1.54–1.61. Wing length/length of profemur 2. Thorax light brown, abdomen and legs pale yellow.

**Head.** AR 0.48–0.50; flagellomere 12 (Fm 12) 192–196  $\mu\text{m}$  long. Eye with 60–64  $\mu\text{m}$  long dorsomedial extension. Temporal setae 6, including 2 inner verticals (IV), 2 outer verticles

(OV) and 2 postoculars (Po). Clypeus with 17–19 setae. Tentorial length 105  $\mu\text{m}$ , 19  $\mu\text{m}$  wide at sieve pore, 9  $\mu\text{m}$  wide at posterior tentorial pit. Palpomere lengths (I–V): 27  $\mu\text{m}$ , 30  $\mu\text{m}$ , 84  $\mu\text{m}$ , 93  $\mu\text{m}$ , 117  $\mu\text{m}$ .

**Thorax.** Acrostichals 12–14; dorsocentrals 9–10; scutellars 9–10.

**Wing** (Figure 1(a)). Membrane covered with setae, especially in distal half. Costal length 1.59 mm. Costa not extended. CR 0.90. VR 1.51. Sc, M and  $\text{Cu}_1$  bare, R with 16–18 setae;  $R_1$  7–9;  $R_{4+5}$  60–64;  $M_{1+2}$  54–56;  $M_{3+4}$  48–52; Cu 60–64; PCu 68–70; An 26–28. Cell m with 10–12 setae,  $r_{4+5}$  about 68,  $m_{3+4}$  about 10, cu and an combined about 40 setae.  $R_{2+3}$  absent. RM well proximal to FCu.

**Legs.** Spur of fore tibia (ti) 22–24  $\mu\text{m}$  long; spurs of mid ti unequal 20–22  $\mu\text{m}$  and 32–34  $\mu\text{m}$  long including 36–38 of comb; of hind ti spurs 26–28  $\mu\text{m}$  and 36–38  $\mu\text{m}$  long including 40–42 of comb. Width at the apex of fore tibia 36–40  $\mu\text{m}$ ; mid tibia 32–34  $\mu\text{m}$ ; hind tibia 38–40  $\mu\text{m}$ . Lengths and proportions of leg segments as in Table 1.

**Hypopygium** (Figures 1(b)–1(f)). Tergite IX with 16–18 setae, anal tergite band V-shaped, separate, not joined by basal tergite band. Anal point 40–42  $\mu\text{m}$  long, 8–10  $\mu\text{m}$  wide at base, 6  $\mu\text{m}$  wide at apex. Crest narrowly V-shaped and basally open, 40–44  $\mu\text{m}$  long. Phallapodeme 45  $\mu\text{m}$  long, transverse sternapodeme 54  $\mu\text{m}$  long. Superior volsella (Figure 1(d)) 45  $\mu\text{m}$  long, oval with knob like little apical projection; median volsella (Figure 1(e)) relatively short, 33  $\mu\text{m}$  long, subulate setae fused into plate, not extending beyond both superior and inferior volsella; inferior volsella (Figure 1(f)) 60  $\mu\text{m}$  long with 11–13 setae at apex. Gonocoxite 81  $\mu\text{m}$  long; gonostylus 87  $\mu\text{m}$  long, 26–28  $\mu\text{m}$  wide at mid point with distal part not abruptly narrowed. HR 0.93, HV 2.75.

**Pupa** ( $n = 2$ ) (Figure 2). Total length 3.51 mm. Exuviae little dark.

**Cephalothorax.** Frontal apotome (Figure 2(a)) rugulose. Frontal setae 46–48  $\mu\text{m}$  long, seated medially, arising from tubercles. Thoracic horn (Figure 2(b)) 216  $\mu\text{m}$  long, slender, pointed at the apex and completely bare. Thorax smooth, wing sheath with prominent nose (Figure 2(c)), 18–21  $\mu\text{m}$  long. Two anteprenotals, one median anteprenotal 36  $\mu\text{m}$  long and one lateral anteprenotal 18  $\mu\text{m}$  long. Three precorneals, anterior one 63  $\mu\text{m}$  long, lemelliform; median one 36  $\mu\text{m}$  long and posterior 36  $\mu\text{m}$  long. Dorsocentrals  $\text{Dc}_1$  and  $\text{Dc}_2$  paired 14–18  $\mu\text{m}$  and 10–12  $\mu\text{m}$  long respectively and  $\text{Dc}_3$  and  $\text{Dc}_4$  also paired, 20–24  $\mu\text{m}$  and 6–10  $\mu\text{m}$  long respectively; distance between two paired dorsocentrals 78–82  $\mu\text{m}$ .

**Abdomen** (Figures 2(d)–2(g)). Tergite I bare. Tergites II–V with anterior pair of spines of circular patches. Tergites III–V with extensive shagreen present posterior of circular patches extending over and beyond the first dorsal seta, most pronounced on tergite V. Pair of circular patches on tergite V smaller than others. Median shagreen essentially absent,

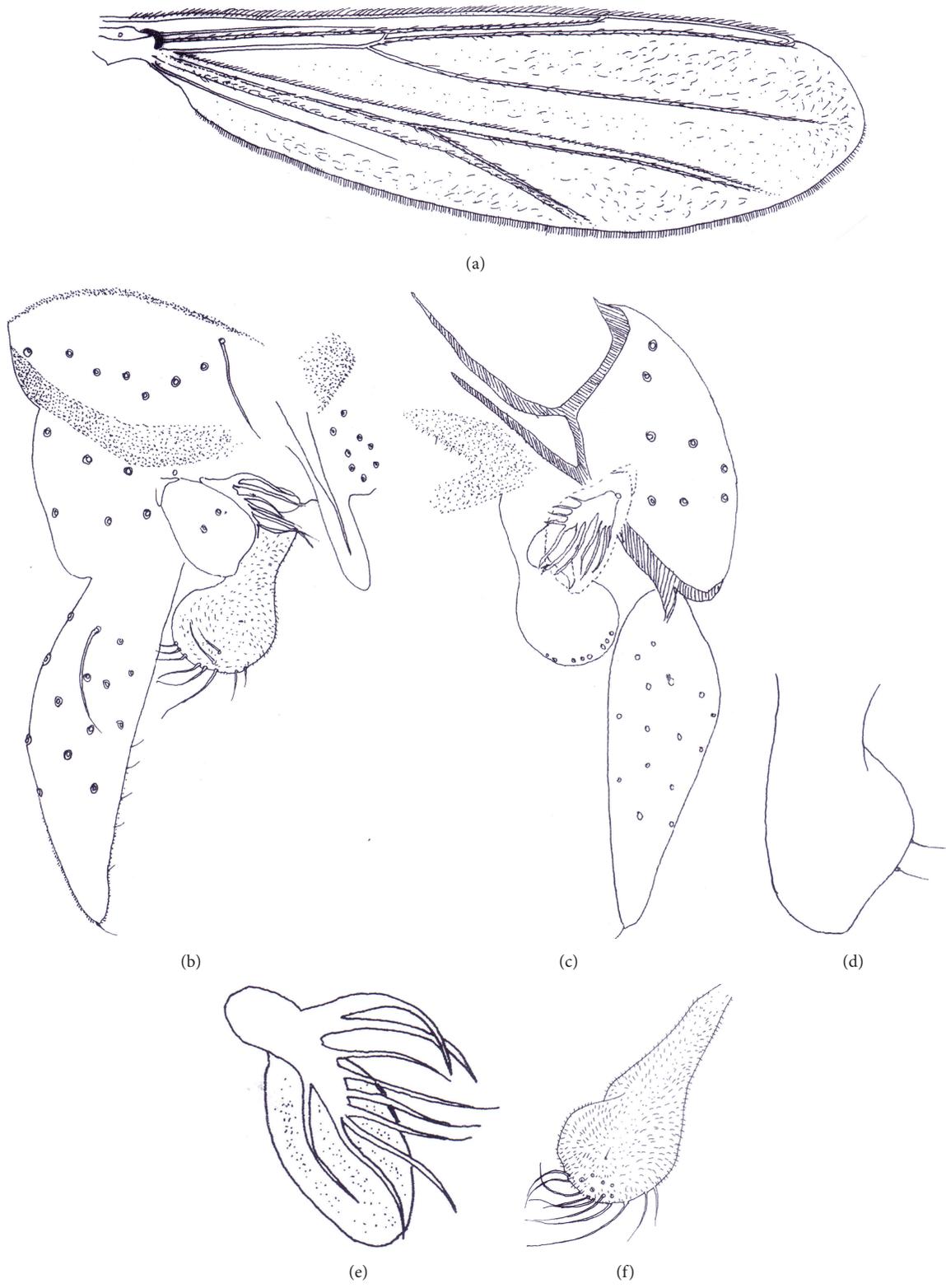


FIGURE 1: *Rheotanytarsus nudicornus* n. sp., adult male: (a) wing; (b) hypopygium (left-dorsal view); (c) hypopygium (right-ventral view); (d) superior volsella; (e) median volsella; and (f) inferior volsella.

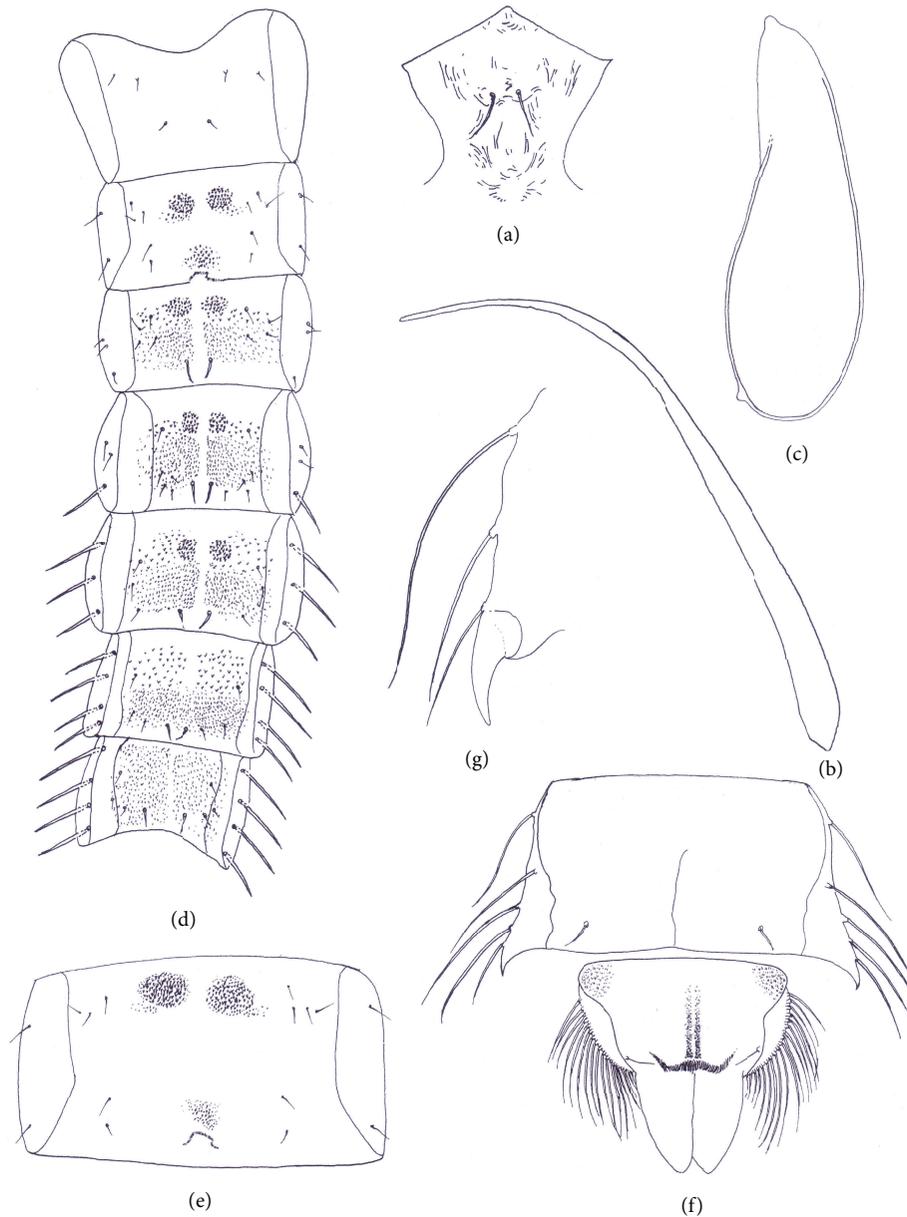


FIGURE 2: *Rheotanytarsus nudicornus* n. sp., pupa: (a) frontal apotome; (b) thoracic horn; (c) wing sheath; (d) tergites I–VII; (e) tergite II; (f) tergite VIII and anal lobe; and (g) caudolateral spur.

TABLE 1: Lengths ( $\mu\text{m}$ ) and proportions of leg segments.

	fe	ti	ta <sub>1</sub>	ta <sub>2</sub>	ta <sub>3</sub>	ta <sub>4</sub>	ta <sub>5</sub>	LR	BV	SV
P <sub>1</sub>	765	405	900	465	330	420	150	2.23	1.51	1.3
P <sub>2</sub>	675	615	345	165	120	90	75	0.56	3.64	3.74
P <sub>3</sub>	855	705	480	285	240	135	105	0.68	2.67	3.25

weak and sparse shagreen present caudolaterally on tergites IV–V. Number of spines on patches tergites II–V: 94–100; 84–88; 70–74; 44–48. Tergite II with additional few shagreen of very fine spinules just above the hook row; hook row small, not dividing medially, occupying  $0.08 \mu\text{m}$  width of the segment width, containing about 36–40 hooklets (Figure 2(e)).

Conjunctives without shagreen. Segment II with 2 L setae, III with 3 fine L setae; IV with 2 L setae and 1 posterior LS seta; V with 3 LS setae; VI–VII with 4 LS setae; VIII (Figure 2(f)) with 5 LS setae. Caudolateral spur (Figure 2(g)), single,  $22\text{--}25 \mu\text{m}$  long. Shagreen present anterolaterally on anal lobe,  $117 \mu\text{m}$  long and  $163 \mu\text{m}$  wide with 34–36 taeniae in fringe,

longest taenia 180–192  $\mu\text{m}$  long. Anal lobe (Figure 2(f)) with one hair-like dorsal seta 36  $\mu\text{m}$  long. ALR 1.45, G/F 1.71.

**3.1.4. Remarks.** *Rheotanytarsus nudicornus* n. sp. is close to Afrotropical species *R. aquilus* Kyerematen & Sæther [13] in number of flagellomeres, wing length, number of acrostichals, absence of basal tergite band, median volsella not reaching beyond the apex of superior volsella but differs in AR, HR, shape of median volsella, anal point and anal crest. The species may be separated from other species of the *aquilus* group including oriental species *R. bullus* Wang & Guo [7], *R. kuantanensis* Kyerematen, Andersen & Sæther [2], *R. madarihatensis* Kyerematen, Andersen & Sæther [2], and *R. polychaetus* Wang & Guo [7], with 12 flagellomeres and gonostylus not abruptly narrowed by the following combination of characters: (i) anal tergite band V-shaped not joined by basal tergite band, (ii) anal crest narrowly V-shaped and open at the base, (iii) superior volsella oval with knob-like small apical projection, (iv) subulate setae of median volsella fused to form a plate in adult male, and (v) bare thoracic horn, without a median bend, (vi) tergites II–V with anterior pair of spines of circular patches, (vii) posterior spinules on tergite II undivided, and (viii) anal lobe with hair-like dorsal seta of the pupa.

### 3.2. The muscicola Group [6]

**Emended Diagnosis.** Anal lobe of pupa with or without dorsal seta and superior volsella of male with or without knob-like or slightly hooked posterior extension.

*Rheotanytarsus spinicornus* n. sp. <http://zoobank.org/NomenclaturalActs/CDE958CA-F272-4CB9-B8EA-2B85D6C3DB0A> (Figures 3–5).

**3.2.1. Studied Specimens.** Holotype (male with pupal and larval exuviae) (reared) (Type number B.U. Ent. 269), India, West Bengal, Darjeeling (27°05'00"N; 88°26'67"E), 23/v/1996, N. Hazra leg; Paratypes (4 males with pupal exuviae) (reared), as holotype.

**3.2.2. Etymology.** From the Latin *spina*, spine, and *cornus*, horn, referring to the numerous/many spinules of the thoracic horn of the pupa.

### 3.2.3. Description

**Adult Male** ( $n = 5$ ) (Figure 3). Total length 1.85–1.88 mm. Wing length 1.37–1.4 mm. Total length/wing length 1.34–1.35. Wing length/length of profemur 1.9–1.95. Thorax, abdomen and legs pale yellow.

**Head.** AR 0.31–0.38; flagellomere 13 (Fm 13) 106–110  $\mu\text{m}$  long with a large seta 50–62  $\mu\text{m}$  long. Eye with 42–50  $\mu\text{m}$  long dorsomedial extension. Temporal setae 6–7, including 2 inner verticals (IV), 3 outer verticals (OV) and 1–2 postoculars (Po). Clypeus with 19–21 setae. Tentorium not measurable.

Palpomere lengths (I–V): 18–20  $\mu\text{m}$ ; 26–34  $\mu\text{m}$ ; 56–68  $\mu\text{m}$ ; 86–102  $\mu\text{m}$ ; 98–126  $\mu\text{m}$ .

**Thorax.** Acrostichals 12–13; dorsocentrals 11–13; scutellars 8.

**Wing** (Figure 3(a)). Membrane densely covered with setae, especially in distal half. Costal length 1.24 mm. Costa not extended. CR 0.90. VR 1.40. Sc, M and RM bare, R with 22–26 setae;  $R_1$  28–32;  $R_{4+5}$  64–66;  $M_{1+2}$  48–52;  $M_{3+4}$  104–108; Cu 32–34;  $Cu_1$  22–26; PCu 46–48; An 25. Cell m with 5–10 setae,  $r_{4+5}$  about 200,  $m_{3+4}$  about 50, cu and an combined 25 setae. RM well proximal to FCu.

**Legs.** Spur of fore tibia (ti) 20–24  $\mu\text{m}$  long; spurs of mid ti unequal 24–28  $\mu\text{m}$  and 36–38  $\mu\text{m}$  long including 12–14 of comb; spurs of hind ti 28–30  $\mu\text{m}$  and 30–32  $\mu\text{m}$  including 12–16 of comb. Width at the apex of fore tibia 26–28  $\mu\text{m}$ ; mid tibia 34–36  $\mu\text{m}$ ; hind tibia 32–36  $\mu\text{m}$ . Lengths and proportions of leg segments as in Table 2.

**Hypopygium** (Figures 3(b)–3(f)). Tergite IX with 11–13 setae and prominent shoulder. Anal tergite band V-shaped with medially joined 33  $\mu\text{m}$  long basal tergite band. Anal point spatulate 58–62  $\mu\text{m}$  long, 8  $\mu\text{m}$  wide at base, 6  $\mu\text{m}$  wide at apex; crest nearly V-shaped, open. Phallopodeme 27  $\mu\text{m}$  long, coxapodeme 45  $\mu\text{m}$  long, lateral sternapodeme 57  $\mu\text{m}$  long, transverse sternapodeme 54  $\mu\text{m}$  long. Superior volsella (Figure 3(d)) 50–52  $\mu\text{m}$  long, 15  $\mu\text{m}$  wide, ovoid; median volsella (Figure 3(e)) 40–42  $\mu\text{m}$  long with subulate setae fused into a plate with apical point not extending beyond both superior volsella and inferior volsella; inferior volsella (Figure 3(f)) 42–44  $\mu\text{m}$  long with 7–8 setae and microtrichia. Gonocoxite 56–58  $\mu\text{m}$  long; Gonostylus 84–88  $\mu\text{m}$  long, abruptly narrowed distally. HR 0.66–0.67, HV 1.67.

**Pupa** ( $n = 5$ ) (Figure 4). Total length 3.07–3.11 mm. Exuviae pale with outer edge of cephalothorax and margins of tergite VIII darker.

**Cephalothorax.** Frontal apotome (Figure 4(a)) rugulose. Frontal setae 75–80  $\mu\text{m}$  long, seated medially, arising from tubercles. Thoracic horn (Figure 4(b)) 518–526  $\mu\text{m}$  long, 35 width at base, without a median bend with many spinules in distal 2/3, horn arising from oval base. Thorax smooth, wing sheath with prominent nose (Figure 4(c)), 15–24  $\mu\text{m}$  long. Two anteprenotals, one median anteprenotals 136–140  $\mu\text{m}$  long and one lateral anteprenotals 40–44  $\mu\text{m}$  long. Three pre-corneals, anterior one 150–156  $\mu\text{m}$  long, lamelliform; median one 60–66  $\mu\text{m}$  long, lamelliform and posterior one 64–68  $\mu\text{m}$  long. Dorsocentrals  $Dc_1$  and  $Dc_2$  paired 32–36  $\mu\text{m}$  and 12–16  $\mu\text{m}$  long respectively and  $Dc_3$  and  $Dc_4$  also paired, 62–70  $\mu\text{m}$  and 14–18  $\mu\text{m}$  long respectively; distance between two paired dorsocentrals 38–42  $\mu\text{m}$ .

**Abdomen** (Figures 4(d)–4(g)). Tergite I bare. Tergites II–V with circular anterior pair of spines patches; posterior spinules on tergite II undivided (Figure 4(e)). Tergites III–V with shagreen next to circular patches extending over and beyond the first dorsal seta. Pair of circular patches on tergite V smaller than others. Median shagreen essentially

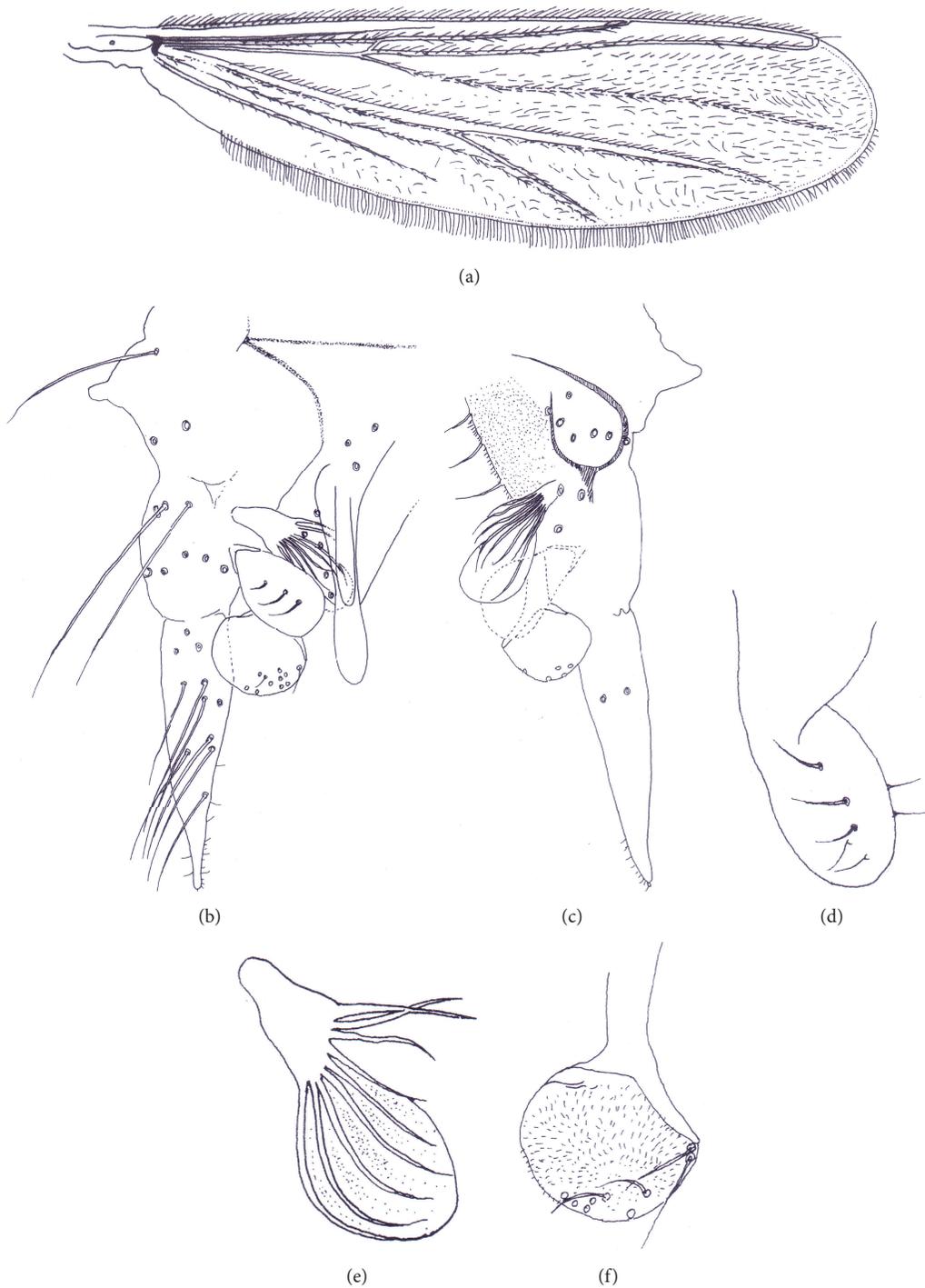


FIGURE 3: *Rheatanytarsus spinicornus* n. sp., adult male: (a) wing; (b) hypopygium (left-dorsal view); (c) hypopygium (right-ventral view); (d) superior volsella; (e) median volsella; (f) inferior volsella.

TABLE 2: Lengths ( $\mu\text{m}$ ) and proportions of leg segments.

	fe	ti	ta <sub>1</sub>	ta <sub>2</sub>	ta <sub>3</sub>	ta <sub>4</sub>	ta <sub>5</sub>	LR	BV	SV
P <sub>1</sub>	676–690	360–374	870–884	420–434	286–300	240–254	106–120	2.36–2.42	1.76–1.82	1.19–1.20
P <sub>2</sub>	660–674	510–524	270–286	136–150	106–120	60–74	46–60	0.53–0.54	3.67–4.14	4.19–4.34
P <sub>3</sub>	690–704	616–630	450–464	226–254	210–224	136–150	60–74	0.73–0.74	2.56–2.78	2.87–2.90

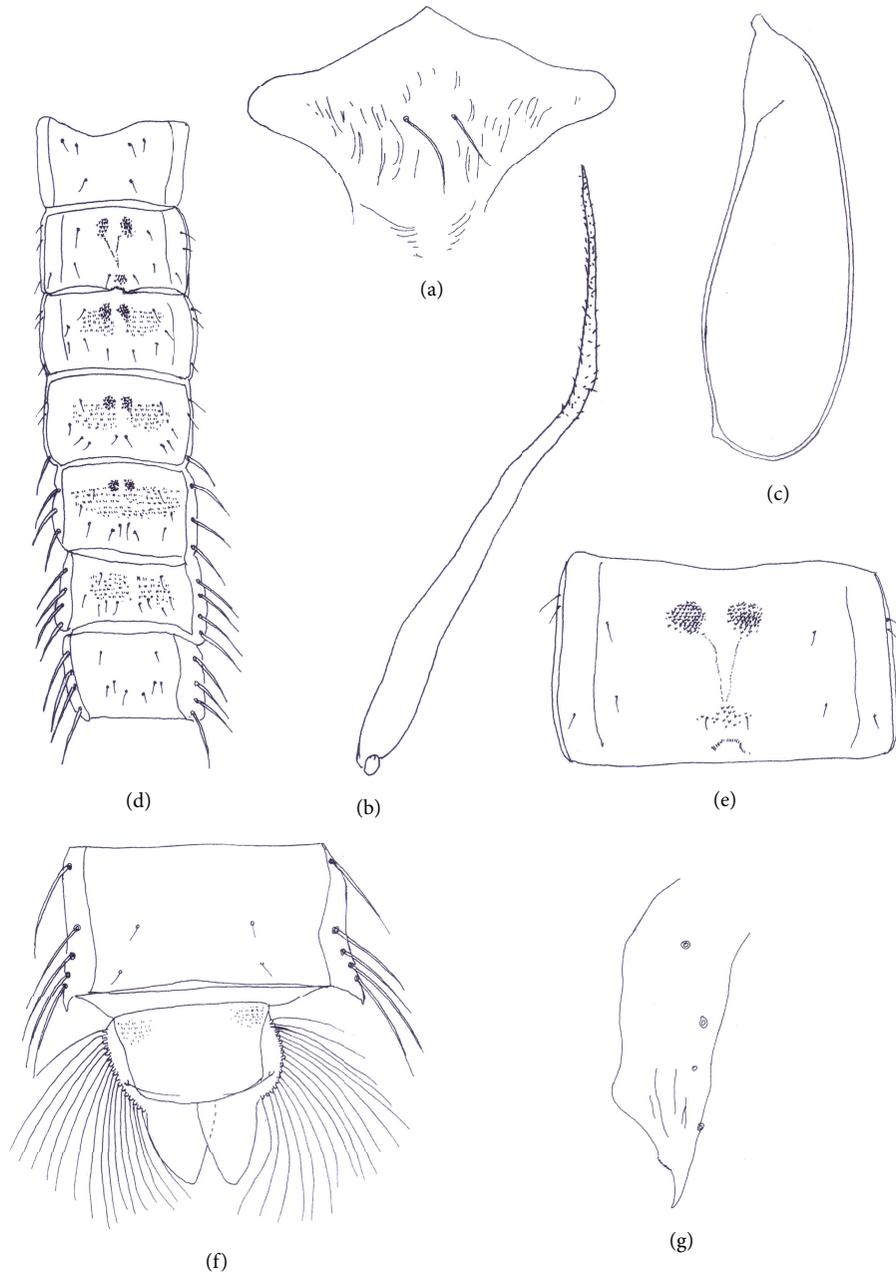


FIGURE 4: *Rheotanytarsus spinicornus* n. sp., pupa: (a) frontal apotome; (b) thoracic horn; (c) wing sheath; (d) tergites I–VII; (e) tergite II; (f) tergite VIII and anal lobe; and (g) caudolateral spur.

absent on tergites IV–V, weak and sparse shagreen present caudolaterally on tergites IV–V. Number of spines on patches on tergites II–V: 130–138; 100–110; 84–90; 50–54. Hook row small, not dividing medially, occupying 0.06 width of the segment width, containing about 26–30 hooklets. Conjunctives without shagreen. Segments II and III with 3 fine L setae; IV with 2 L setae and 1 posterior LS seta; V with 3 LS setae; VI–VII with 4 LS setae; VIII with 5 LS setae (Figure 4(f)). Caudolateral spur single (Figure 4(g)), 16–22  $\mu\text{m}$  long. Shagreen present anterolaterally on anal lobe, 114–118  $\mu\text{m}$  long and 180–186  $\mu\text{m}$  wide with complete fringe

of 34–36 lamelliform setae. Anal lobe (Figure 4(f)) with one dorsal seta, 32–36  $\mu\text{m}$  long. ALR 1.26, G/F 1.71.

*Larva* ( $n = 2$ ) (Figure 5). Total length 3.0–3.4 mm.

*Antenna* (Figure 5(a)). Length of antennal segments: 85–89  $\mu\text{m}$ , 22–26  $\mu\text{m}$ , 5–7  $\mu\text{m}$ , 3.5–4.5  $\mu\text{m}$ , 1.8–2.5  $\mu\text{m}$ ; AR 2.21–2.26; distance of ring organ and seta from base 1.85–2.96  $\mu\text{m}$  and 5.55–6.29  $\mu\text{m}$  respectively; style of segment II 3.7–5.5  $\mu\text{m}$  long and opposite large Lauterborn organ 7.4–9.2  $\mu\text{m}$  long placed on pedicels, not extending beyond antennal apex;

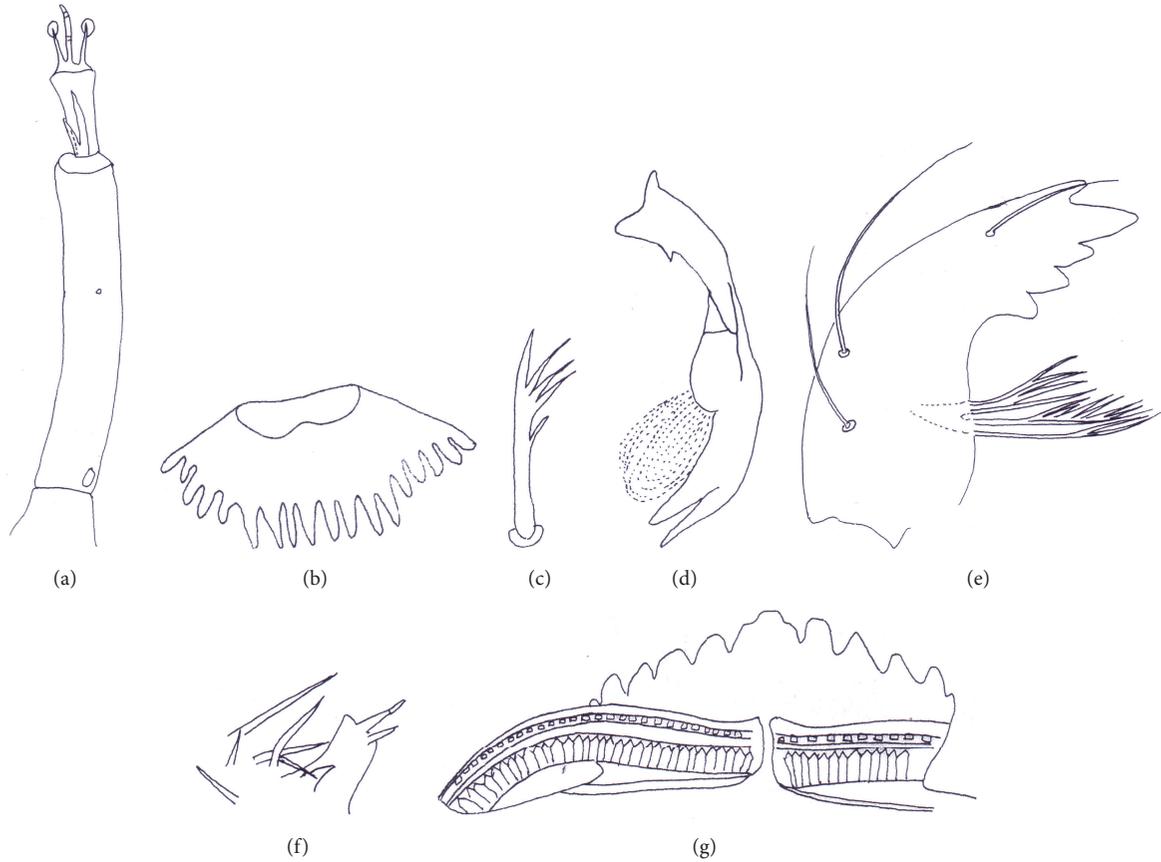


FIGURE 5: *Rheotanytarsus spinicornus* n. sp., larva: (a) antenna; (b) pecten epipharyngis; (c) S I of labrum; (d) premandible; (e) mandible; (f) maxillary palp; and (g) mentum.

blade 20–23  $\mu\text{m}$  long with basally fused accessory blade 13–15  $\mu\text{m}$  long.

**Labroepipharyngeal Region.** Labral lamella 20–23  $\mu\text{m}$  long and maximum width 24–29  $\mu\text{m}$ ; *pecten epipharyngis* (Figure 5(b)) a single broad distally serrated plate; S I as in the Figure 5(c); *premandible* (Figure 5(d)) 55–74  $\mu\text{m}$  long, apically bifid. *Mandible* (Figure 5(e)) 92–96  $\mu\text{m}$  long with 1 dorsal, 1 apical and 3 inner teeth; seta subdentalis 37–44  $\mu\text{m}$  long reaching near the apex of mandible; seta interna with branches, largest branch 44–47  $\mu\text{m}$  and shortest one 20–24  $\mu\text{m}$  long.

**Maxilla.** Maxilla as in the Figure 5(f).

**Mentum** (Figure 5(g)). Median tooth 66–71  $\mu\text{m}$  wide with 2 indistinct notches laterally; ventromental plate 64–67  $\mu\text{m}$  long, separated by a narrow gap with rectangular 33–35 numbers of strial markings.

**Body.** Procercus 22–29  $\mu\text{m}$  long with 7 setae. Anal tubules 103–111  $\mu\text{m}$  long and 51–59  $\mu\text{m}$  wide.

**3.2.4. Remarks.** *R. spinicornus* n. sp. belonging to the *musvicola* group is nearer to *R. foliatus* Kyerematen & Andersen [14] in basal tergite band but differs in shape of anal point. The pupa appears similar to those of *R. musvicola* Thienemann [15] and *R. photophilus* [16]. Larval characters such as antenna, mandible, premandible, and mentum show resemblances with *Rheotanytarsus* sp. 1 described by Roback & Coffman [17] from Nepal Alpine zone. In spite of the above similarities, the following combination of characters separates the new species from other members of the *musvicola* group in (i) V-shaped anal tergite band with medially joined basal tergite band, (ii) anal crest roughly V-shaped and open, (iii) median volsella not reaching the apex of superior volsella with subulate apical setae fused into a plate, (iv) gonostylus longer than gonocoxite and abruptly narrowed distally in adult male, (v) numerous spinules on distal 2/3 of thoracic horn without a median bend, (vi) tergites II–V with anterior pair of spines of circular patches, (vii) posterior spinules on tergite II undivided, (viii) anal lobe with hair-like dorsal seta on pupa, (ix) pecten epipharyngis, a single broad distally serrated plate, (x) median tooth of mentum with 2 indistinct notches laterally, and (xi) mandible with 3 inner teeth on larva.

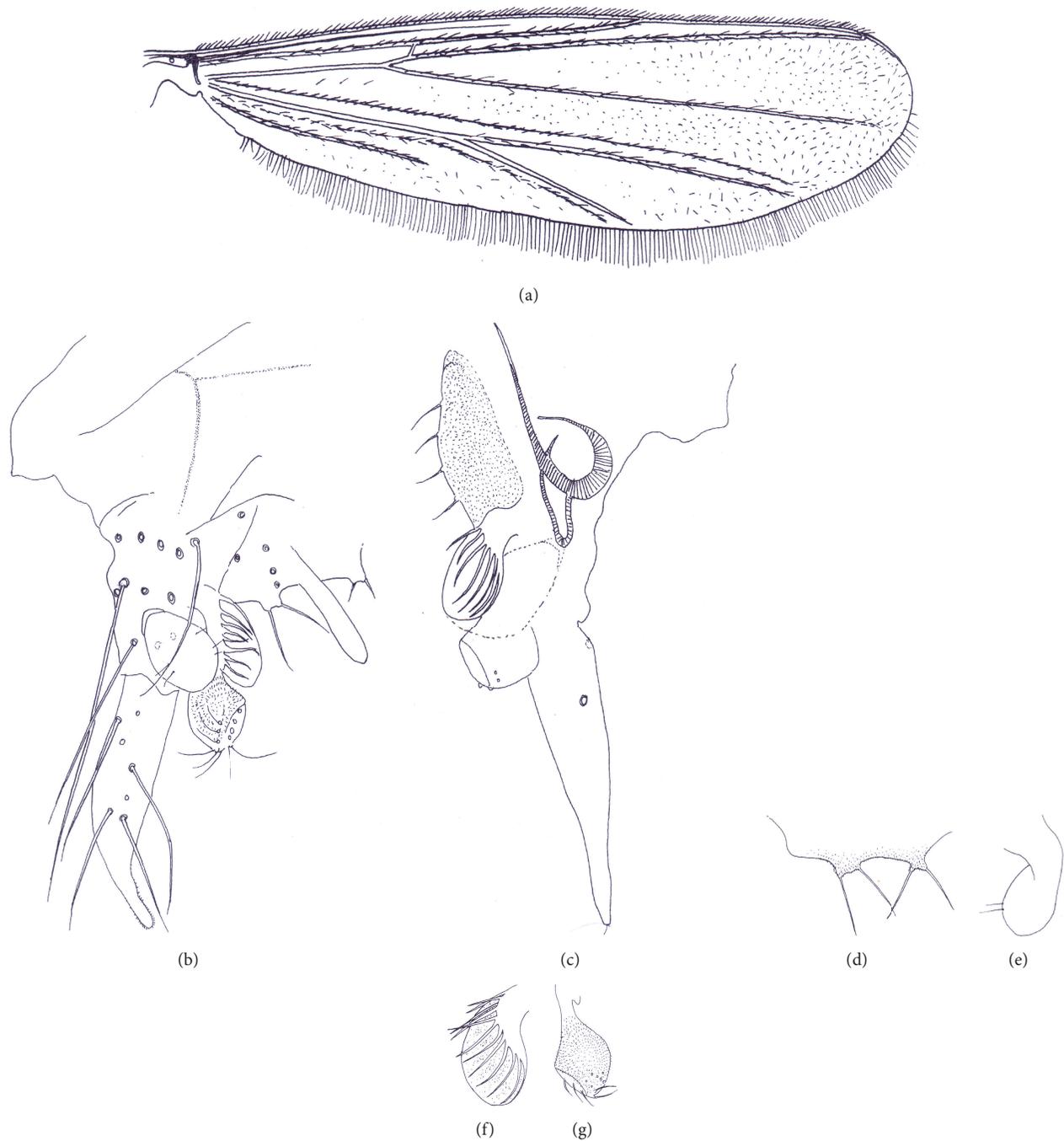


FIGURE 6: *Rheotanytarsus caputimberus* n. sp., adult male: (a) wing; (b) hypopygium (left-dorsal view); (c) hypopygium (right-ventral view); (d) shoulders at the posterior margin of tergite IX; (e) superior volsella; (f) median volsella; and (g) inferior volsella.

### 3.3. *The trivittatus* Group [6]

**Emended Diagnosis.** Median volsella reaching or not reaching beyond the apex of superior volsella and basal anal tergite band joined at the middle or interrupted in adult male.

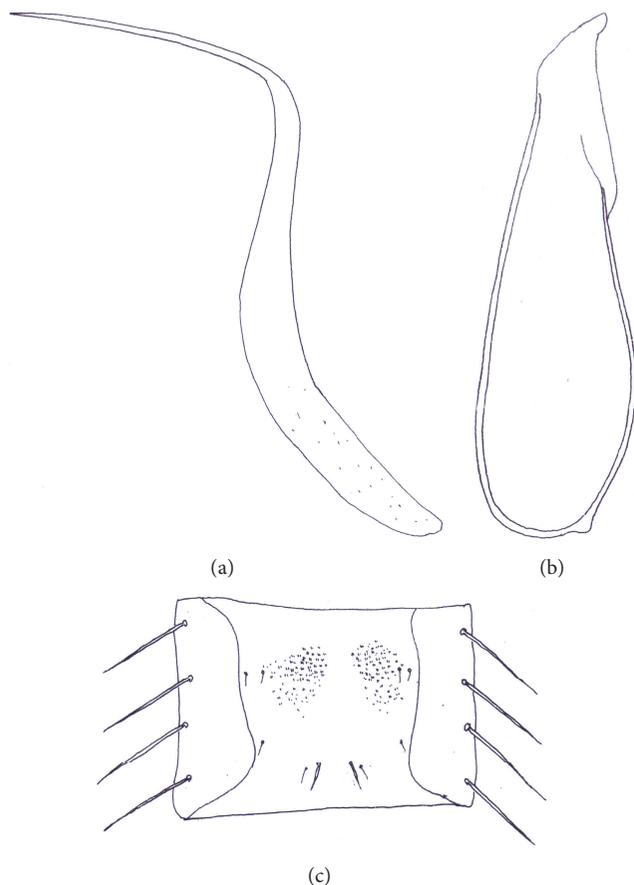
*Rheotanytarsus caputimberus* n. sp. <http://zoobank.org/NomenclaturalActs/044B8A86-BD12-4E4A-93D0-872184AA6201> (Figures 6-7).

**3.3.1. Type Material.** Holotype (male with damaged pupal exuviae) (reared) (Type No. B.U. Ent.270), India, Sikkim, Tadong (27°31'67"N; 88°60'00"E), 06/iv/1996, N. Hazra leg. Paratype (1 male), India, Sikkim, Ravangla (27°29'25"N; 88°35'94"E), 11/vii/2014, K. Sanyal leg.

**3.3.2. Etymology.** From the Latin *caput*, head and *imber*, shower, referring to shape of the inferior volsella similar to the

TABLE 3: Lengths ( $\mu\text{m}$ ) and proportions of leg segments.

	fe	Ti	ta <sub>1</sub>	ta <sub>2</sub>	ta <sub>3</sub>	ta <sub>4</sub>	ta <sub>5</sub>	LR	BV	SV
P <sub>1</sub>	800	432	—	—	—	—	—	—	—	—
P <sub>2</sub>	816	720	352	126	90	72	60	0.48	5.42	4.36
P <sub>3</sub>	912	404	480	210	117	117	75	0.68	3.58	3.36

FIGURE 7: *Rheotanytarsus caputimberus* n. sp., pupa: (a) thoracic horn; (b) wing sheath; and (c) tergite VI.

head of hand shower, and the suffix *-us* denoting the gender of the genus.

### 3.3.3. Description

**Adult Male** ( $n = 2$ ) (Figure 6). Total length 1.92–2.51 mm. Wing length 1.33–1.55 mm. Total length/wing length 1.44–1.61. Wing length/length of profemur 1.89–2.00. Thorax, abdomen and legs brownish yellow.

**Head.** AR 0.63–0.64; flagellomere 13 (Fm 13) 690  $\mu\text{m}$  long. Eye with 90–96  $\mu\text{m}$  long dorsomedial extension. Temporal setae 8, including 6 outer verticles (OV) and 2 postoculars (Po).

Clypeus with 16–20 setae. Tentorium 66  $\mu\text{m}$  long. Palpomere lengths (I–V): 21–24  $\mu\text{m}$ ; 27–30  $\mu\text{m}$ ; 72–75  $\mu\text{m}$ ; 72–84  $\mu\text{m}$ ; 144  $\mu\text{m}$ .

**Thorax.** Acrostichals 12–14; dorsocentrals 8–11; scutellars 7–8.

**Wing** (Figure 6(a)). Membrane densely covered with setae, especially in distal half. Costal length 0.88–0.92 mm. Costa not extended. CR 0.67–0.92. VR 1.32–1.39. Sc, M and RM bare, R with 13–15 setae; R<sub>1</sub> 20–23; R<sub>4+5</sub> 44–52; M<sub>1+2</sub> 30–33; M<sub>3+4</sub> 22–28; Cu 13–18; Cu<sub>1</sub> 16–21; PCu 45; An 25. Cell m with about 3 setae, r<sub>4+5</sub> about 300, m<sub>3+4</sub> about 34, cu and an combined 30 setae. RM well proximal to FCu.

**Legs.** Spur of fore tibia (ti) 21  $\mu\text{m}$  long; spurs of mid tibia unequal 30  $\mu\text{m}$  and 24  $\mu\text{m}$  long including 17–18 of comb; spurs of hind ti 21  $\mu\text{m}$  and 9  $\mu\text{m}$  long including 14–15 of comb. Width at the apex of fore tibia 33  $\mu\text{m}$ ; mid tibia 36  $\mu\text{m}$ ; hind tibia 30  $\mu\text{m}$ . Lengths and proportions of leg segments as in Table 3.

**Hypopygium** (Figures 6(b)–6(g)). Anal tergite band nearly V-shaped with medially joined 27–30  $\mu\text{m}$  long basal tergite band. Tergite IX (Figure 6(d)) with projections to each side of the anal point, 3–4 setae on the dorsal side and 3 caudal setae including 2 setae in each projection. Anal point 36–45  $\mu\text{m}$  long, 9–12  $\mu\text{m}$  wide at base 3–6  $\mu\text{m}$  wide at apex; crest not visible. Phallapodeme 30–36  $\mu\text{m}$  long, transverse sternapodeme 18–20  $\mu\text{m}$  long, lateral sternapodeme 36  $\mu\text{m}$  long. Superior volsella (Figure 6(e)) 27–30  $\mu\text{m}$  long, 6  $\mu\text{m}$  wide at base, 15  $\mu\text{m}$  wide at apex, ovoid; median volsella (Figure 6(f)) 10–12  $\mu\text{m}$  long with subulate setae fused into a plate reaching at the apex of superior volsella; shape of the distal end of inferior volsella (Figure 6(g)) like the head of hand shower, 38–45  $\mu\text{m}$  long with 12–14 setae, extending beyond the junction of gonocoxite and gonostylus. Gonocoxite 63–66  $\mu\text{m}$  long; gonostylus 81–84  $\mu\text{m}$  long, abruptly narrowed distally and parallel sided. HR 0.78, HV 2.6–2.98.

**Pupa** ( $n = 1$ ) (Mostly Damaged) (Figure 7). Exuviae pale with outer edge of cephalothorax and margins of tergite VIII darker.

**Cephalothorax.** Frontal apotome rugulose. Frontal setae 35 long, seated medially, arising from tubercles. Thoracic horn (Figure 7(a)) 114 long, 7 width at base without any median bend, bearing few spinules at the basal region. Thorax smooth, wing sheath with prominent nose (Figure 7(b)), 21 long. Anteprenotals two, median one 136–140 long and lateral

TABLE 4: Key to Adult Males of Oriental *Rheotanytarsus* Thienemann & Bause (Modified after Kyerematen et al. [2]).

(1) Antenna with 12 flagellomeres	2
Antenna with 13 flagellomeres	6
(2) Apical lamellae of median volsella bulbous, Oriental China	<i>bullus</i> Wang & Guo
Apical lamellae of median volsella not bulbous	3
(3) Apex of anal point broad, India, Malaysia	<i>madarihatensis</i> Kyerematen, Andersen & Sæther
Apex of anal point narrow	4
(4) Anal tergite bands nearly horizontal, Oriental China	<i>polychaetus</i> Wang & Guo
Anal tergite bands V-shaped	5
(5) Anal tergite with narrowly interrupted basal band, Malaysia	<i>kuantanensis</i> Kyerematen, Andersen & Sæther
Anal tergite without basal band, India	<i>nudicornus</i> n. sp.
(6) Median volsella long, reaching beyond apex of inferior volsella	7
Median volsella short, not reaching beyond apex of inferior volsella	10
(7) Median volsella apically with two distinct plates, Indonesia	<i>adjectus</i> (Johannsen)
Median volsella with distal lamellate apical setae never fused into plate	8
(8) Anal tergite band V-shaped, Thailand, Australia	<i>oss</i> Cranston
Anal tergite band transverse	9
(9) Anal tergite band separate; median volsella conspicuously slender, Thailand	<i>minusculus</i> Kyerematen, Andersen & Sæther
Anal tergite band medially fused; median volsella not slender, Oriental China, Ghana	<i>buculicaudus</i> Kyerematen in Kyerematen, Andersen & Sæther
(10) Posterior margin of tergite IX with projections or shoulders to each side	11
Posterior margin of tergite IX triangular, rounded, or at most straight	13
(11) Tergite IX posterior margin with well-developed projections; gonostylus abruptly tapered	12
Tergite IX posterior margin without such projections, but with distinct shoulders, gonostylus not abruptly tapered, Indonesia, Australia	<i>trivittatus</i> (Johannsen)
(12) Inferior volsella hand shower shaped; basal anal tergite band joined medially, India	<i>caputimberus</i> n. sp.
Inferior volsella not as above, basal anal tergite band interrupted, Indonesia	<i>additus</i> (Johannsen)
(13) Digitus well developed, extending beyond margin of superior volsella	14
Digitus small or absent, not extending beyond margin of superior volsella	21
(14) Median volsella not reaching apex of superior volsella; if gonostylus abruptly tapering distally, then apical portion parallel-sided and straight	15
Median volsella at least reaching apex of superior volsella; if gonostylus abruptly tapered, then apical portion not parallel-sided and straight	20
(15) Superior volsella knob- or hook-like posterior extension	16
Superior volsella rounded, ovoid, oblong or thumb-like	18
(16) Superior volsella with posterior extension knob-like, Thailand	<i>orientalis</i> Moubayed
Superior volsella with posterior extension hook-like	17
(17) Superior volsella greatly hooked; apical setae of superior volsella not fused into plate; Thailand, Lebanon, Europe	<i>reissi</i> Lehmann
Superior volsella slightly hooked; apical setae of superior volsella fused into plate; Oriental and Palaearctic China, Europe, North Africa and Canada	<i>muscolica</i> Thienemann
(18) Anal point tapering; Oriental Japan	<i>amamiflavus</i> Sasa
Anal point spatulate	19
(19) Superior volsella rectangular with rounded margin; basal tergite band medially joined; Oriental China, Palaearctic Japan	<i>tamatertius</i> Sasa
Superior volsella rounded; basal tergite band absent; Oriental Japan	<i>okisimplex</i> Sasa

TABLE 4: Continued.

(20) Gonostylus abruptly tapered with apical portion curved; superior volsella with large, bluntly rounded apical projection; median volsella apparently without apical plate, India, Indonesia, Oriental China	<i>acerbus</i> Johannsen
Gonostylus not abruptly tapered; superior volsella subquadrangular; median volsella with wide apical plate; Palaeartic Japan, Oriental and Palaeartic China	<i>tamaquartus</i> Sasa
(21) Abdomen banded; anal point crests long, proximally fused forming an arc; superior volsella rounded; median volsella without plate	22
Abdomen not banded; hypopygium not with above configuration	23
(22) Gonostylus not abruptly tapered plate, India, Indonesia, Oriental and Palaeartic Japan, Palaeartic China	<i>aestuarius</i> (Tokunaga)
Gonostylus abruptly tapered, Oriental China	<i>liuae</i> Wang & Guo
(23) Gonostylus more or less abruptly tapered, with distinctly parallel-sided apical portion or with curved apex; superior volsella with pronounced posterior extension; median volsella extending beyond apex of superior volsella	24
If gonostylus abruptly tapered, then without parallel-sided or curved apex	25
(24) Gonostylus with apical portion distinctly parallel-sided; superior volsella with posterior extension long, digitiform; Malaysia	<i>phaselus</i> Kyerematen, Andersen & Sæther
Gonostylus with apex curved; superior volsella with posterior extension broad and rounded; Thailand	<i>thailandensis</i> Moubayed
(25) Anal tergite bands V-shaped and medially joined	26
If anal tergite bands V-shaped, then not medially joined	27
(26) Anal point nonspatulate; median volsella extremely beyond apex of superior volsella; AR > 0.60, Indonesia	<i>tobaseptidicimus</i> Kikuchi & Sasa
Anal point spatulate; median volsella not extending beyond apex of superior volsella; AR < 0.40, India	<i>spincornus</i> n. sp.
(27) Apex of anal point spatulate; gonostylus tapering abruptly or gradually	28
Apex of anal point parallel-sided or tapering; gonostylus tapering gradually	34
(28) Superior volsella with pronounced, hook-like posterior extension, Thailand	<i>falcpedius</i> Kyerematen, Andersen & Sæther
Superior volsella rounded or rectangular	29
(29) Superior volsella rectangular, Oriental China	<i>quadratus</i> Wang & Guo
Superior volsella rounded	30
(30) Gonostylus tapering gradually	31
Gonostylus abruptly tapered in apical portion	33
(31) Anal point crests proximally fused, forming an arc, Thailand	<i>beccus</i> Kyerematen, Andersen & Sæther
Anal point crest V-shaped	32
(32) Median volsella reaching beyond apex of superior volsella; basal anal tergite bands absent; Thailand, Lebanon, Europe	<i>curtistylus</i> (Goetghebuer)
Median volsella short, not reaching apex of superior volsella; basal anal tergite bands present, Thailand	<i>falcatus</i> Kyerematen, Andersen & Sæther
(33) Median volsella recurved; AR about 0.70, Thailand	<i>sessilipersonatus</i> Kyerematen, Andersen & Sæther
Median volsella not markedly recurved; AR about 0.40, Thailand	<i>soelii</i> Kyerematen, Andersen & Sæther
(34) Median volsella extending beyond apex of superior volsella; anal point crests proximally fused, forming an arc, Thailand	<i>pallidus</i> Kyerematen, Andersen & Sæther
Median volsella not reaching beyond apex of superior volsella; anal point crests V-shaped	35
(35) Anal point broad, parallel-sided; AR about 0.1–0.3, Thailand	<i>koraensis</i> Kyerematen, Andersen & Sæther
Anal point lanceolate; AR about 0.3–0.4, Thailand	<i>verticillus</i> Kyerematen, Andersen & Sæther

TABLE 5: Key to Pupae of Oriental *Rheotanytarsus* Thienemann & Bause (Modified after Kyerematen et al. [2]).

(1) Tergite VIII with caudolateral comb; T II–V with anterior paired patches of spinules; thoracic horn with knee-like bend, heavily sclerotized	2
Tergite VIII with single spur; T II–IV, II–V or II–VI with paired patches of spinules; thoracic horn may be sharply bent but not knee-like	3
(2) Hook row of about 90 hooklets; anal lobe fringe of much less than 20 taeniae	<i>additus</i> (Johannsen)
Hook row of 60–70 hooklets; anal lobe fringe of about 20 taeniae	<i>trivittatus</i> (Johannsen)
(3) Thoracic horn sharply bent at midlength; T II–IV with oral, paired, rounded patches of spinules	4
Thoracic horn not sharply bent; T II–V or II–VI with spinule patches	5
(4) Tergite VIII with 3 lateral taeniae	<i>thailandensis</i> Moubayed
Tergite VIII with 5 lateral taeniae	<i>oss</i> Cranston
(5) Tergites II–VI with sharply defined, paired spinule patches	6
Tergites II–V with sharply defined patches of spinules	7
(6) Anal lobe with one large dorsal seta; thoracic horn with few fine spinules	<i>curtistylus</i> (Goetghebuer)
Anal lobe with two short dorsal setae; thoracic horn with many fine spinules in distal half	<i>orientalis</i> Moubayed
(7) Anal lobe without dorsal setae; distal half of thoracic horn with many spinules	<i>adjectus</i> (Johannsen)
Anal lobe with long dorsal setae; distal half of thoracic horn with or without any spinules	8
(8) Distal half of thoracic horn without any spinules	<i>nudicornus</i> n. sp.
Distal half of thoracic horn with few to many spinules	9
(9) Tergites II and III with transversely elongated or rectangular spine patches	<i>reissi</i> Lehmann
Tergites II–III with circular or elliptical spine patches	10
(10) Numerous spinules on distal 2/3 of the thoracic horn	<i>spinicornus</i> n. sp.
Spinules few on distal 1/3 of the thoracic horn	<i>tamaquartus</i> Sasa

one 40–44 long. Precorneals three, anterior one 72 long, lemelliform; median one 48 long, lamelliform and posterior not seen. Dorsocentrals  $Dc_1$  and  $Dc_2$  paired 12 and 9 long respectively and  $Dc_3$  and  $Dc_4$  also paired, 12 and 18 long respectively; distance between two paired dorsocentrals 51.

**Abdomen.** Tergites II–V with circular anterior pair of spine patches. Tergites III–V with shagreen next to circular patches extending over and beyond the first dorsal seta. Pair of circular patches on tergite V smaller than others. Number of spines on patches on tergites II–V: 75–80; 67–70; 38–40; 34–35. Hook row small, occupying 0.057 width of the segment, containing about 12–13 hooklets. Most of the abdominal segments including anal lobe damaged except segment VI (Figure 7(c)); segment V with 4 LS setae; VI 4 LS setae.

**3.3.4. Remarks.** *Rheotanytarsus caputimberus* n. sp. shows affinity with other members of the group having projections to each side of the anal point except *R. scutulatus* Kyerematen & Andersen [14]. Similarly superior volsella of the new species is similar to other members of the group except *R. ramirezae* Kyerematen [14] and *R. scutulatus* Kyerematen & Andersen [14]. Gonostylus is abruptly tapered like other members except in *R. ceratophylli* [18] and *R. trivittatus* Johannsen [19]. In spite of the above, the proposed species may be separated from other members of the *trivittatus* group including oriental species *R. brevipalpus* Wang & Guo [7], *R. additus* [19], and *R. trivittatus* Johannsen and may be diagnosed by the following combination of characters:

(i) lateral projections on each side of the anal point, (ii) basal anal tergite band medially joined, (iii) superior volsella ovoid, (iv) median volsella not reaching beyond apex of superior volsella with subulate setae fused into plate, (v) inferior volsella typically like head of hand shower, and (vi) gonostylus abruptly tapered.

Key to adult males of Oriental *Rheotanytarsus* Thienemann and Bause (modified after Kyerematen et al. [2]) is shown in Table 4 while Table 5 shows key to pupae of Oriental *Rheotanytarsus* Thienemann and Bause (modified after Kyerematen et al. [2]).

## Disclosure

The new names included in this paper are available under the International Code of Zoological Nomenclature. This work and the nomenclatural acts it contains have been registered in ZooBank. ZooBank Life Science Identifier (LSID) for this publication is <http://zoobank.org/References/9D3AF92A-43A6-4EE1-9319-3C4216740C12>. The LSID registration and any associated information can be viewed in a web browser by adding the LSID to the portal “<http://zoobank.org/>.”

## Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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