

FIRST DESCRIPTION OF THE IMMATURE STAGES AND REDESCRIPTION OF THE ADULTS OF *COSMIOMMA HIPPOPOTAMENSIS* (DENNY, 1843) (ACARI, IXODIDAE) WITH NOTES ON ITS BIONOMICS

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ABSTRACT: *Cosmiomma hippopotamensis* (Denny, 1843) is one of the most unusual, beautiful and rare tick species known to the world. All stages of this species possess a unique morphology, on the one hand making them easy to identify, while on the other they exhibit similarities to certain species of *Amblyomma*, *Dermacentor* and *Hyalomma*. Adults of *C. hippopotamensis* have been collected on only two occasions from their hosts, namely *Hippopotamus amphibius* and *Diceros bicornis* and have been recorded from only a few widely separated localities in East and southern Africa. Here the larva and nymph are described and illustrated for the first time, while the male and female are illustrated and redescribed. Data on the phylogenetic position, hosts, geographic distribution and life cycle of *C. hippopotamensis* are also provided.

Cosmiomma hippopotamensis (Denny, 1843) is one of the most striking but rarely collected species of African ixodid ticks. In 1970, however, a locality in north-west Namibia, at which it was fairly abundant, was discovered, and numerous adult specimens were collected from the vegetation (Bezuidenhout and Schneider, 1972). After this discovery the first experiments on the feeding preferences of the adults were made and most importantly the nymphs and larvae were reared.

Over time the taxonomic position of this tick has changed on numerous occasions. The male and female were originally described as separate species of the genus *Ixodes* Latreille, 1796; initially the female as *Ixodes bimaculatus* Denny, 1843 and thereafter the male as *Ixodes hippopotamensis* Denny, 1843. A year later Koch (1844) realized that *I. bimaculatus* and *I. hippopotamensis* are sexes of the same species. He, as a first reviser, assigned priority to the name *I. hippopotamensis* and placed it in the genus *Amblyomma* Koch, 1844, i.e. *Amblyomma hippopotami* Koch, 1844. Neumann (1899) initially corrected the name to *Amblyomma hippopotamense*

but later placed it in the genus *Hyalomma* Koch, 1844, changing the combination of names to *Hyalomma hippopotamense* (Neumann, 1906). After studying the type specimens and a re-evaluation of their morphological characters, Schulze (1919) created an independent genus for this species, namely *Cosmiomma* Schulze, 1919 with *Ixodes hippopotamensis* as the type species of the genus. According to Hoogstraal (1956), Zumpt (1951) sunk *Cosmiomma* under *Dermacentor* Koch, 1844. As a result Hoogstraal (1956) placed *C. hippopotamensis* in the genus *Dermacentor* and considered *Cosmiomma* a subgenus of *Dermacentor*. However, after an examination of the publication by Zumpt (1951), we were unable to confirm this nomenclatural change. Most workers now agree that *Cosmiomma* is a monotypic genus comprising the species *C. hippopotamensis*. Santos Dias (1958) after studying the original descriptions of *I. bimaculatus* and *I. hippopotamensis* decided that page priority should be given to the name *Cosmiomma bimaculatum*, and he therefore considered this name as valid for the species. However, as mentioned above, Koch (1844), as first reviser, had already given the name *I. hippopotamensis* priority, and consequently, according to the International Code for Zoological Nomenclature (1999 and previous editions) this binomen should be accepted as valid. Based on a study of the external morphology of the adults Fillipova (1997) considered *Cosmiomma* to be most closely related to the *Rhipicephalus* Koch, 1844 lineage. However, a later analysis, also based on morphological characters, indicated that *Cosmiomma* was more closely related to the *Dermacentor* lineage (Klompfen et al., 1997). No molecular data have ever been obtained for this species.

After discovering reared specimens of nymphs and larvae in the J. B. Walker and United States National Tick Collections (USNTC) we decided to describe these stages and more exactly redescribe the adult stages to facilitate a better understanding of the phylogenetic position of *C. hippopotamensis*.

MATERIAL AND METHODS

The material examined is summarized in Table I. Both field-collected and laboratory-reared ticks were studied. The specimens that were examined are deposited in the USNTC (the James H. Oliver, Jr. Institute of Arthropodology and Parasitology, Georgia Southern University, Statesboro), the Gertrud Theiler Tick Museum at the ARC-Onderstepoort Veterinary Institute (ARC-OVI) (Onderstepoort, South Africa), Natural History Museum of Berlin (NHMB) (Berlin, Germany) and the personal East African tick collection of the late J.B. Walker (South Africa).

The immature stages and the more delicate structures of the adults were mounted on glass slides and examined under a light microscope and also by means

of a scanning electron microscope, and the macrostructures of males and females under a stereoscopic microscope. Measurements for the male and female are given in millimetres and those for the various features of the immature stages in micrometers. The measurements are arranged as follows: minimum–maximum (mean, n = number of specimens measured). All illustrations have been drawn by D.A. Apanaskevich.

DESCRIPTION AND REDESCRIPTION

Cosmiomma hippopotamensis (Denny, 1843)

(Figs. 1–8)

MALE (redescription) (Figs. 1A, 2A, 3). **Conscutum** (Fig. 1A): broadly-oval, widest at mid-length; distance from scapular apices to posterior margin of conscutum 5.22–6.93 (6.04; n = 13), maximum width 4.27–5.60 (4.91; n = 13), ratio length to width 1.16–1.27 (1.23; n = 13). Coloration: ornate with light ivory or pale yellow enamelled patches grouped in 6 pairs marginally on a dark brown background, a single central patch anteriorly and a pair of medial patches; some patches may be connected with neighboring patches as illustrated; small enamelled patches on 3rd and 4th festoons. Cervical grooves distinct, moderately deep; a pair of central depressions, and a second posterior pair that correspond to paramedian grooves; 7 distinct festoons. Large punctations sparse, fine punctations dense, evenly distributed over scutum. **Eyes** (Fig. 1A): round, convex, at anterior one-seventh of scutal length. **Setae** sparse and short. **Venter** (Fig. 2A): as illustrated; setae numerous, short, somewhat longer along posterior margin of venter. **Apron** of genital aperture (Fig. 2A): at level of coxae II. **Adanal plates** (Figs. 2A, 3A): long and broad, subtriangular, posterior margin crenulate, length 1.51–1.92 (1.69; n = 13), width 0.91–1.27 (1.09; n = 13), ratio length to width 1.41–1.72 (1.56; n = 13); setae relatively dense, especially on posterior margin of plates. **Genital groove** (Fig. 2A): well-developed. **Anal groove** (Figs. 2A, 3A): indistinct short arch posterior to anus. **Spiracular plates** (Figs. 2A, 3B): positioned on ventral surface in unengorged specimens, subtriangular with mildly concave anterior margin, greatest diameter in anteroposterior plane, length 0.89–1.30 (1.11; n = 13), width 0.77–1.10 (0.95; n = 13), ratio length to width 1.00–1.40 (1.17; n = 13); dorsal prolongation short, perforated portion of dorsal prolongation broad, tapering to apex, non-perforated portion of dorsal prolongation with narrow projections giving it a jagged appearance; dorsal non-perforated portion of spiracular plate with whitish enamelling. **Gnathosoma** (Figs. 1A, 2A, 3C, 3D): length from palpal apices to posterior margin of basis capituli dorsally 1.63–1.85 (1.76; n = 13), width of basis capituli 0.96–1.18 (1.09

± 0.08; n = 13), ratio length to width 1.53–1.72 (1.61; n = 13). **Basis capituli** (Figs. 1A, 2A, 3C, 3D): dorsally subrectangular; posterior margin concave; cornua inconspicuous; lateral margins with whitish enamelling; ventrally subrectangular; posterior margin convex. **Palpi** (Figs. 1A, 2A, 3C, 3D): elongate, relatively narrow; length (I–III segments) 1.08–1.27 (1.21; n = 13), width 0.38–0.48 (0.44; n = 13), ratio length to width 2.65–3.00 (2.78; n = 13), length of segments in descending order: 2, 3, 1, 4; segment I well-developed; segment II narrow at base and thereafter parallel-sided; segment III subrectangular; segments II and III with whitish enamelling on dorsal surfaces. **Hypostome** (Figs. 2A, 3D): club-shaped; dental formula 3/3; length 0.96–1.20 (1.07; n = 13), maximum width 0.38–0.46 (0.42; n = 13), ratio length to width 2.32–2.67 (2.54; n = 13). **Legs** (Figs. 1A, 2A): of medium length, robust; with extensive whitish enamelling mostly on dorsal and lateral aspects. **Coxae** (Figs. 2A, 3E): coxae I with long triangular widely separated, subequal internal and external spurs with narrowly-rounded apices; coxae II and III each with larger triangular external spur and smaller internal spur; coxae IV with relatively long, triangular, subequal internal and external spurs. **Genu** and **Tibia** (Figs. 1A, 2A) with 2 rows of short projections ventrally. **Tarsus I** length 1.27–1.54 (1.43; n = 13); **tarsus IV** length 0.89–1.25 (1.11; n = 13); **tarsi II–IV** (Figs. 1A, 2A): with well-developed hook-like terminal projection. **Pulvilli** (Figs. 1A, 2A): very short.

FEMALE (redescription) (Figs. 1B, 2B, 4). **Idiosoma** (Figs. 1B, 2B): broadly-oval, widest at mid-length; length from scapular apices to posterior body margin 6.74–8.55 (7.73; n = 14, unengorged females), width 5.32–6.84 (5.93; n = 14, unengorged females), ratio length to width 1.15–1.43 (1.31; n = 14). **Scutum** (Fig. 1B): long, margins diverge in anterior one-fourth of total length, thereafter gradually converging to narrowly-rounded posterior margin, length 3.12–3.84 (3.56; n = 14), width 3.31–4.03 (3.83; n = 14), ratio length to width 0.89–0.97 (0.93; n = 14). Coloration: ornate, major portion of scutal surface covered with whitish or yellowish enamelling; two narrow, brown, strips extend from cervical pits to posterior scutal margin with anterolaterally directed branches arising from the middle of each strip, brown patches surround eyes, extending anteriorly along scutal margin with a branch directed posteromedially; anterolateral branch of cervical strip and posteromedian branch of eye patch may be connected. Cervical grooves distinct, relatively deep. Large brown punctations sparse, fine punctations dense, evenly distributed over scutum. Eyes round, convex, positioned at widest point of lateral scutal margins. Setae sparse and short. **Alloscutum** (Fig. 1B): as illustrated, with 2 ivory-coloured to yellowish subcircular, raised, cuticular patches with smooth dorsal surfaces (these raised patches are absent on all specimens examined from Kenya), longitudinal

diameter 0.90–1.13 (1.02; n = 11); 11 festoons. Setae of alloscutum short, numerous, mainly distributed in centre and posterior surface; the majority of latter setae directed laterally and anteriorly. **Venter** (Fig. 2B) as illustrated; setae numerous, mainly distributed on posterior surface. **Genital aperture** (Figs. 2B, 4A): at level of coxae II, U-shaped; pre-atrial fold flat or concave. **Genital groove** (Fig. 2B) well-developed. **Anal groove** (Fig. 2B) indistinct short arch posterior to anus. **Spiracular plates** (Fig. 2B, 4B): suboval; positioned on ventral surface in unengorged specimens, greatest diameter in anterolateral-posteromedian plane in unengorged specimens, length 1.37–1.82 (1.65; n = 14), width 1.13–1.44 (1.26; n = 14), ratio length to width 1.19–1.46 (1.31; n = 14); dorsal prolongation short, perforated portion of dorsal prolongation broad, central non-perforated portion with long and narrow projections giving it a jagged appearance; dorsal un-perforated portion of spiracular plate with whitish enamelling. **Gnathosoma** (Figs. 1B, 2B, 4C, 4D): length from palpal apices to posterior margin of basis capituli dorsally 1.73–2.16 (1.99; n = 14), width of basis capituli 1.13–1.44 (1.29; n = 14), ratio length to width 1.46–1.61 (1.55; n = 14) as long as broad. **Basis capituli** (Figs. 1B, 2B, 4C, 4D): dorsally subpentagonal with short lateral margins with whitish enamelling; posterior margin slightly concave with slight central indentation; cornua inconspicuous. Porose areas inwardly inclined, deeply sunken with clearly circumscribed borders, separated by a narrow elevation less than half their width. Basis capituli ventrally subrectangular; with convex posterior margin. **Palpi** (Figs. 1B, 2B, 4C, 4D): elongate, relatively narrow; length (I–III segments) 1.27–1.70 (1.47; n = 14), width 0.43–0.53 (0.48; n = 14), ratio length to width 2.80–3.55 (3.08; n = 14), length of segments in descending order: 2, 3, 1, 4; segment I well developed ventrally; segment II narrow at base and thereafter parallel-sided; segment III broad, subrectangular; segments II and III with whitish enamelling on dorsal surfaces. **Hypostome** (Figs. 2B, 4D): club-shaped; dental formula 3/3; length 1.13–1.42 (1.30; n = 14), maximum width 0.38–0.48 (0.45; n = 14), ratio length to width 2.62–3.11 (2.88; n = 14). **Legs** (Figs. 1B, 2B): of medium length, robust; with extensive whitish enamelling mostly on dorsal and lateral aspects. **Coxae** (Figs. 2B, 4E): coxae I with long, narrow, triangular, widely-separated, subequal internal and external spurs with narrowly-rounded apices; coxae II and III each with triangular larger external spur and smaller internal spur; coxae IV with relatively long, narrow, triangular internal and external spurs. **Genu** and **Tibia** (Figs. 1B, 2B) with 2 rows of short projections ventrally. **Tarsus I** length 1.56–1.90 (1.78; n = 13); **tarsus IV** length 1.27–1.68 (1.52; n = 13); **tarsi II–IV** (Figs. 1B, 2B): with well-developed hook-like terminal projection. **Pulvilli** (Figs. 1B, 2B): very short.

NYMPH (description) (Figs. 5, 6). **Idiosoma** (Figs. 5A, 5B): suboval, widest at level of coxae III, distinctly narrowing posterior to spiracular plates, length of unengorged specimens from apices of scapulae to posterior body margin 1760–2000 (1904, n=5), width 1400–1640 (1496, n=5), ratio length to width 1.17–1.35 (1.27; n=5). **Scutum** (Figs. 5A, 6A): length 771–835 (798; n=5), width 874–938 (914; n=5), ratio length to width 0.84–0.89 (0.87; n=5); pentagonal, posterior margin broadly-rounded, posterolateral depressions deep; cervical grooves distinct, deep. Setae ca. 9 pairs, length 38–52 (45; n=6). Eyes suboval, bulging, located on lateral margins of scutum at approximately its mid-length. **Alloscutum** (Fig. 5A): as illustrated. Dorsal setae numerous; setae in anterolateral field very long, length 164–198 (180; n=5); setae in intermediate rows (between lateral and central rows) length 76–100 (92; n=4); setae in central rows length 48–60 (53; n=4). **Venter** (Fig. 5B): as illustrated; faint posterior anal groove. Ventral setae numerous; anal valves with 3 pairs of setae. **Spiracular plates** (Fig. 6B): oval, maximal length in dorso-ventral plane; few perforations. **Gnathosoma** (Figs. 5A, 5B, 6C, 6D): length from hypostomal apex to posterior ventral margin of basis capituli 739–803 (774; n=5), width at apices of dorsolateral projections 533–588 (561; n=5); ratio length to width 1.32–1.45 (1.38; n=5). **Basis capituli** (Figs. 5A, 5B, 6C, 6D): dorsally short and broad; dorsally and ventrally subtriangular, with short and blunt lateral projections. Post-hypostomal setae 1 pair. **Palpi** (Figs. 5A, 5B, 6C, 6D): elongate, length 324–348 (339; n=5), maximum width 86–98 (94, n=5), ratio length to width 3.31–3.91 (3.63; n=5); segment I well-developed, cylindrical, distinct suture between segments II and III, segment II the longest, narrow proximally and sharply expanding distally; segment I with 1 ventral seta, segment II with 5 dorsal and 3 ventral setae, segment III with 5 dorsal and 2 ventral setae, segment IV with about 11 setae. **Hypostome** (Fig. 5B, 6D): length from apex to the level of post-hypostomal setae 392–448 (425; n=5), width at narrowest portion 118–136 (126; n=5), ratio length to width 3.29–3.53 (3.37; n=5); protruding anteriorly considerably beyond palpal apices, club-shaped, broadly rounded at apex, dental formula distal 2 rows 3/3, proximal rows 2/2, 8–9 denticles in files. **Legs** (Figs. 5A, 5B): moderate in length. **Coxae** (Figs. 5B, 6E): coxae I–IV with modest, broadly-arcuate external spurs, internal spurs virtually invisible; coxae I–IV each with 3 setae. **Trochanters**: lack spurs. **Tarsus I**: length 348–392 (379; n=5). **Tarsus IV**: length 348–384 (369; n=5). **Tarsi I–IV** (Figs. 5A, 5B) with hook-like terminal projection.

LARVA (description) (Figs. 7, 8). **Idiosoma** (Figs. 7A, 7B): suboval, widest at level of coxae III; length of unengorged specimens from apices of scapulae to posterior body margin 580–636 (614; n=29), width 501–548 (529; n=26), ratio length

to width 1.10–1.23 (1.16; n=24). **Scutum** (Figs. 7A, 8A): length 328–360 (346; n=25), width 424–480 (456; n=31), ratio length to width 0.73–0.78 (0.75; n=25); pentagonal, posterior margin broadly-rounded, posterolateral marginal depressions indistinct; cervical grooves as faint, shallow depressions. Setae 3 pairs, Sc₂ 32–40 (36; n=15), Sc₃ 26–32 (29; n=27). **Alloscutum** (Fig. 7A): as illustrated. Dorsal setae 10 pairs; 2 pairs of central dorsals, Cd₁ 24–30 (26; n=24), Cd₂ 26–30 (28; n=22); 8 pairs of marginal dorsals, Md₁ 34–42 (39; n=30), Md₇ 24–31 (27; n=29). **Venter** (Fig. 7B): as illustrated; faint posterior anal groove. Sensilla sagittiforma present. Ventral setae 14 pairs plus 1 pair on anal valves; 3 pairs of sternals, St₁ 38–48 (42; n=31); 2 pairs of preanals, Pa₁ 34–42 (38; n=24), Pa₂ 36–44 (40; n=26); 4 pairs of premarginals; 5 pairs of marginal ventrals, Mv₁ 26–32 (28; n=31). **Gnathosoma** (Figs. 7A, 7B, 8B, 8C): length from hypostomal apex to posterior ventral margin of basis capituli 224–268 (251; n=27), width at apices of dorsal projections 156–184 (169; n=31); ratio length to width 1.37–1.60 (1.49; n=27). **Basis capituli** (Figs. 7A, 7B, 8B, 8C): dorsally hexagonal, with very short and obtuse lateral projections; ventrally rectangular. Post-hypostomal setae 1 pair, Ph₁ 22–30 (26; n=20); distance between Ph₁ 52–66 (58; n=30). **Palpi** (Figs. 7A, 7B, 8B, 8C): elongate, length 124–142 (137; n=30), width 46–50 (48, n=30), ratio length to width 2.64–2.96 (2.84; n=30); segment I well-developed, cylindrical, distinct suture between segments II and III; segment I without setae, segment II with 4 dorsal and 2 ventral setae, segment III with 5 dorsal and 1 ventral setae, segment IV with about 11 setae. **Hypostome** (Figs. 7B, 8C): length from apex to the level of post-hypostomal setae 118–142 (136; n=27), minimum width 48–56 (52; n=28), ratio length to width 2.27–2.87 (2.62; n=27); protrudes considerably beyond palpal apices anteriorly, club-shaped, broadly-rounded at apex, dental formula 2/2 throughout length, 6–7 larger denticles in files. **Legs**: moderate in length. **Coxae** (Fig. 7B, 8D): coxae I–III lacking spurs, coxae I sometimes with an indication of a slight thickening of the surface instead of spur; coxae I with 3 setae, coxae II and III with 2 setae each. **Trochanters**: lack spurs. **Tarsus I**: length 176–194 (186; n=31), width 64–74 (69; n=28), ratio length to width 2.50–2.87 (2.70; n=28).

Taxonomic summary

Type specimens: original description based on female (as *Ixodes bimaculatus*) from Southern Africa and male (as *Ixodes hippopotamensis*) from South Africa (Denny, 1843). Santos Dias (1958) found 3 males, one of which is the type of *I. hippopotamensis*, and 6 females, one of which is the type for *Ixodes bimaculatus*, in the Natural History Museum (London). Theiler (1962) stated that the type specimens of *C. hippopotamensis* are in the Natural History Museum (NHM)

(London) and NHMB (Berlin, Germany). Bezuidenhout and Schneider (1972) indicated that the types of *C. hippopotamensis* (1 male and 4 females; № 43.19; Hippopotamus) are in the NHM (London). According to the type catalogues of the NHM (London) and NHMB there are no type specimens of *C. hippopotamensis* in their collections (Moritz and Fischer, 1980; Keirans and Hillyard, 2001). We have been unable to confirm whether the type specimens still exist or not.

Synonyms (Camicas et al., 1998): *Ixodes bimaculatus* Denny, 1843; *Ixodes hippopotamensis* Denny, 1843; *Amblyomma hippopotami* (Denny, 1843) Koch, 1844; *Amblyomma hippopotamense* (Denny, 1843) Neumann, 1899; *Hyalomma hippopotamense* (Denny, 1843) Neumann, 1906; *Dermacentor (Cosmiomma) hippopotamensis* (Denny, 1843) Hoogstraal, 1956; *Cosmiomma bimaculatum* (Denny, 1843) Santos Dias, 1958. We believe that the generic name *Cosmiomma* was derived from the Greek 'cosmima', meaning jewellery and 'omma' (ομμα), meaning eye.

Distribution and hosts: There are only a few definite localities at which *C. hippopotamensis* has been found, and these are all confined to sub-Saharan Africa (Fig. 9). It has been recorded in Angola (Cuando Cubango District: Tondo), Botswana (North-West District: Lake Ngami), Kenya (Makueni District: Makindu: Chale area; Teita District: Kangetchwa, Manyani, Mazinga Hill near Voi, and the Tsavo area), and Namibia (Kunene Region: Ekoto, Ohopoho, Ondjarrakagha, Otjiboronbonga, Otjijanjasemo and Otjipembe) (Hoogstraal, 1956; Serrano, 1964; Bezuidenhout and Schneider, 1972; Walker, 1974; our data). The type specimens of *Ixodes hippopotamensis* originate from South Africa, but since the late 1840s no *C. hippopotamensis* has been found in this country (Walker, 1991). Both Neumann (1899) and Dönitz (1910) mention that specimens have been collected somewhere between Zanzibar and the Great Lakes, while Santos Dias (1960) assumed that *C. hippopotamensis* might occur in Mozambique. Arthur (1960) stated that unconfirmed specimens of *C. hippopotamensis* were reported from Tanzania (= Tanganyika). In the Nuttall tick catalogue (Keirans, 1985) 3 females (No. 1030) identified as "*Amblyomma hippopotamensis* or n. sp." collected from grass and leaves in Deep Bay, Malawi are mentioned. Unfortunately this collection lot is listed as missing and we cannot confirm the identity of these females.

There are only two host records for the adults – hippopotamus, *Hippopotamus amphibius* Linnaeus, and black rhinoceros, *Diceros bicornis* (Linnaeus) (Denny, 1843; Serrano, 1964). It has also been suggested that rhinoceroses rather than hippopotamuses might be the preferred hosts for the adults of *C. hippopotamensis*

(Bezuidenhout and Schneider, 1972). The hosts of the immature stages remain unknown.

Life cycle: Cosmiomma hippopotamensis is a two-host tick. In 1960, 6 adult ticks were sent to Onderstepoort by Dr. J.D. Coetzee, the State Veterinarian at Ohopoho in the Kunene Region, Namibia. This stimulated further interest in this colorful tick and in 1970 one of us (J.D. Bezuidenhout), encouraged by Dr. Gertrud Theiler, instituted a thorough search for it in Kaokoland, in the north-western corner of Namibia. The results of this quest, during which some 80 adult ticks were collected, persuaded Bezuidenhout and Schneider (1972) to visit the region. Here they collected a further 114 adult ticks from the vegetation bordering footpaths used by rhinoceroses to get to springs. They attempted to feed some of these ticks on terrapins, tortoises, a monitor lizard, rabbits and a goat without success, but were eventually successful in feeding them on a black rhinoceros.

Bezuidenhout and Schneider (1972) gave only a brief account of their tick-feeding experiments on the rhinoceros and these studies will now be described in greater detail. They initially placed 3 male and 4 female ticks on the back of a hand-reared 14-month-old black rhinoceros kept in a small enclosure at the Etosha National Park, Namibia. Within 10 minutes 5 of these ticks had attached in the animal's perianal region and the other 2 quickly attached to its body, from which they were later removed. In contrast, only 1 of the 3 ticks that were confined in a bag behind one of the animal's ears, ultimately attached. Four adult ticks that were put on the ground near the rhino soon found the animal, climbed onto it and attached under its tail. Other ticks that had been liberated in the enclosure and that had climbed up a tree, also quickly transferred to the rhino when it came into contact with twigs on which they were waiting.

The ticks on the rhino were carefully examined 3 times daily. During the initial 48 hours those attached under the animal's tail changed their positions twice. Two, a male and a female, finally attached 2-3 cm within the anus. Three females completed their engorgement on the rhino and dropped off 8 days after their attachment. Only one of these females subsequently laid a large batch of fertile eggs. This batch was divided before the eggs hatched, part of it being retained at the Regional Veterinary Laboratory, Windhoek, Namibia, while the 2nd part was sent to the late Dr W.O. Neitz at Onderstepoort for further laboratory studies on the life cycle.

With the exception of one mouse, from which 7 engorged nymphs were obtained, attempts by Neitz to feed the larvae on domestic fowls and white mice were unsuccessful. When placed on the ears of rabbits, however, both the larvae and the nymphs, to which they subsequently moulted, engorged successfully. After detaching

from the rabbits the engorged nymphs successfully moulted to adults. The life cycle of *C. hippopotamensis*, based on the studies of Bezuidenhout and Neitz, is summarized in Table 1.

Disease relationships: the medical and veterinary importance of *C. hippopotamensis* remains undetermined.

Remarks

Identification: the adults of *Cosmiomma hippopotamensis* superficially resemble some of those in the genera *Amblyomma* and *Dermacentor* because of the extent of ornamentation on the conscutum of males and scutum of females. Males can readily be distinguished from all African *Amblyomma* and *Dermacentor* species by the presence of adanal plates and the pattern of ornamentation on the conscutum. Females are distinguished from those of African *Amblyomma* and *Dermacentor* species by the pattern of coloration on the scutum and the presence (in Southern African populations) of large, circular, ivory-colored raised patches on the alloscutum. Additionally both sexes of *C. hippopotamensis* can be distinguished from all African *Amblyomma* species [except *A. sylvaticum* (De Geer, 1778)] by the presence of 2 posterior spurs on coxae II–IV and a generally shorter gnathosoma.

The morphology of nymphs is unique. A combination of the following characters will guarantee identification of *C. hippopotamensis* on the nymphal stage: scutum with deep posterolateral depressions, prominent eyes, numerous exceptionally long setae on the anterolateral fields of the alloscutum, hypostome considerably longer than palpi, rudimentary spurs on all coxae. Larvae are similar in appearance to those of *Amblyomma* and *Hyalomma*, but are readily distinguished from them by the following characters: hypostome considerably longer than palpi and the absence of spurs on coxae.

Type locality: *C. hippopotamensis* was originally discovered amongst the skins of some mammals collected for the Earl of Derby by Joseph Burke, a British naturalist. According to K.H. Hyatt, British Museum of Natural History (in a personal communication to J.B. Walker, 1968), the locality of the holotypes collected by Burke was “in the interior of South Africa at the parallel of Lalagor”. This locality cannot now be traced. We can, however, speculate as to its approximate whereabouts. Burke arrived in Table Bay, South Africa, on 17 March 1840 and proceeded north into the interior of the subcontinent. During June 1840 he shot both a black rhinoceros and hippopotamus at a locality somewhere between $\pm 25^{\circ}44'S$, $27^{\circ}51'E$ and $\pm 25^{\circ}59'S$, $27^{\circ}33'E$. We surmise that it is from these skins that the holotypes were collected. The latitude of this spot is almost parallel to that of Maputo Bay, Mozambique ($26^{\circ}00'S$,

32°45'E) (formerly known as Delagoa Bay, *Baía da Lagoa* [in Portuguese]). “Lalagor” thus possibly represents a miss-spelling of Delagoa. Based on this assumption we believe that the type locality lies somewhere between 25°59'S, 27°33'E and 25°44'S, 27°51'E, and have accordingly indicated this on the distribution map.

Life cycle and hosts: the two-host life cycle of *C. hippopotamensis* is similar to that of *Hyalomma rufipes* and *Hyalomma truncatum* in southern Africa. Large ungulates, including rhinoceroses, are the preferred hosts of the adults of the latter two species, and hares (*Lepus* spp.) of the immature stages (Norval, 1982; Horak and Fourie, 1991). The immature stages of *H. rufipes* also feed on birds and those of *H. truncatum* on murid rodents (Norval, 1982; Matthee et al., 2007). In the laboratory studies conducted by Neitz and Bezuidenhout the immature stages of *C. hippopotamensis* fed successfully on rabbits and on a single mouse, but not on domestic fowls. Extrapolating these results to the field, hares and murid rodents could prove to be good hosts for the immature stages at localities within which adult ticks are present.

The rapidity with which adult *C. hippopotamensis* placed on the young rhinoceros scuttled to its perianal region and attached, and with which the ticks placed on the ground, or that had climbed onto a tree, transferred to the rhino, implies that rhinos are a preferred host of the adults. In support of this theory the ticks engorged and females detached from the rhino and one of them laid fertile eggs. Furthermore, adult ticks collected in the field were encountered on vegetation along footpaths used by rhinoceroses to get to springs, whereas hippopotamuses do not occur in this area (Bezuidenhout and Schneider, 1972). The closest hippopotamuses to these springs were present in the Kunene River about 90 km upstream from one of the collecting sites.

ACKNOWLEDGEMENTS

Although now deceased, Jane Walker had actively participated in the rearing of the immature stages of *C. hippopotamensis* at the Onderstepoort Veterinary Institute in the early 1970s. At the time she had also put aside a partially completed first draft of a description of this intriguing tick. When approached by DAA in 2006 she enthusiastically agreed to participate in the present endeavour, but unfortunately did not live to enjoy its realization.

We are most grateful to Dr. Jan Coetzee, at the time State Veterinarian, who sent the 6 adult ticks from Kakaoland to Dr. Gertrud Theiler in 1960 and was thus indirectly responsible for the research on this tick that was to follow. We are indebted to Mr. J. Roos who was responsible for feeding the ticks on various host species at

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Table 1. *Cosmiomma hippopotamensis*, material studied.

No. of ticks*				Host	Locality	Date	Collector	Acc. No.
♂	♀	N	L					
Kenya, Eastern Province								
1	2			vegetation	Makindu, Chale area	2 January 1968	G.C. Backhurst	RML 50613
1				vegetation	Makindu, Chale area	10 November 1967	G.C. Backhurst	RML 51750
	1			vegetation	Makindu, Chale area	10 November 1967	G.C. Backhurst	RML 51749
Namibia, Kunene Region (Kaokoland)								
8	8			vegetation	Otjipembe	March 1971	J.D. Bezuidenhout	RML 62898
4	4	10	20			reared in laboratory		RML 65717
1	1					reared in laboratory		RML 122176
No Data								
1	1							ZMB
16	17	10	20	Total				

* L, larvae; N, nymphs.

Table 2. Life cycle of *Cosmiomma hippopotamensis*

Development stage	Development period	Host species
Female engorgement	8 days	Black rhinoceros
Pre-oviposition	19 days	
Oviposition (duration)	10 days	
Larvae hatch	66-71 days	
Larval and nymphal engorgement	25 days	Rabbits, mouse
Nymphs moult to adults	28-63 days	

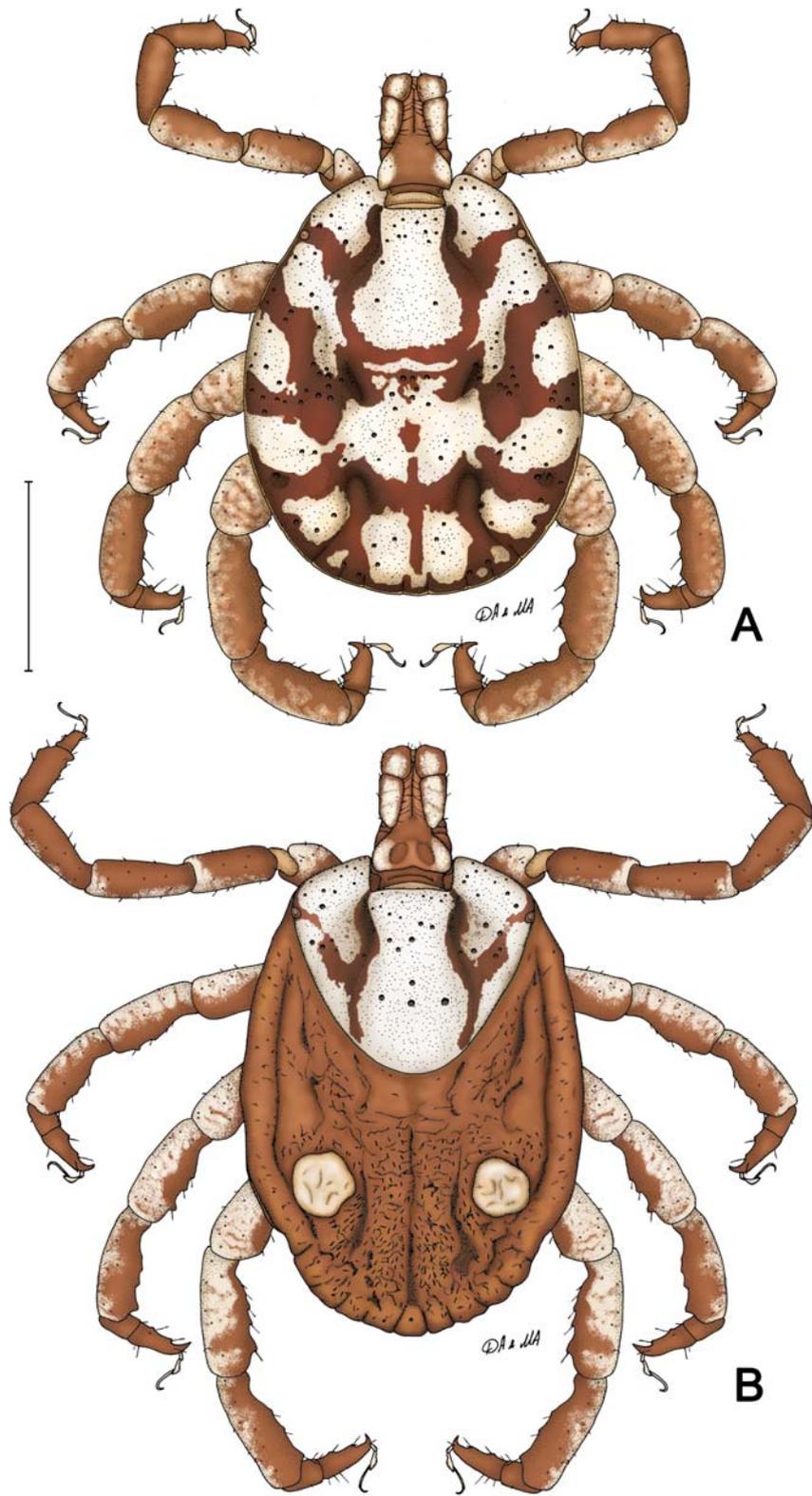


Figure 1

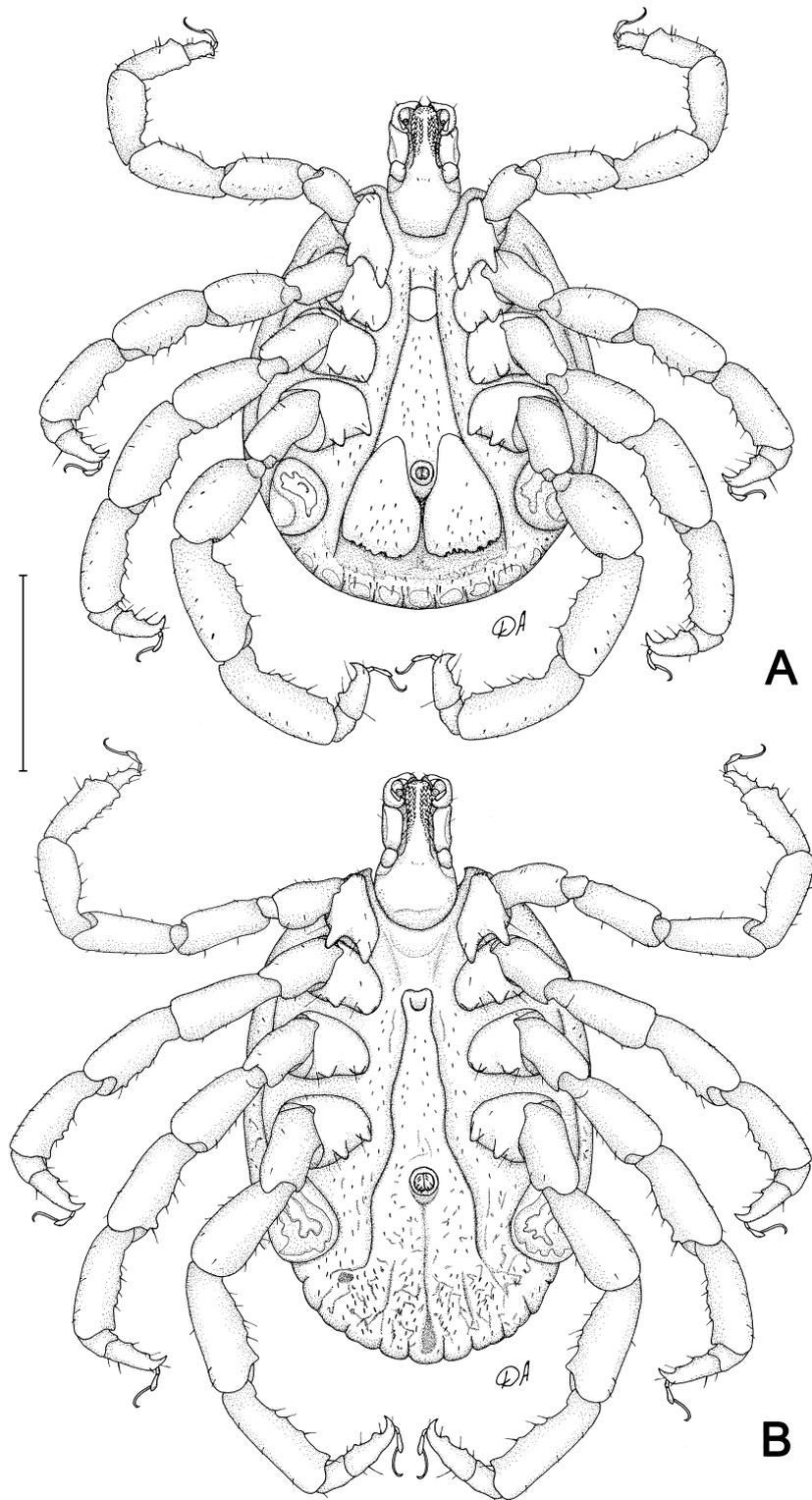


Figure 2

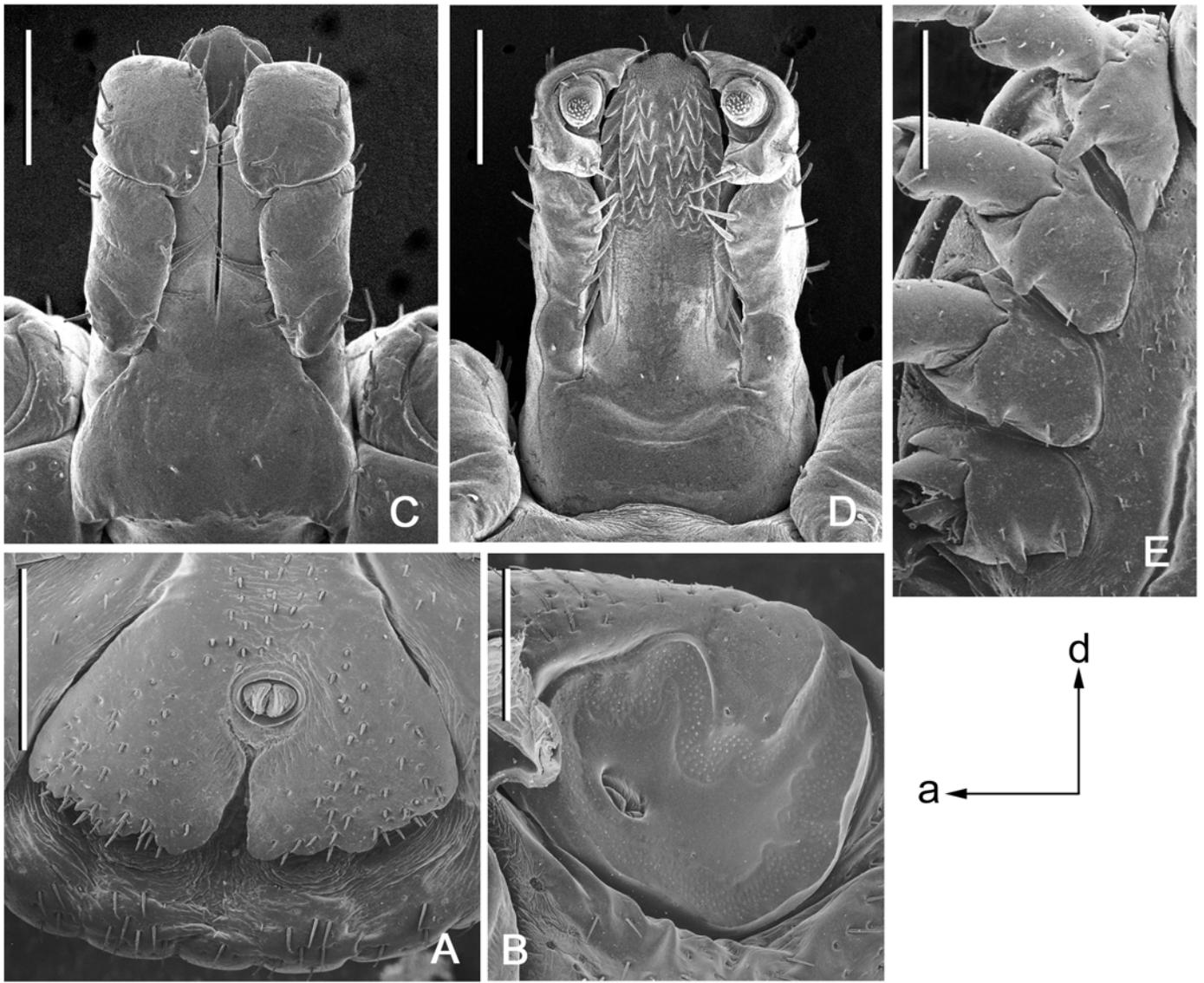


Figure 3

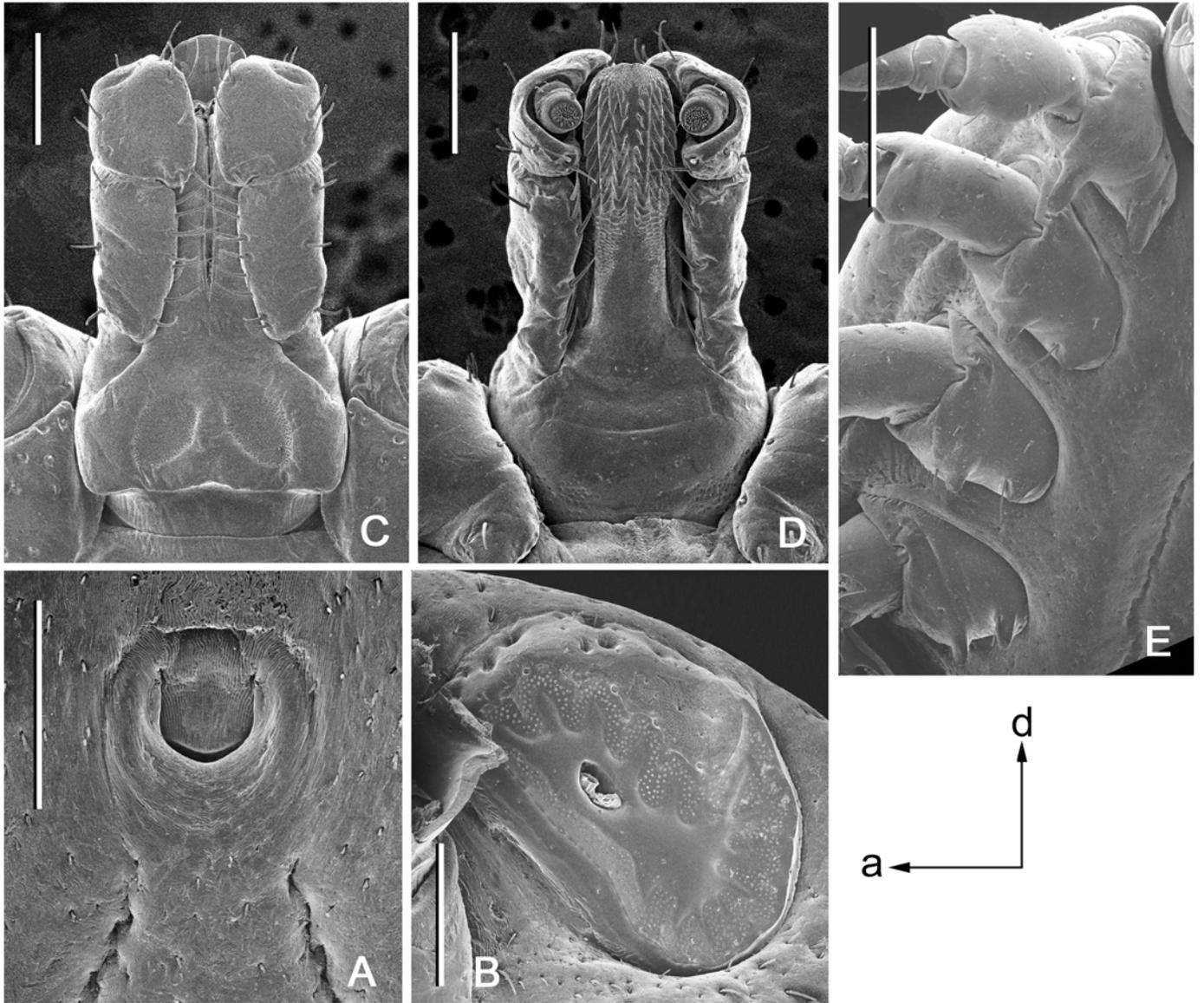


Figure 4

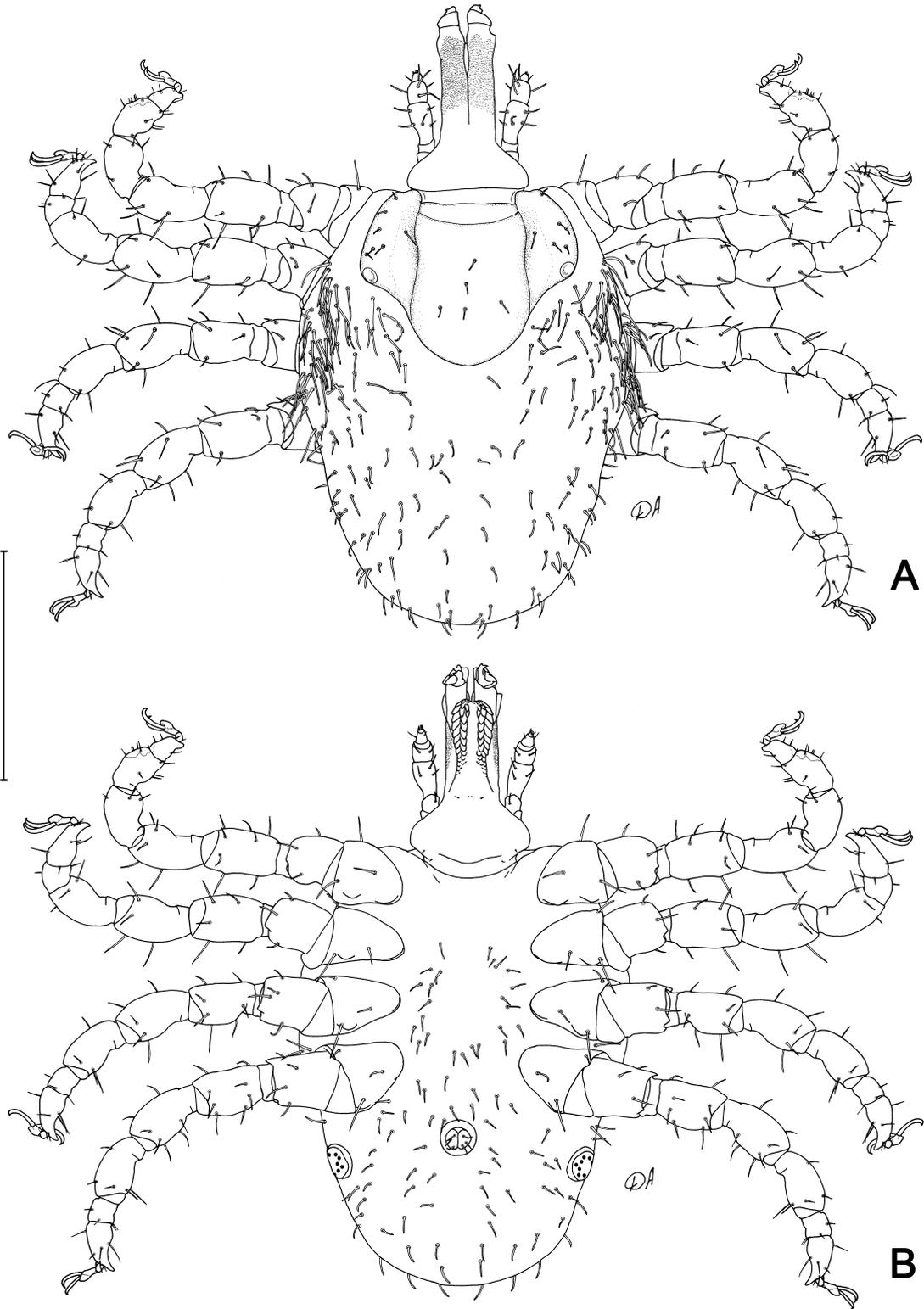


Figure 5

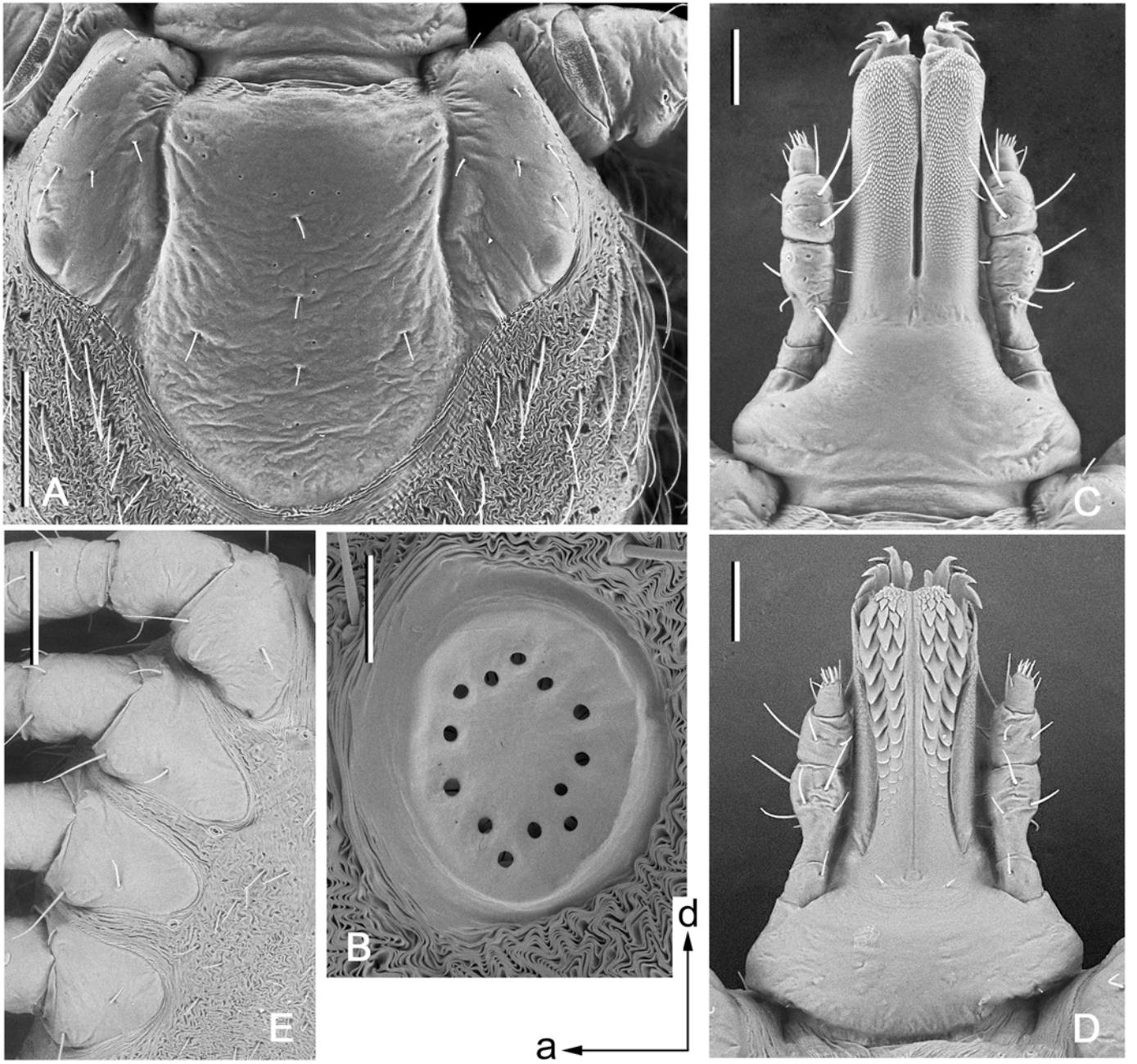


Figure 6

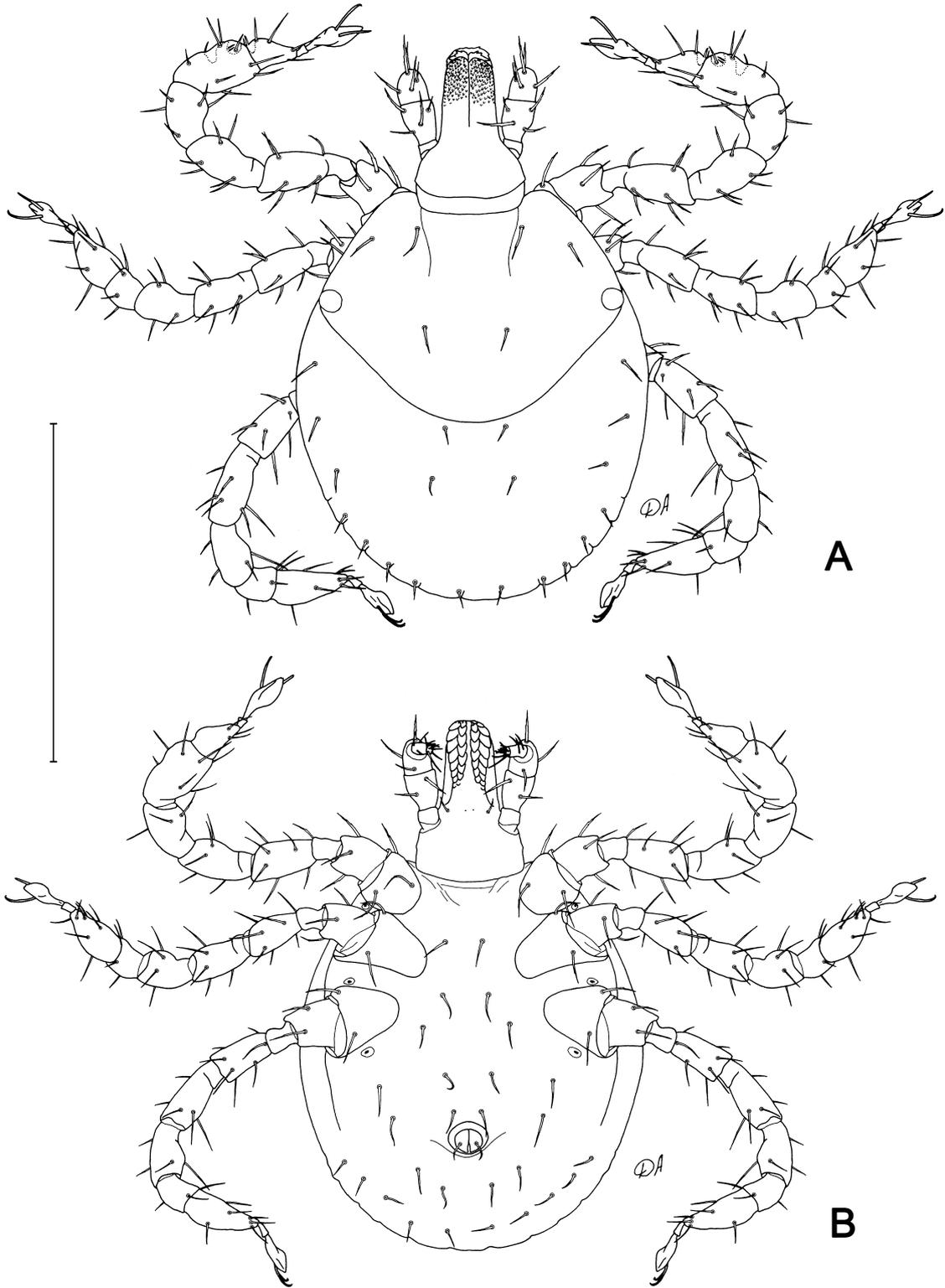


Figure 7

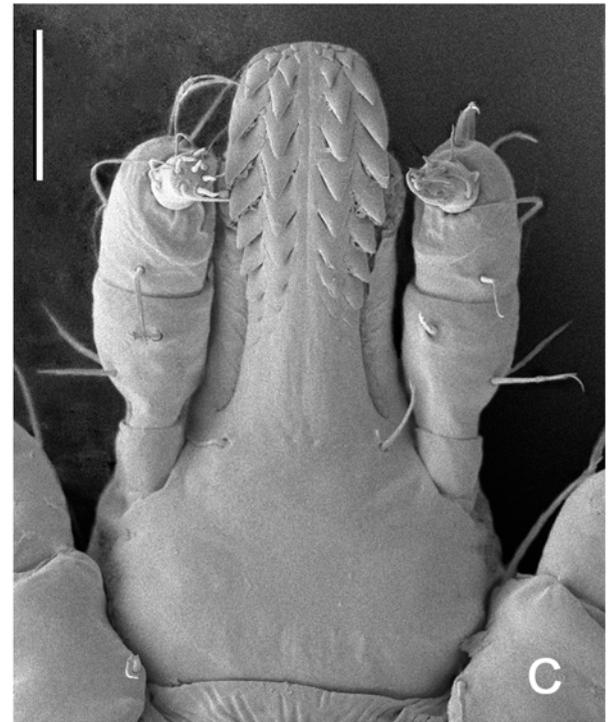
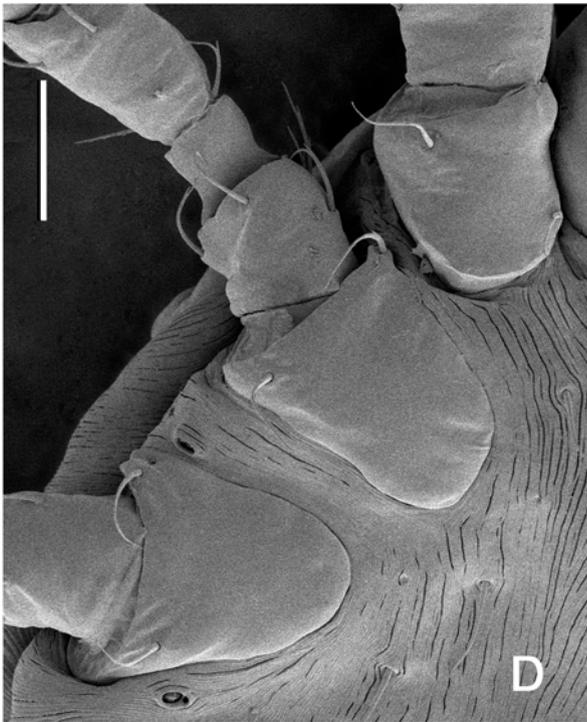
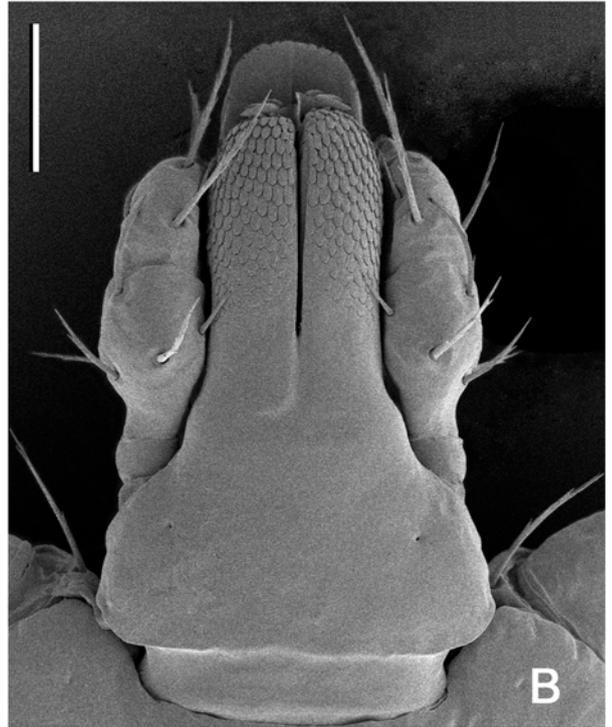
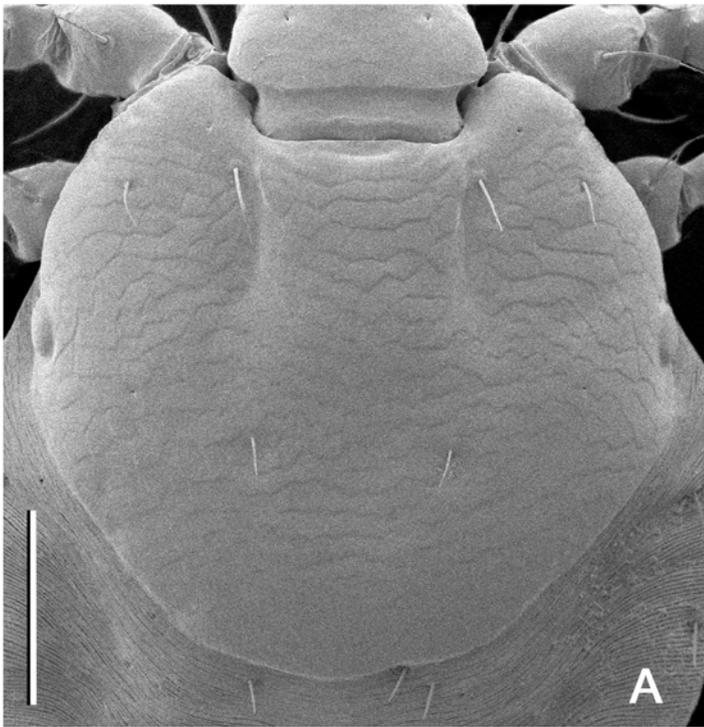


Figure 8

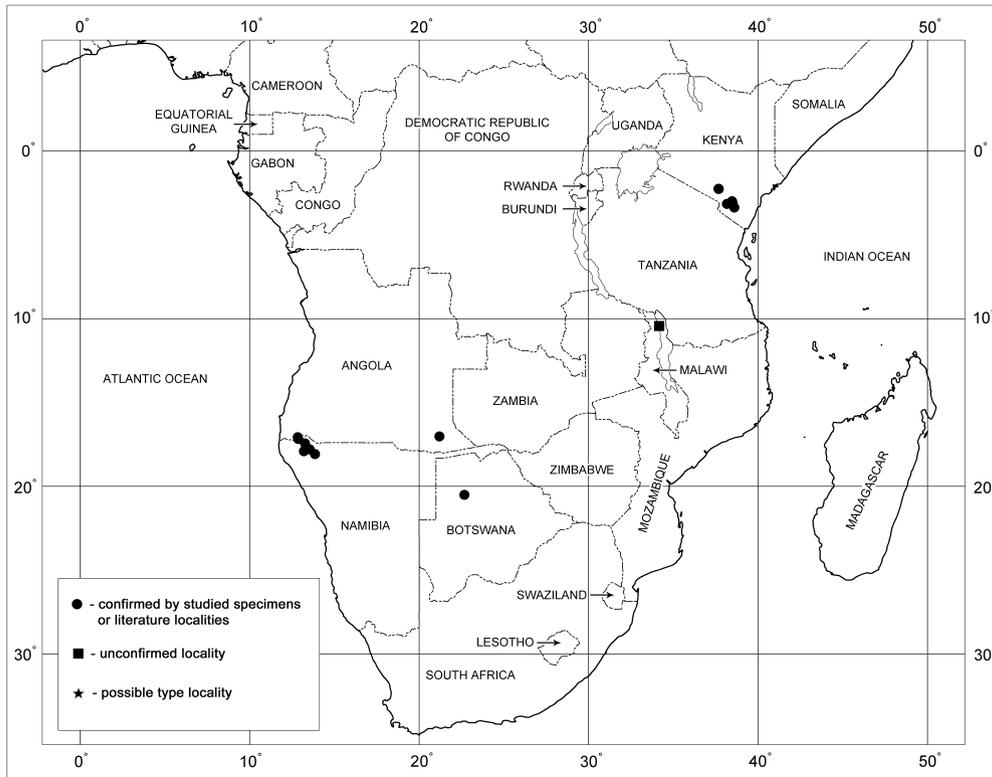


Figure 9