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# A new species of *Unixenus* Jones, 1944 (Diplopoda, Polyxenidae) found in far north Queensland, Australia

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## ABSTRACT

*Unixenus* Jones, 1944 (Polyxenidae) is the dominant genus of penicillate millipedes found throughout mainland Australia. Herein, a new species, *Unixenus mossmanus* sp. nov., is described from coastal forest near Mossman. The new species is similar to *U. karajinensis*, sharing the same sensilla pattern on antennal article VI and the same arrangement of leg setae. *Unixenus mossmanus* sp. nov. differs by having only 3 ornamental trichomes c per side (v. 5–9), 2 pairs coxal glands in the male (v. 6 pairs), and a slender claw (v. robust). These characteristics differ from those of *U. karajinensis*, which has 5–9 ornamental trichomes c; 6 pairs coxal glands in male; and a robust claw structure. 18S sequence of *Unixenus mossmanus* sp. nov. is included.

□ *Diplopoda, Polyxenidae, Unixenus, Queensland, Australia.*

*Unixenus* Jones, 1944 (Polyxenidae) is a well-documented penicillate millipede genus found throughout mainland Australia (Short & Huynh 2011, 2013). The genus is characterised by having: 8 ommatidia on each eye; 13 pairs of legs; 8 antennal articles with VI longest and VIII shortest with 4 sensory cones; labrum surface with spherical papillae; tergal trichomes with two or more rows arranged in two latero-posterior clusters either side midline, with a central gap, anterior row often uneven, intermediate rows rarely in defined rows, and the posterior row of trichome sockets continuous or with a medial gap; and tarsus 2 with a slender seta. There are 13 previously described species worldwide: the type species *Unixenus padmanabhai* Jones, 1937 from India; *U. broelemanni* Condé & Jacquemin, 1962 from Madagascar; *U. vuillaumei* Condé & Terver, 1963 from the Ivory Coast; *U. intragramineus* Huynh & Veenstra, 2018c and *U. moniquea* Huynh & Veenstra, 2020 from Vietnam; and 8 Australian species: *U. mjoebergi* Verhoeff, 1924; *U. attemsi*

Nguyen Duy-Jacquemin & Condé, 1967; *U. corticolus* Short & Huynh, 2011; *U. karajinensis* Short & Huynh, 2011; *U. barrabaensis* Short & Huynh, 2013; *U. carnarvonensis* Short & Huynh, 2013; *U. corringlensis* Short & Huynh, 2013 and *U. myallensis* Short & Huynh, 2013.

Herein we describe a new species of *Unixenus* from Far North Queensland, Australia. Little is known of these millipedes from Queensland, with the only species being *U. mjoebergi*, which is recorded from scattered coastal localities from them southeast to northeast of the state.

## MATERIALS AND METHODS

Penicillate millipedes were collected from leaf litter by sieving and preserved in 90% ethanol. Further examinations were done in the laboratory as details below.

**Morphometric study.** Specimens were examined and measured using a SMZ 800 stereoscope with an Infinity I camera and an

Olympus CX41 compound microscope with a DP21 digital camera. Specimens were measured from head to telson, excluding the caudal bundle of trichomes. The sex of specimens was identified by the presence of sex organs on the coxal plates of the 2nd pair of legs. The specimens were prepared for taxonomic illustration following the staining and slide mounting technique of Short & Huynh (2010). This technique was used with modifications (included in the paragraph below) to permit the extraction of DNA for genetic studies. The remaining cuticles of the specimens were mounted on slides for morphometric analysis as described in Huynh & Veenstra (2015). Scanning electron microscopy (SEM) followed the technique of Huynh & Veenstra (2018b). The holotype and paratypes were deposited in the Queensland Museum (QMS), Brisbane, Australia.

**Genetic study.** The quantity of DNA extracted from six individual *Unixenus* specimens from Mossman (Queensland, Australia) was determined using a NanoDrop 1000 Spectrophotometer (ND 1000V3.60 software) following the manufacturer's instructions. The 18S gene was sequenced for this study. The 18S small subunit ribosomal RNA gene (primers 1F and 5R, White *et al.* 1990), has been used to elucidate relationships among arthropod groups including crustaceans, insects and myriapods (Turbeville *et al.* 1991, Luan *et al.* 2005, Wesener *et al.* 2010, 2016). This gene has also been used to help separate penicillate millipede species of the genera *Lophoturus*, *Monographis* and *Phryssonotus* in combination with morphological characters (Huynh & Veenstra 2015, 2018a, 2018b).

A representative DNA sequence from *Unixenus mossmanus* sp. nov. has been deposited in GenBank (<http://www.ncbi.nlm.nih.gov>), the following accession number for *Unixenus* sp. nov.: MT656009 (18S).

## SYSTEMATICS

Subclass PENICILLATA Latreille, 1831

Order POLYXENIDA Verhoeff, 1934

Family POLYXENIDAE Lucas, 1840

Genus *Unixenus* Jones, 1944

*Unixenus* Jones, 1944: 94; Nguyen Duy-Jacquemin & Condé 1967: 68.

**Type species.** *Unixenus padmanabhai* (Jones 1937)

**Genus diagnosis.** as per (Huynh & Veenstra 2020)

***Unixenus mossmanus* sp. nov.**  
(Figs 1–4)

**Material examined.** HOLOTYPE: Subadult male, 12 pairs of legs (QMS 113000) collected from a roadside in coastal forest, Mossman, 16.385003 S, 145.416656 E, elevation 29 m, 11 km North northeast from the town centre of Mossman, Far North Queensland, Australia; on 10th December 2016, by C. Huynh. PARATYPES: QMS 113001 (paratype 1) subadult male, 12 pairs of legs; QMS 113002 (paratype 2) subadult male, 10 pairs of legs; QMS 113003–4 (paratypes 3 and 4), two females, adult – 13 pairs of legs; QMS 113005 (paratype 5) subadult female, 8 pairs of legs. Paratype collection data as for holotype male. All mounted slides to be catalogued and lodged in the Queensland Museum, Brisbane, Queensland, Australia.

**Etymology.** The species is named *Unixenus mossmanus* sp. nov. as this *Unixenus* species was first found in Mossman, Far North Queensland, Australia.

**Diagnosis.** Eye with 8 ommatidia, 13 pairs of legs; antennal article VI with a conical sensillum, 3 bacilliform sensilla arranged transversely and a setiform sensillum in anterior position; labrum with apical papillae; chaetotaxy with spined biarticulated setae; 3 ornamental trichomes *c*, 2 pairs coxal glands; telotarsus slender, length of posterior lateral process equal to half length of claw and setiform process longer than claw.

**Description.** *Measurements* Holotype male (subadult 12 pairs of legs) 2.4 mm and caudal bundle 0.4 mm; paratypes: Adult females 2.9–3.0 mm, caudal bundle 0.5 mm, subadults 2.0 mm and caudal bundle 0.3 mm in both sexes.

*Colouration.* Head with two dark brown transverse bands on vertex connecting with

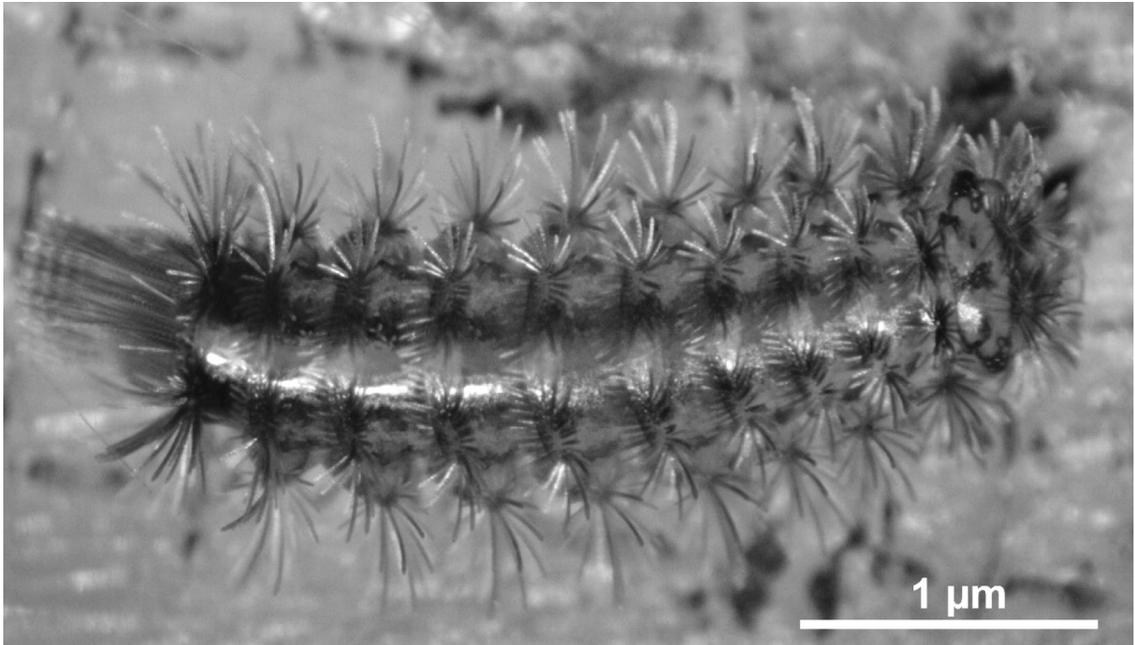


FIG. 1. Image of live *Unixenus mossmanus* sp. nov. (Polyxenidae).

dark brown eyes. Body light brown, contrasting with light silvery pleural trichomes and darker colour on caudal bundle; dark brown marks on latero-posterior rosette trichomes forming a dark band along each side of body laterally; darkest colour on last tergite (Fig. 1).

*Head.* Eye with 8 ommatidia: 4 dorsal, 4 lateral positions (1 anterior, 2 medial and 1 posterior position). Vertex with two posterior trichome groups, a large medial gap between these groups. Each posterior trichome group has 3 rows: anterior row short, with small trichome sockets, intermediate row longest, with larger trichome sockets arranged obliquely; posterior row short, with 5–6 large trichome sockets. Intermediate and posterior row separated by narrow space. Holotype's posterior trichome group with: anterior row with 8 sockets (Left: L) and 8 sockets (Right: R); intermediate rows with 14 sockets (L) and 13 sockets (R); posterior row with 6 sockets (L) and 5 sockets (R) (Figs. 2A, E, F) (Paratypes: adult females with: anterior rows 9–18 sockets, intermediate rows 12–15 sockets, posterior rows 7–10 sockets; all subadults with 3 clear rows

each with fewer trichome sockets (Fig. 5A)). Trichobothria Typically thin sensory hairs with narrow cylindrical funicles; trichobothria equal in socket size forming an isosceles triangle with equal distance *ab* and *bc* (Figs. 2G, 5A) (trichobothrium a located in posterior position to head capsule, trichobothrium b in lateral position, trichobothrium c in anterior position). Antennae 8 antennal articles, 4 sensory cones, typical characteristics of Polyxenidae. Holotype: antennal article VI with 3 thick bacilliform sensilla, different lengths: anterior shortest, thick bacilliform sensillum (Ta), intermediate longest thick bacilliform sensillum (Ti), posterior sensillum long thick bacilliform (Tp); setiform sensillum (s) next to Ta, conical sensillum (c) next to Tp (Figs 3B, C; 6A, C). Antennal article VII with 2 thick bacilliform sensilla, Ta longer than Tp; setiform sensillum (s) between them and conical sensillum (c) next to Tp. (Figs. 3A, C; 6A, B). (Pattern of sensilla on antennal article VII common in *Unixenus*). Clypeolabrum Holotype with labrum bearing 10 setae along posterior margin, these setae less than half width of labrum (paratypes: 10–12 setae in both sexes). Labral surface with

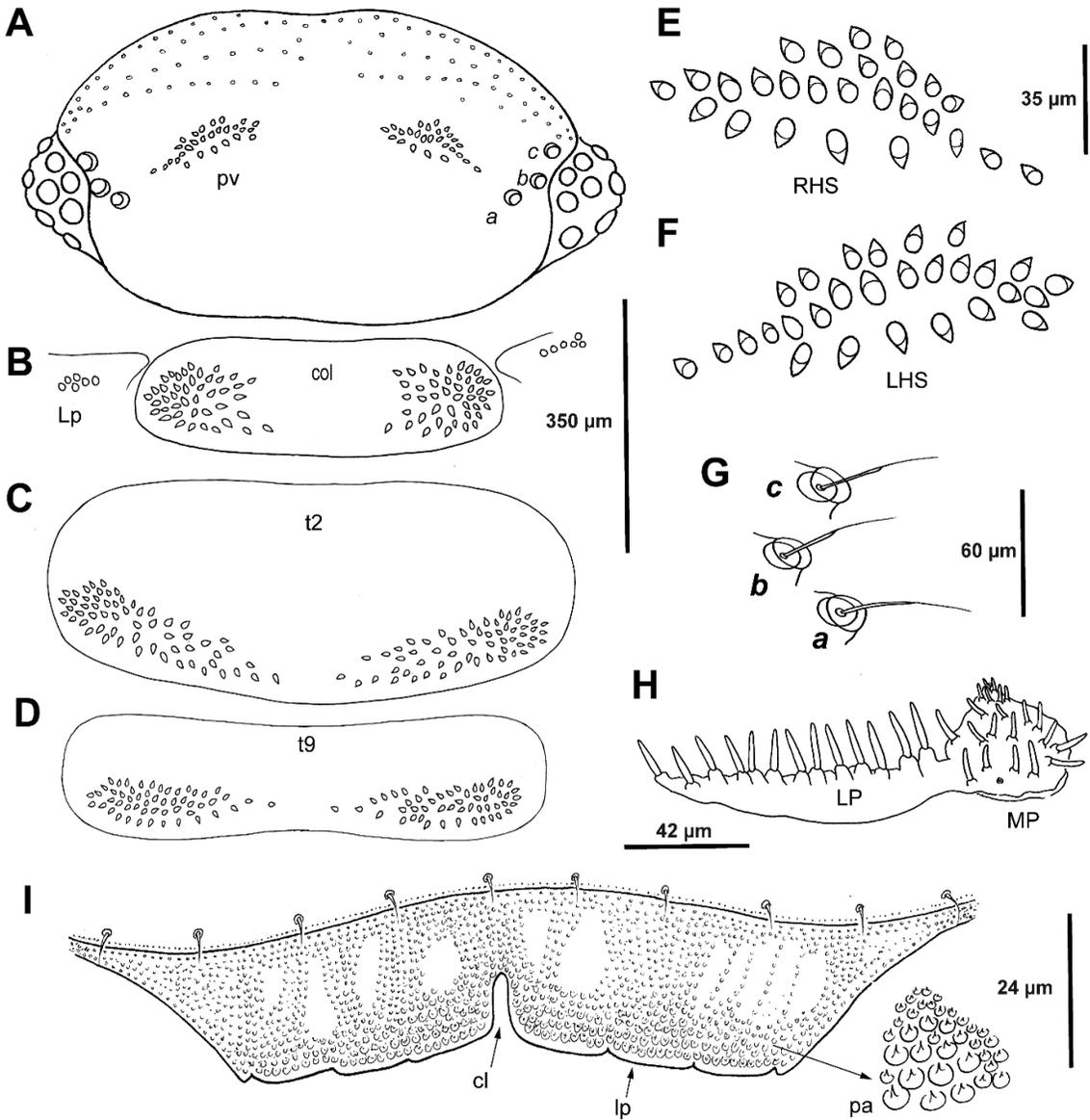


FIG. 2. Depiction of holotype male, *Unixenus mossmanus* sp. nov. **A**, Head capsule showing the posterior vertex trichome sockets (pv) and trichobothria (a, b and c); **B**, Collum (col) with trichome sockets patterns and the lateral protuberances (Lp); **C**, Tergite 2 (t2); **D**, Tergite 9 (t9); **E**, Posterior vertex trichome sockets (pv), right hand side (RHS), and **F**, Left hand side (LHS); **G**, Trichobothria: trichobothrium a (located posteriorly), trichobothrium b (located laterally) and trichobothrium c (located anteriorly); **H**, Gnathochilarium showing 2 parts: Lateral palp (LP) with 13 sensilla, medial palp (MP) with 22 sensilla; **I**, Labrum showing 4 linguiform processes (lp) on each side of the median cleft (cl) and the surface of labrum showing pointed end spherical papillate (pa).

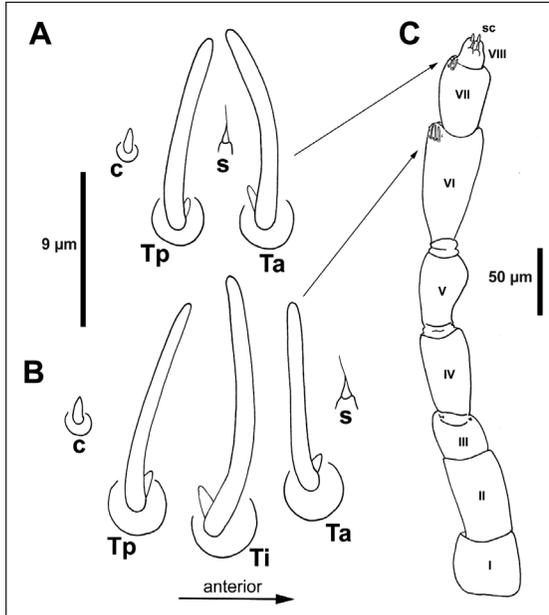


FIG. 3. Antennal articles and sensilla of the holotype male *Unixenus mossmanus* sp. nov. **A**, Arrangement of sensilla on the antennal article VII; **B**, Sensilla on the article VI; **C**, The left antenna showing 8 articles and the arrangement of sensilla on the antennal articles VI and VII. (c: conical sensillum, Ta: Thick bacilliform sensillum located in anterior position, Ti: Thick bacilliform sensillum located intermediately, Tp: Thick bacilliform sensillum in posterior position, s: setiform sensillum).

apical papillae, each bearing setae, large along anterior margin, becoming smaller posteriorly. Anterior margin of labrum with lateral lamella and 3 lamellae on each side of median cleft (Figs 2I, 5D). Gnathochilarium: Lateral palp 2.5 times size medial palp. Lateral palp with 13 conical sensilla, medial palp with 22, same in holotype and paratypes (Figs 2H, 5B). Trunk: 10 tergites, 9 pleural projections, and telson excluding caudal bundle; 13 pairs of legs. Collum (tergite 1) with trichome sockets arranged in 2 oval shapes in lateral position pointed opposite each other, connected by posterior row of trichome sockets forming a line separated by large medial gap. Holotype, trichome sockets on collum with 43 on both sides, lateral protuberances (first pleural projections reduced in size) with 6 trichome sockets on each side (Fig. 2B) (Trichome

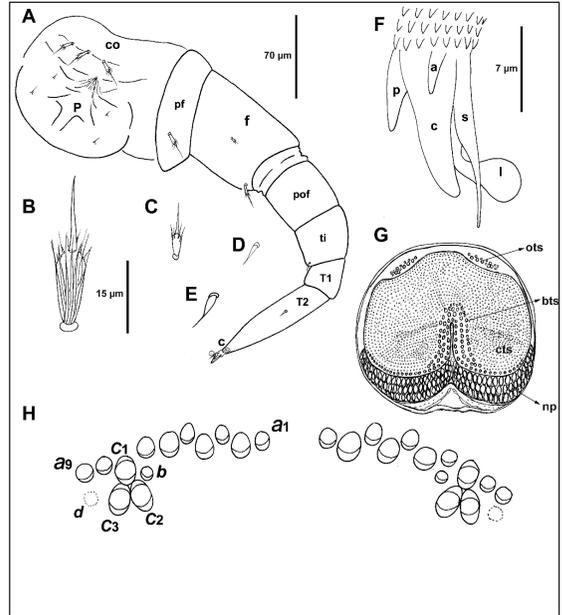


FIG. 4. Holotype male of *Unixenus mossmanus* sp. nov. **A**, The second left leg showing a penis (p), seven leg segments (co: coxa, pf: pre-femur, f: femur, pof: post-femur, ti: tibia, T1: tarsus 1, T2: tarsus 2), a claw and its chaetotaxy (setae on the leg segments); **B**, The large spined biarticulated, ridged funicular cylindrical sensilla presented on coxae, pre-femurs, the distal edge of the femurs and the posterior edge of the last sternite; **C**, A small version of B presented in the middle of femurs; **D**, A seta on tibiae; **E**, A slender seta on Tarsi 2; **F**, Telotarsus-claw showed all processes: Anterior lateral process (a), posterior lateral process (p), claw (c), the anterior setiform process (s) and the lamella process (l); **G**, The caudal bundle structure of the subadult showed 3 main parts (Dorsal - ventral): Ornamental trichome sockets (ots), caudal trichome sockets (cts) with the barbate trichome sockets (bts) in the centre, and the present of the new forming pleural projections (np); **H**, The ornamental trichome sockets, located dorsally on the caudal bundle structure, with 9 trichome a, 1 trichome b, 3 trichomes c and the circular indentation d.

sockets on collum varying in paratypes ranging from 46–60 sockets and 5 sockets on lateral protuberances in adult female; subadults: male (12 pairs of legs) with 42 sockets and 4 sockets). Tergites 2–10 each with pleural projections in anterolateral positions. Tergal trichome socket

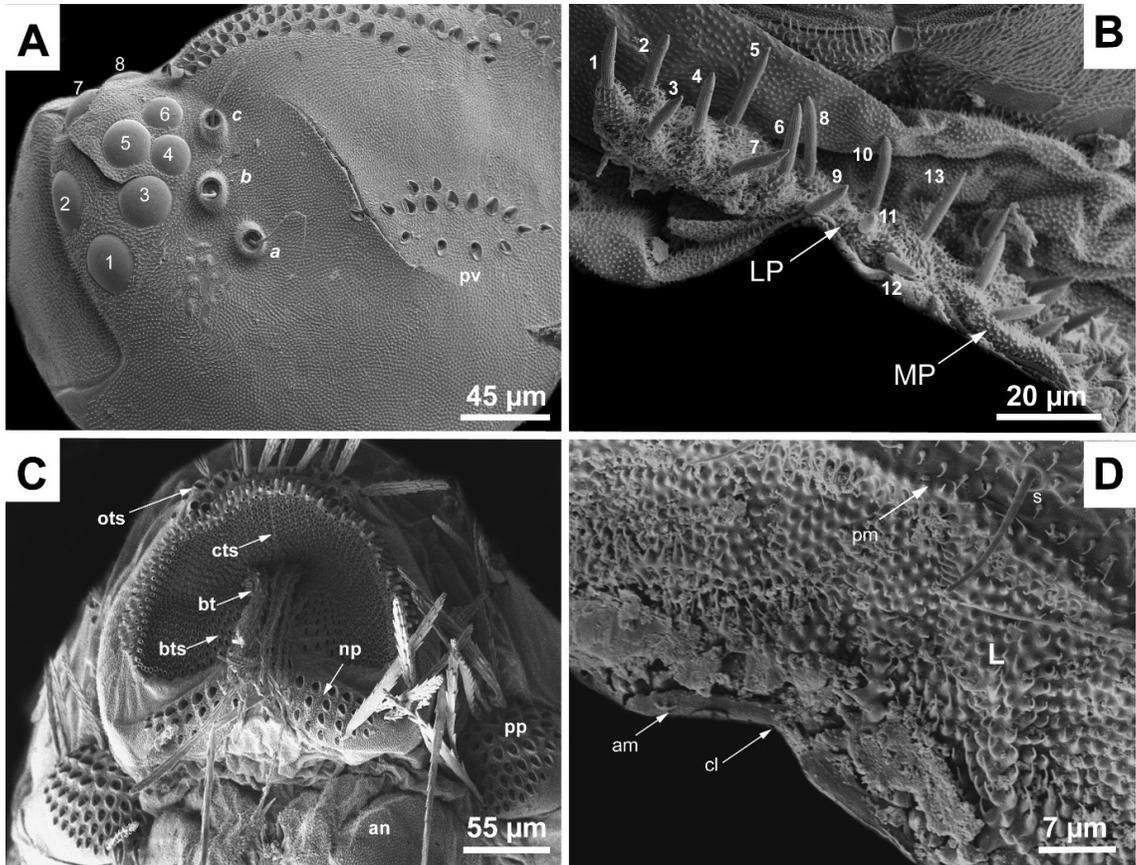


FIG. 5. SEM images of *Unixenus mossmanus* sp. nov. **A**, Dorsal view of the head capsule, left hand side, showing eye pattern with 8 ommatidia, trichobothria (a, b and c) and the posterior vertex trichome sockets (pv); **B**, Gnathochilarium: Lateral palp (LP) with 13 sensilla and the medial palp (MP) showing some sensilla; **C**, Telson structure showing the ornamental trichome sockets (ots), caudal trichome sockets (cts) and some barbate trichome sockets (bts), the newly formed pleural projections (np), the pleural projections (pp) and the anus (an); **D**, Labrum (L) showing the anterior margin (am) with the median cleft (cl) and the surface of labrum with pointed end spherical papillate, the posterior margin (pm) and a seta (s).

arrangements from tergites 2–8 typically with 2 thin oval shapes, slightly enlarged laterally, connected by posterior row extending toward to centre with large gap between these trichome sockets (Fig. 2C). Tergite 9 similar but with trichome sockets smaller and denser (Fig. 2D). Tergite 2 with 59 (L) and 58 (R) trichome sockets (Fig. 2C). Tergite 9 with 53 (L) and 52 (R) sockets (Fig. 2D) (In contrast, trichome sockets on tergite 2 in paratypes: Females 72–74, whereas tergite 10 with 58–64 trichome sockets; subadults with fewer sockets). Legs:

Legs 1 and 2 without trochanter, leg 1 lacking tarsus 1. Chaetotaxy (setae on leg articles): Coxa 1: 1 seta, coxa 2: 2 setae, coxae 3–13: 2–3 setae; pre-femur and tibia with 1 seta; femur with 2 setae and tarsus 2 with 1 slender seta (Figs. 4A, 7A). Setae on coxa, pre-femur, femur with distal spines, ridged funicular cylindrical sensilla (Fig. 4B); setae on mid femur and tibia similar but smaller (Figs. 4C, 7A), tarsus 1 without seta, tarsus 2 with slender seta (Figs. 4A, E; 7A). Posterior edge of last sternite without seta in holotype (paratypes with 2–4 setae in adult). Sex

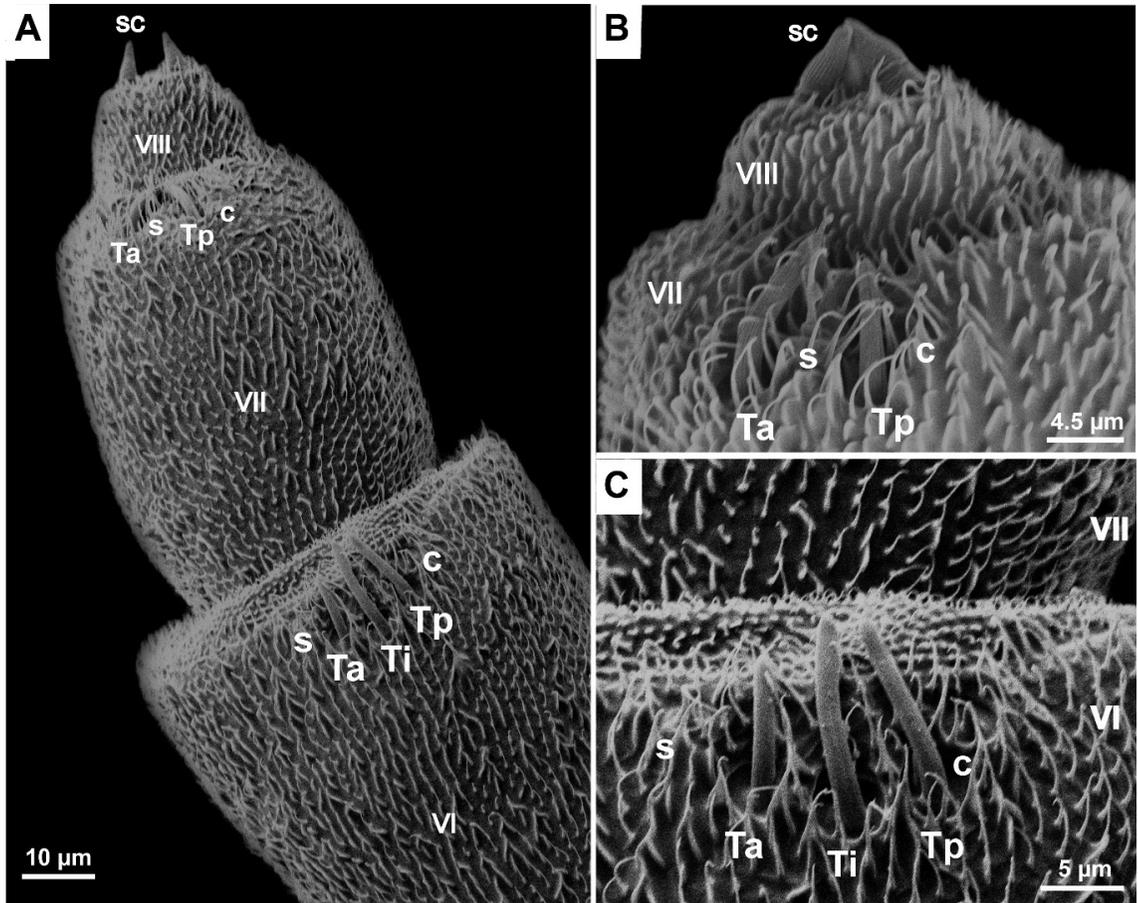


FIG. 6. SEM images of antennal articles VI – VIII of *Unixenus mossmanus* sp. nov. **A**, Antennal articles VI – VIII, sensory cones (sc) and the arrangement of sensilla; **B**, Antennal article VII with the sensilla, VIII and the sensory cones; **C**, Article VI with sensilla: A conical sensillum (c), the thick bacilliform sensilla (Tp: located in posterior position, Ti: located intermediately position, Ta: anterior position) and a setiform sensillum (s).

organs in male: Pair of penes present on coxa 2; 2 pairs of coxal glands on coxal plates of 8th and 9th legs. Telotarsus-Claw slender, bearing posterior lateral process equal to half length of claw. Small anterior lateral process and lamella process present, anterior setiform process slightly enlarged at base and longer than claw (Figs. 4F, 7B). Telson Dorsal ornamental trichome sockets arranged symmetrically on both sides of telson with 9 trichome a sockets in holotype (paratypes with 7–10 trichomes a), these trichome a sockets vary in size with small sockets and larger sockets forming

transverse rows (Fig. 4H), single trichome b socket and 3 trichome c with large protruding base sockets: c1, c2 and c3, forming triangular shape each side of telson. Circular indentation d apparent near exterior side of trichomes c. Caudal bundles holotype male (subadult) with single bundle of uniform large trichome sockets of caudal trichomes, barbate trichome sockets in centre, and newly formed pleural projections located in ventral position of the bundle structure (Figs. 4G, 5C). Female, two obvious distinguishing structures: main dorsal structure similar to male, and 2 latero-sternal

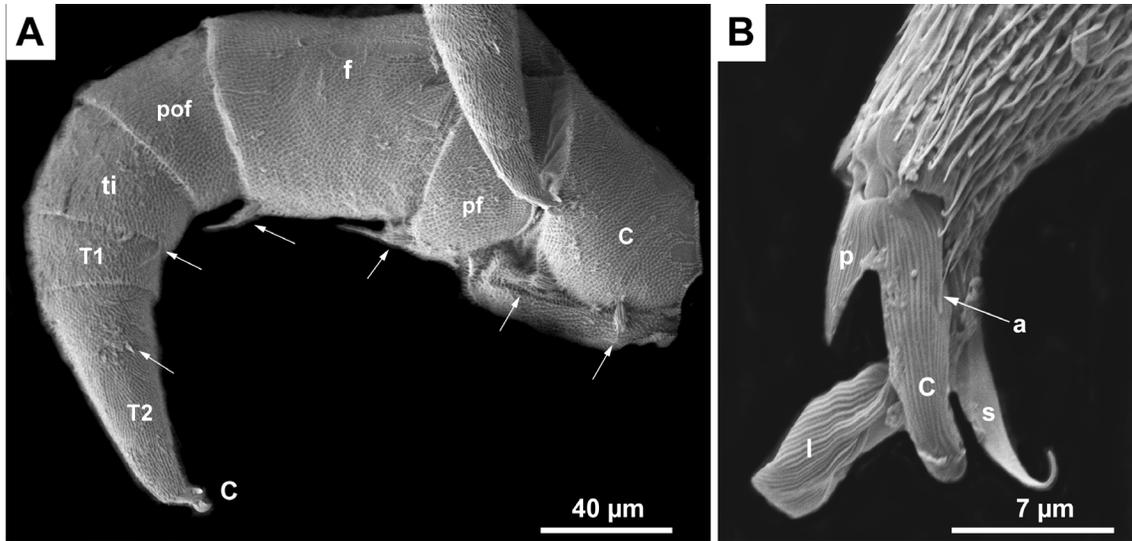


FIG. 7. SEM images of the leg segments and claw structure of *Unixenus mossmanus* sp. nov. **A**, The second leg (right hand side) without penis, showing its chaetotaxy (setae on the leg segments): Seven leg segments (c: coxa, pf: pre-femur, f: femur, pof: post-femur, ti: tibia, T1: tarsus 1, T2: tarsus 2) and a claw; **B**, Telotarsus-claw: Anterior lateral process (a), the posterior lateral process (p), claw (c), the setiform process (s) and the lamella (l).

bundles of smaller trichome sockets of nest trichomes. Caudal trichomes 2–4 hooks. (These caudal structures similar to *Monographis* (Huynh & Veenstra 2013) which are classified as caudal bundle type I (Condé & Nguyen Duy-Jacquemin 2008)).

**Remarks.** *Unixenus mossmanus* is similar to *U. karajinensis* by having has the same sensilla pattern on the antennal article VI and a similar arrangement of setae on the leg segments. *Unixenus karajinensis* has 5–9 ornamental trichomes *c*, 6 pairs of coxal glands in the male, and a robust claw structure. In contrast, *Unixenus mossmanus* has only 3 ornamental trichomes *c* per side, 2 pairs of coxal glands, and a slender claw. In the key published by Huynh & Veenstra (2020), the new species comes to *U. karajinensis* and can be separated from it as per the differential diagnosis above.

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