



Review of the flat bug genus *Cretopiesma* Grimaldi & Engel, 2008 from mid-Cretaceous Burmese amber and description of three new species (Hemiptera: Heteroptera: Aradidae: Archearadinae)

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Abstract

Grimaldi & Engel (2008) described *Cretopiesma suukyiae* from Burmese amber and attributed it to Piesmatidae (mainly because of its very small size), but was later recognized as belonging to Aradidae. Herein we add some morphological characters to the description of *Cretopiesma* Grimaldi & Engel, 2008, **sens. lat.**, **sens. nov.** which we assign to Archearadinae Heiss & Grimaldi, 2002. We revise the diagnosis of Archearadinae and synonymize *Microaradus* Heiss & Poinar, 2012, **nov. syn.** with *Cretopiesma*. We also describe, illustrate and characterize (from the same fossil genus) three new species *Cretopiesma engelgrimaldii* **sp. nov.**, *C. lini* **sp. nov.** and *C. inexpectatum* **sp. nov.** A key to all species of *Cretopiesma* is given. The new discoveries provide new insight for understanding the palaeobiodiversity of the Aradidae during the mid-Cretaceous period.

Keywords: Mesozoic, fossil insect, Myanmar, new species, *Microaradus*, *Cretopiesma*

Introduction

Mid-Cretaceous Burmese amber is considered to be the richest in species among the Cretaceous ambers (Grimaldi *et al.*, 2002). To date, more than 1,200 species have been described from this material and the number is still growing fast (Ross, 2019).

Aradidae Brullé, 1836 are a large pentatomorphan bug family, mostly mycophagous comprising eight recent subfamilies (Aneurinae Douglas & Scott, 1865; Aradinae Amyot-Serville, 1843; Calisiinae Stål, 1873; Carventinae Usinger, 1950; Chinamyersiinae Usinger & Matsuda, 1959; Isoderminae Stål, 1873; Mezirinae Oshanin, 1908, and Prosympiestinae Usinger & Matsuda, 1959) with

about 2050 species in 285 genera (Schuh & Weirauch, 2020) and an extinct fossil subfamily Archearadinae Heiss & Grimaldi, 2002 known only from mid-Cretaceous Burmese amber comprising two genera. Most aradid species are flattened dorsoventrally or elliptical, oval, or rectangular shape (Coscarón & Contreras, 2015). They usually have somber colors and are well adapted for a lifestyle on or under the bark of dead trees. The family Aradidae exhibits a variety of wing development, macroptery, brachyptery, and aptery. Many tropical species are wingless and the dorsal surface is frequently appearing granular or rugose. Flat bugs can be identified by their mandibular and maxillary stylets extremely elongated and coiled, which are however not visible in fossil specimens. Ocelli are absent, rostrum usually short and stout with four distinct segments, trochanters not fused to femora, and tarsi bisegmented (Coscarón & Contreras, 2015).

From the rich mid-Cretaceous Burmese amber, 11 species assigned to ten genera of Aradidae have been described to date: (*Aradoleptus birmanus* Heiss, 2016; *Archeaneurus neli* Heiss, 2019a; *Archearadus burmensis* Heiss & Grimaldi, 2001; *Archearadus elongatus* Heiss, 2016; *Archealysius longiventris* Heiss, 2019b; *Calisiomorpha yuripopovi* Heiss, 2016; *Cretopiesma suukyiae* Grimaldi & Engel, 2008; *Ellenbergeria oviventris* Heiss, 2016; *Kachinocoris brevipennis* Heiss, 2012; *Microaradus anticus* Heiss & Poinar, 2012; *Myanmezira longicornis* Heiss & Poinar, 2012). *Cretopiesma suukyiae* Grimaldi & Engel, 2008 was originally assigned to Piesmatidae, and was later recognized as belonging to Aradidae and transferred to this family by Cassis & Schuh (2010). Heiss & Grimaldi (2002) erected the subfamily Archearadinae (known only from the mid-Cretaceous Burmese amber), which includes *Archearadus burmensis*

Heiss & Grimaldi, 2001; *Archeoradus elongatus* Heiss, 2016 and *Microaradus anticus* Heiss & Poinar, 2012.

Herein we add some morphological characters to a redescription of the genus *Cretopiesma* Grimaldi & Engel, 2008, **sens. lat., sens. nov.** to which we also assign to subfamily Archeoradinae Heiss & Grimaldi, 2002. We revise the diagnosis of Archeoradinae and synonymize *Microaradus* Heiss & Poinar, 2012, **nov. syn.** with *Cretopiesma*. We also describe three new species: *Cretopiesma engelgrimaldii* **sp. nov.**, *Cretopiesma lini* **sp. nov.** and *Cretopiesma inexpectatum* **sp. nov.**

Material and methods

Studied material originates from Hukawng Valley in Tanai Township, Myitkyina District of Kachin State, Northern Myanmar (for map and details refer to Kania *et al.*, 2015). The age of this amber is believed to be earliest Cenomanian (~99 Ma) after U-Pb dating of zircons (Shi *et al.*, 2012), but could be older as late Albian (*e.g.*, Mao *et al.*, 2018).

Specimen examination and photographs were made using a Zeiss AXIO Zoom V16, a Zeiss SteREO Discovery V20 stereo microscopes and a Zeiss AXIO Imager Z2 compound microscope equipped with fluorescence laser. The figures were prepared with Adobe Photoshop CC 2015. Terminology of wing venation generally follows Usinger & Matsuda (1959). Terminology of genitalia follows Coscarón & Contreras (2015) and Usinger & Matsuda (1959). The type material of the new species is deposited in the collections of the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, China and in the collection of the second author (EH) at the Tiroler Landesmuseum Ferdinandeum, Innsbruck, Austria.

Abbreviations used for veins of hemelytra: A, anal; C, costa; Cu, cubitus; M, media; R, radius.

Systematic palaeontology

Class Insecta Linnaeus, 1758

Order Hemiptera Linnaeus, 1758

Suborder Heteroptera Latreille, 1810

Superfamily Aradoidea Brullé, 1836

Family Aradidae Brullé, 1836

Subfamily Archeoradinae Heiss & Grimaldi, 2002

Type genus. *Archeoradus* Heiss & Grimaldi, 2001.

Diagnosis (revised after Heiss & Grimaldi, 2002). Body flattened, surface granular; labium of variable length, short (reaching at most prosternum) to more

or less developed (reaching the mesosternum in some cases), arising well beyond apex of elongate clypeus, enclosed by bucculae at base, with open atrium; eyes pedunculate; winged adults with or without dimorphic wing development, when existing with macropterous male and brachypterous female; corium laterally dilated at base; metathoracic scent-gland openings in the form of a pit, sometimes with an erect bristle-like structure arising from middle; legs long and slender, without spines, trochanters not fused to femora; tarsi two-segmented with claws bearing pulvilli; abdominal terga III–VI separated by sutures and not fused to a tergal plate; pattern of glabrous spots 2:1:1 above and 1 (2?): 1:1 below; eighth abdominal segment well developed in both sexes, their lateral lobes produced on either side of bilobate segment IX.

Genus *Cretopiesma* Grimaldi & Engel, 2008 sens. lat., sens. nov.

Cretopiesma Grimaldi & Engel, 2008: 3.

Microaradus Heiss & Poinar, 2012: 311, **nov. syn.**

Type species. *Cretopiesma suukyiae* Grimaldi & Engel, 2008.

Included species. *Cretopiesma suukyiae* Grimaldi & Engel, 2008; *Cretopiesma anticum* (Heiss & Poinar, 2012) **comb. nov.**, *Cretopiesma engelgrimaldii* **sp. nov.**, *Cretopiesma lini* **sp. nov.** and *Cretopiesma inexpectatum* **sp. nov.**

Diagnosis (revised after Grimaldi & Engel, 2008 for *Cretopiesma* and after Heiss & Poinar, 2012 for *Microaradus*). Small sized species of *Aradus*-like habitus, less than 3 mm; head ventrally with shallow rostral groove; rostrum of variable length (reaching mesosternum in some cases), inserted far from clypeal apex, enclosed by developed bucculae at base; eyes large, globular and protruding; ocelli absent; thorax with pronotum with four distinct longitudinal carinae and large scutellum; macropterous (wings developed but not exceeding tip of abdomen); hemelytra with well-differentiated clavus, corium, and membrane, last with 4 or 5 veins sometimes anastomosing apically to form closed cells; corium with venation distinctive (veins R+M, Cu and A not fused), forming variable number of closed cells between R+M at outer wing margin and Cu and between Cu and A; prosternum with rostral groove between fore coxa; metathoracic scent-gland openings reduced, in form of pit.

Remarks. *Microaradus* shares all the features as in *Cretopiesma* except the disk of pronotum with only two (instead of four) longitudinal carinae and spiracles on laterotergites II–V (= III–VI) dorsal (instead of ventral), but these two later characters are erroneous as given here. The original attribution of this species to the Piesmatidae

and the fact that the description was based on a badly visible exemplar, probably led the authors to incorrectly assume a dorsal position of the spiracles and a pronotal disk with two longitudinal veins instead of four.

***Cretopiesma suukyiae* Grimaldi & Engel, 2008**

(Fig. 1)

Cretopiesma suukyiae Grimaldi & Engel, 2008: 3.

Additional material. Specimens BUB-ARAD-14/11, male and specimen BUB-ARAD-17/12, male (Fig. 1). Material deposited in the Tiroler Landesmuseum Ferdinandeum, Austria.

Diagnosis (revised after Grimaldi & Engel, 2008). Antenna with four antennomeres; antennomeres I and II short and wide, almost same size; antennomere III thin and the longest; antennomere IV fusiform, longer than

each of the two basal antennomeres; ratio antennomeres III/IV = 1.9; ventral face of head areolate; rostrum 4-segmented extending to level of fore coxae; pronotum broad, explanate; trapezoidal in shape, with lateral margins diverging caudad, posterior margin slightly sinuate; pronotal disk with four distinct longitudinal veins; forewing with corium areolate.

Remarks. Grimaldi & Engel (2008) in their original description of *Cretopiesma suukyiae* stated the presence of dorsal spiracles on laterotergites II–V (= III–VI) and erroneously attributed this species to the Piesmatidae, this assumption (due to the fact that the description was based on a badly visible exemplar because of the amber turbidity) probably led the authors to incorrectly assume a dorsal position of the spiracles and a pronotal disk with two longitudinal veins instead of four as present in Piesmatidae.

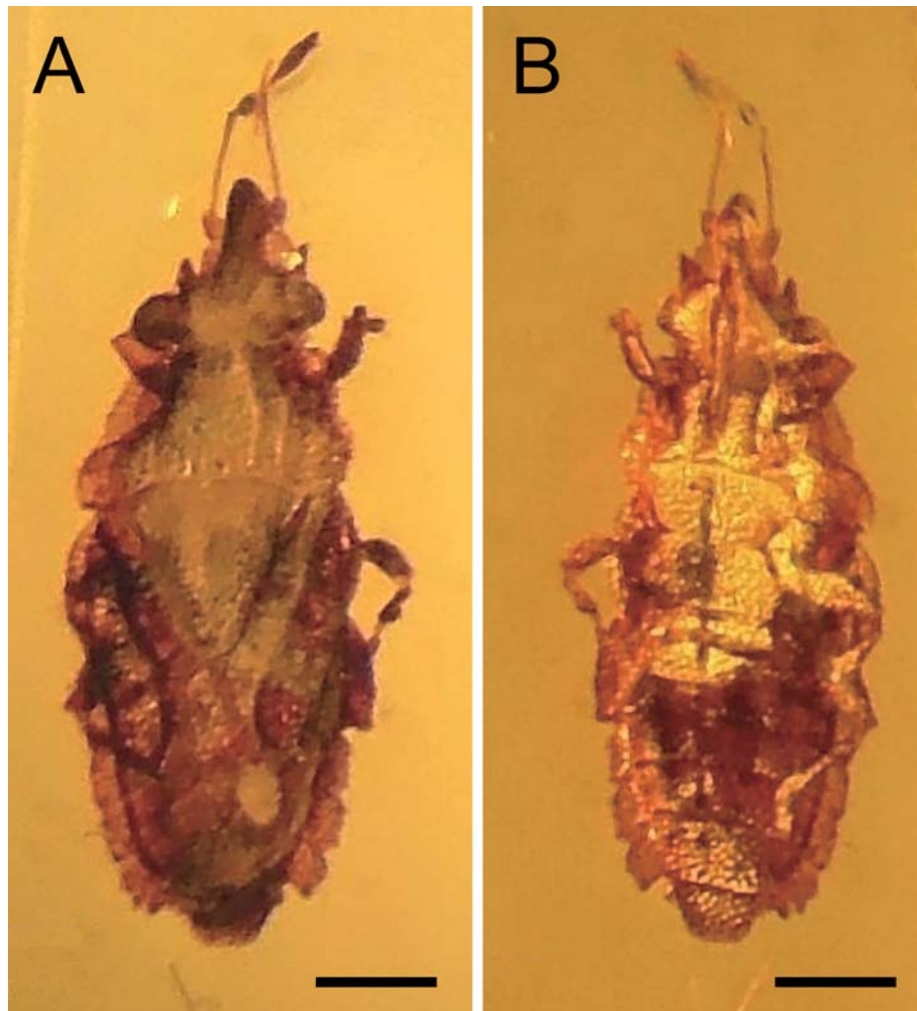


FIGURE 1. *Cretopiesma suukyiae* Grimaldi & Engel, 2008; specimen BUB-ARAD-17/12, male. **A**, Dorsal view. **B**, Ventral view. Scale bars = 0.2 mm.

***Cretopiesma anticum* (Heiss & Poinar, 2012) comb. nov.**

(Figs 2–7)

Microaradus anticum Heiss & Poinar, 2012: 313.

Diagnosis. As in the original description of Heiss & Poinar (2012).

Additional material. Specimen NIGP172151,

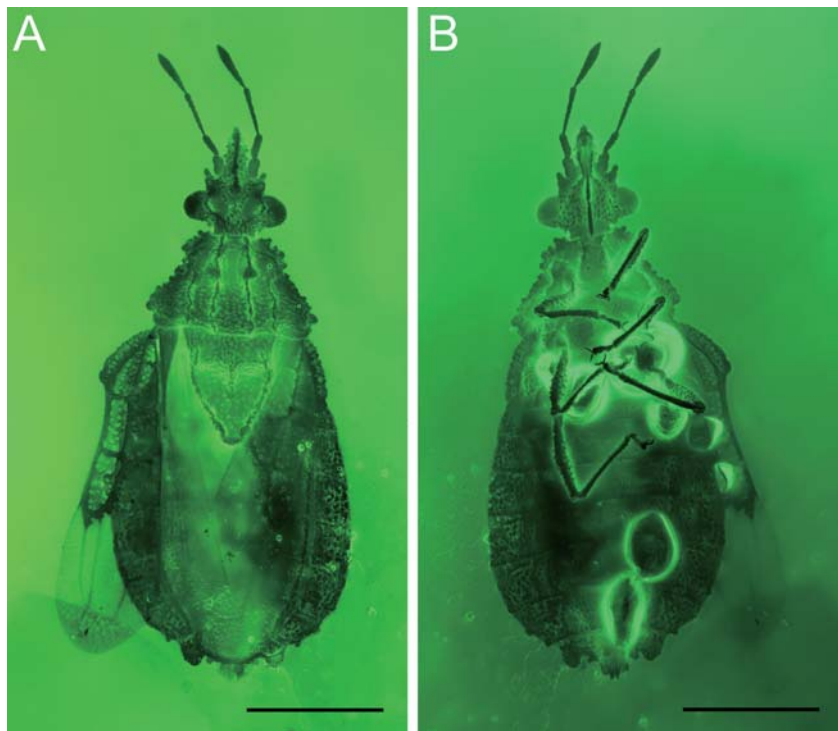


FIGURE 2. *Cretopiesma anticum* (Heiss & Poinar, 2012) **comb. nov.**, specimen number NIGP172151, female; habitus (under fluorescence). **A**, Dorsal view. **B**, Ventral view. Scale bars = 0.5 mm.

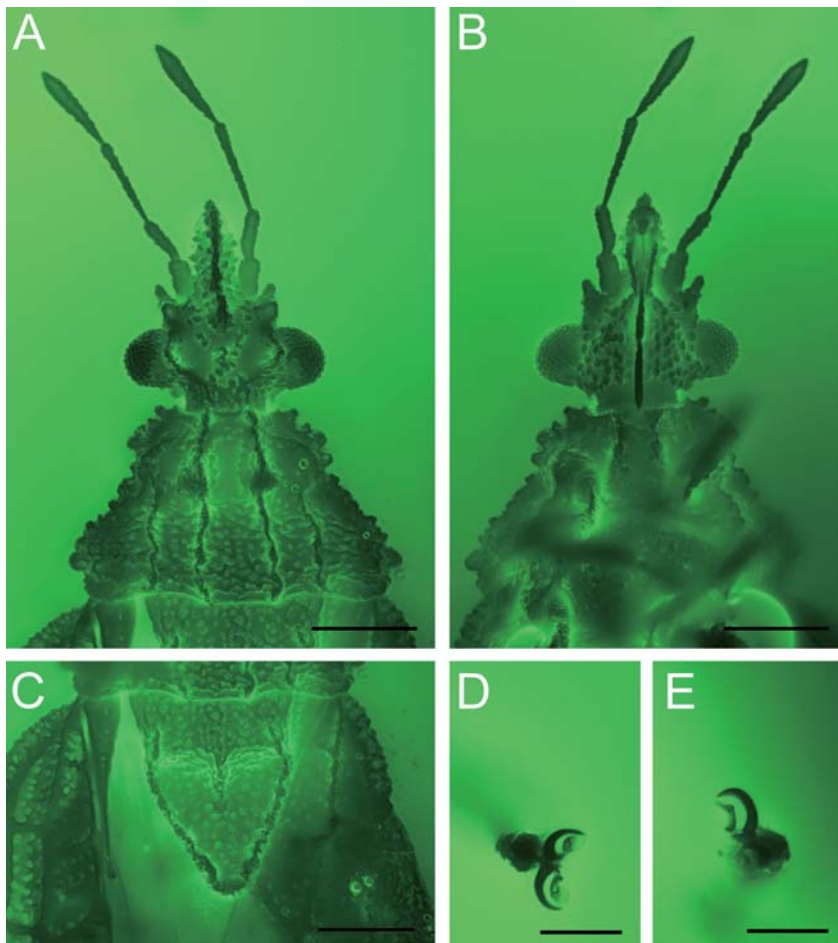


FIGURE 3. *Cretopiesma anticum* (Heiss & Poinar, 2012) **comb. nov.**, specimen number NIGP172151, female (under fluorescence). **A**, Head dorsal view. **B**, Head ventral view. **C**, Scutellum. **D** and **E**, Terminal tarsi. Scale bars of **A–C** = 0.2 mm; of **D** and **E** = 0.05 mm.

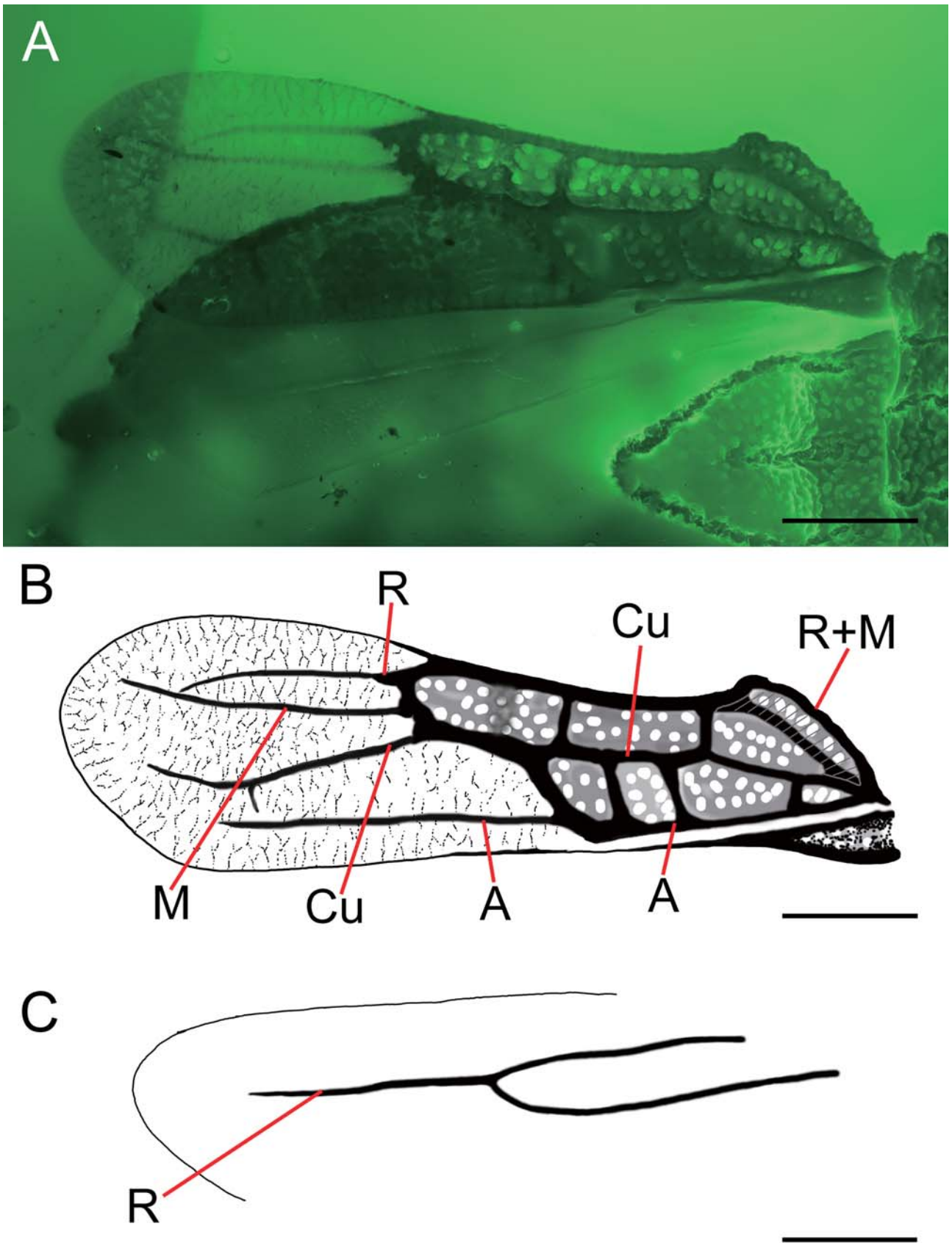


FIGURE 4. *Cretopiesma anticum* (Heiss & Poinar, 2012) **comb. nov.**, specimen number NIGP172151, female; wings. **A**, Forewing under fluorescence. **B**, Line drawing of forewing. **C**, Line drawing of hind wing. Scale bars = 0.2 mm.

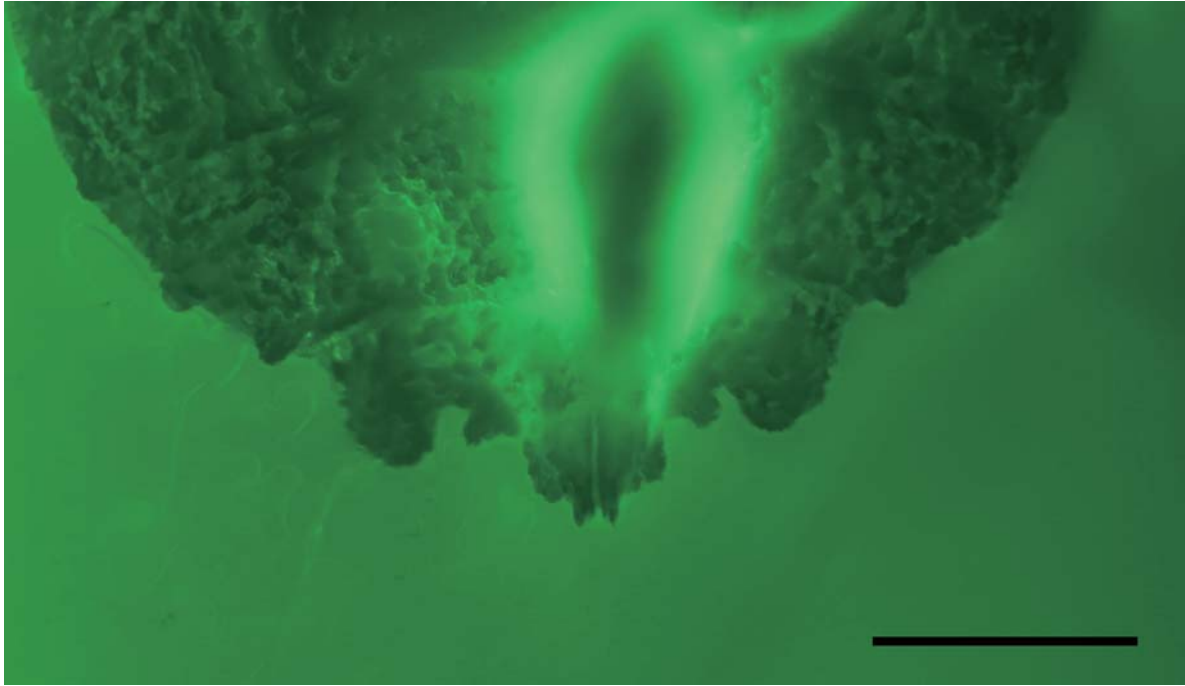


FIGURE 5. *Cretopiesma anticum* (Heiss & Poinar, 2012) **comb. nov.**, specimen number NIGP172151, female; genitalia under fluorescence. Scale bar = 0.2 mm

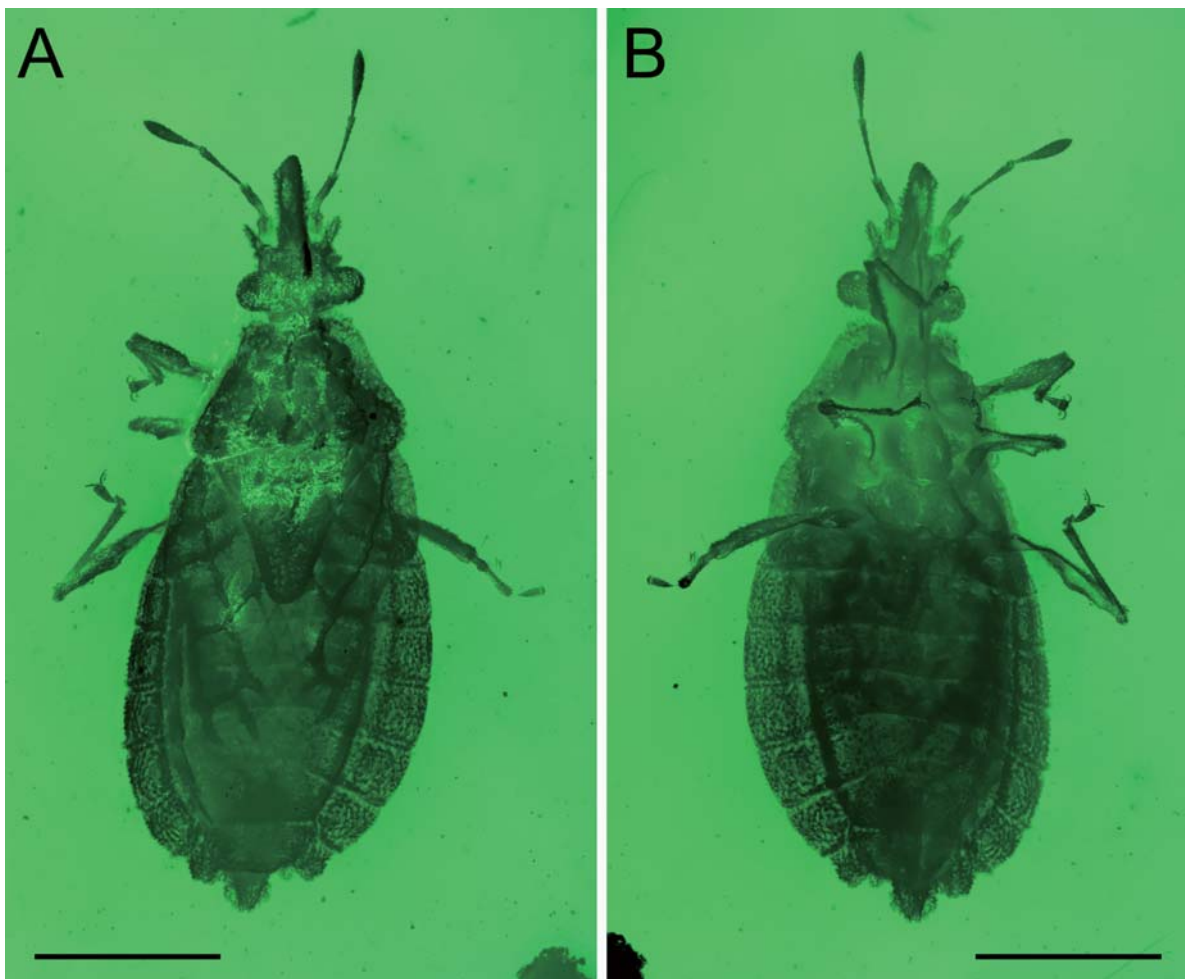


FIGURE 6. *Cretopiesma anticum* (Heiss & Poinar, 2012) **comb. nov.**, specimen number NIGP172158, female; habitus under fluorescence. **A**, Ventral view. **B**, Dorsal view. Scale bars = 0.2 mm.

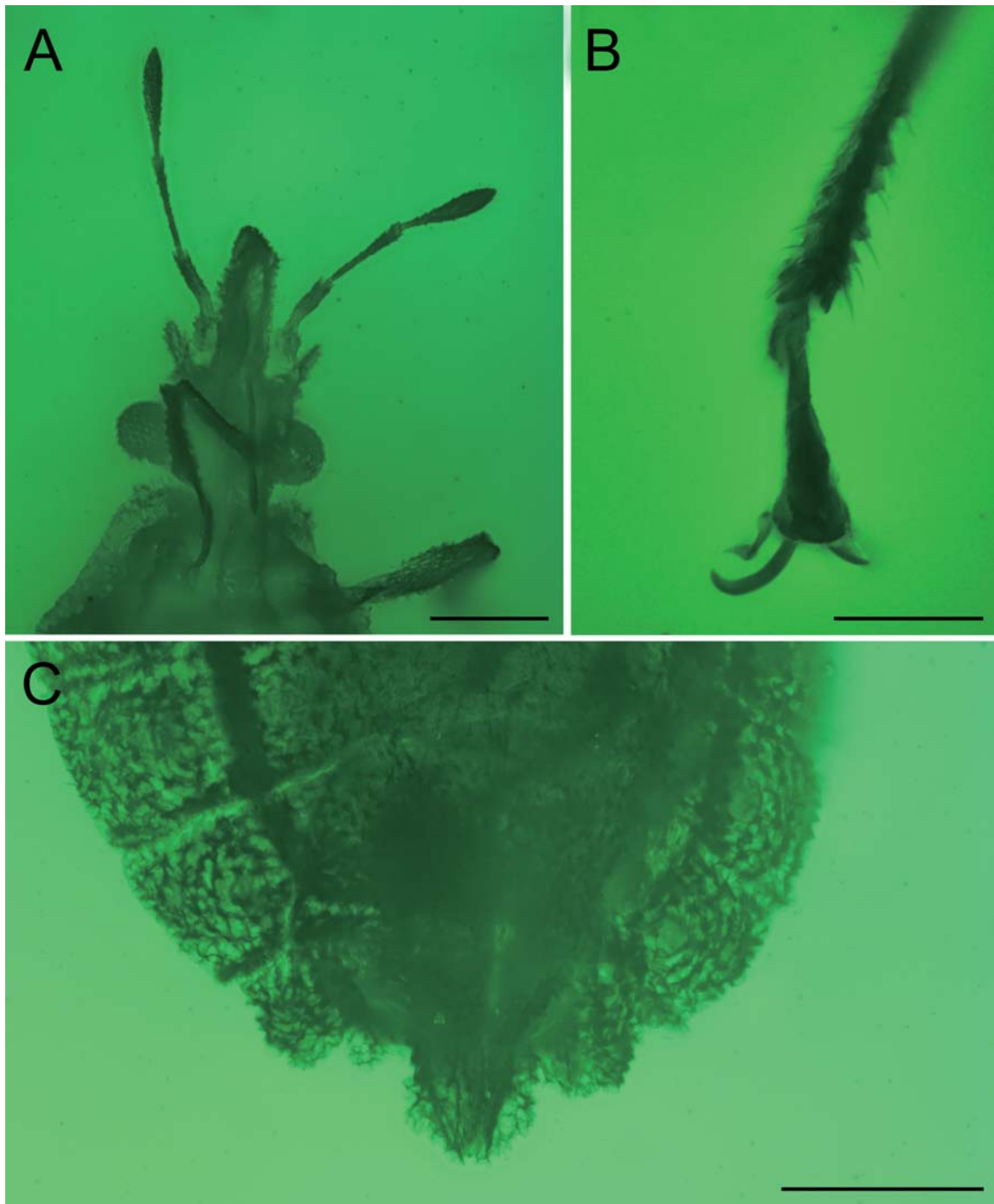


FIGURE 7. *Cretopiesma anticum* (Heiss & Poinar, 2012) **comb. nov.**, specimen number NIGP172158, female; under fluorescence. **A**, Head ventral view. **B**, Terminal tarsi detail. **C**, Genitalia ventral view. Scale bars of **A** and **C** = 0.2 mm; of **B** = 0.05 mm.

female (length 2 mm), Figs 2–5, with corium bearing 3–4 cells between R+M on outer wing margin and Cu and 4 cells between Cu and A, some veins in membrane anastomosing apically forming two closed cells (Fig. 4); specimen number NIGP172158, female (Figs 6, 7) with corium bearing 4 cells between R+M on outer wing margin and Cu and 3 cells between Cu and A, deposited in the collections of the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences; speci-

mens BUB-ARAD-15/21, BUB-ARAD-18/15, females; specimens BUB-ARAD-16/03 and BUB-ARAD-16/19, males; deposited in the collections of the Tiroler Landesmuseum Ferdinandeum.

***Cretopiesma engelgrimaldii* sp. nov.**
(Figs 8–15)

Type material. Holotype: specimen number NIGPAS

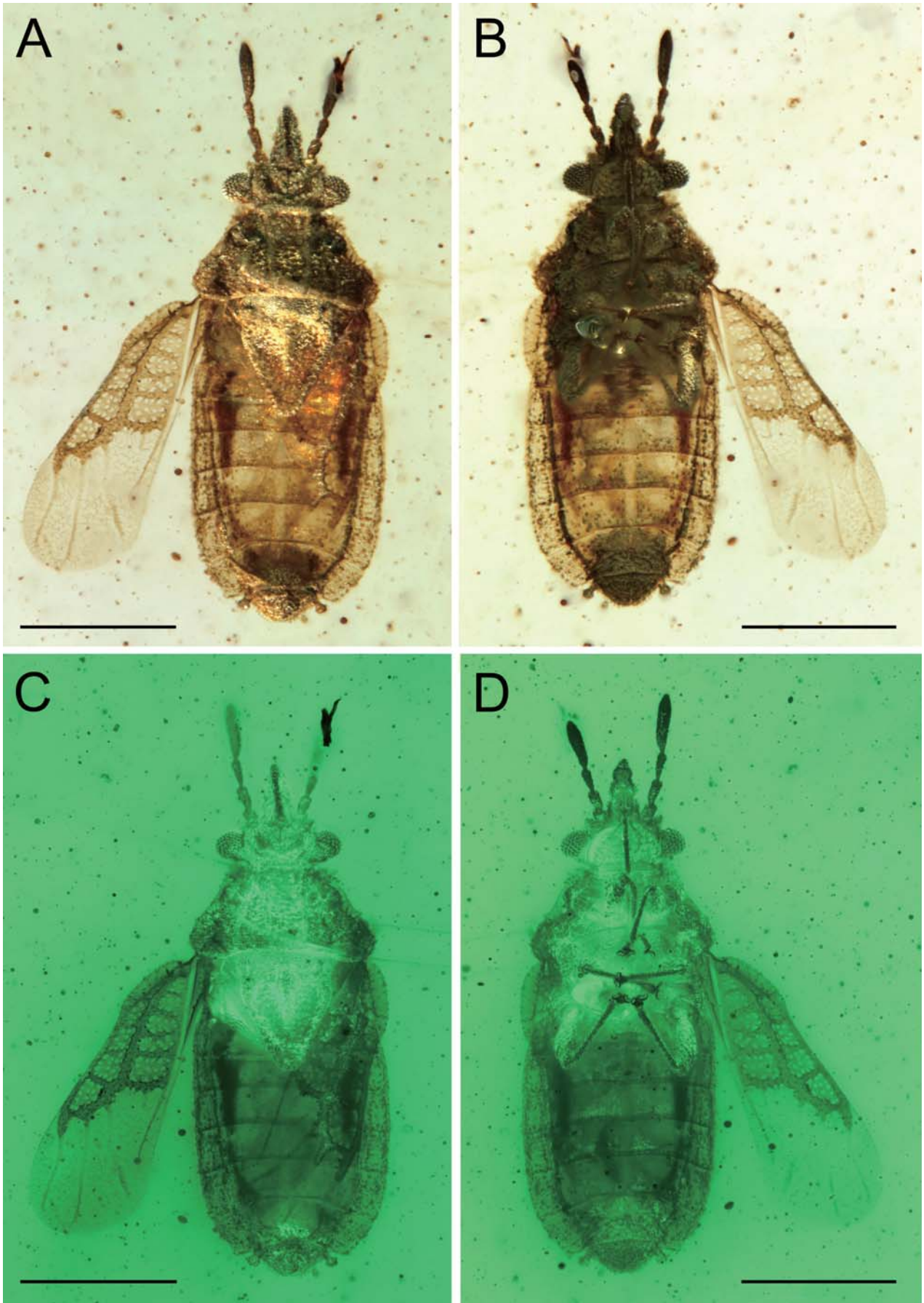


FIGURE 8. *Cretopiesma engelgrimaldii* sp. nov., holotype, specimen number NIGP172152, male; habitus. **A**, Dorsal view. **B**, Ventral view. **C**, Dorsal view under fluorescence. **D**, Ventral view under fluorescence. Scale bars = 0.5 mm

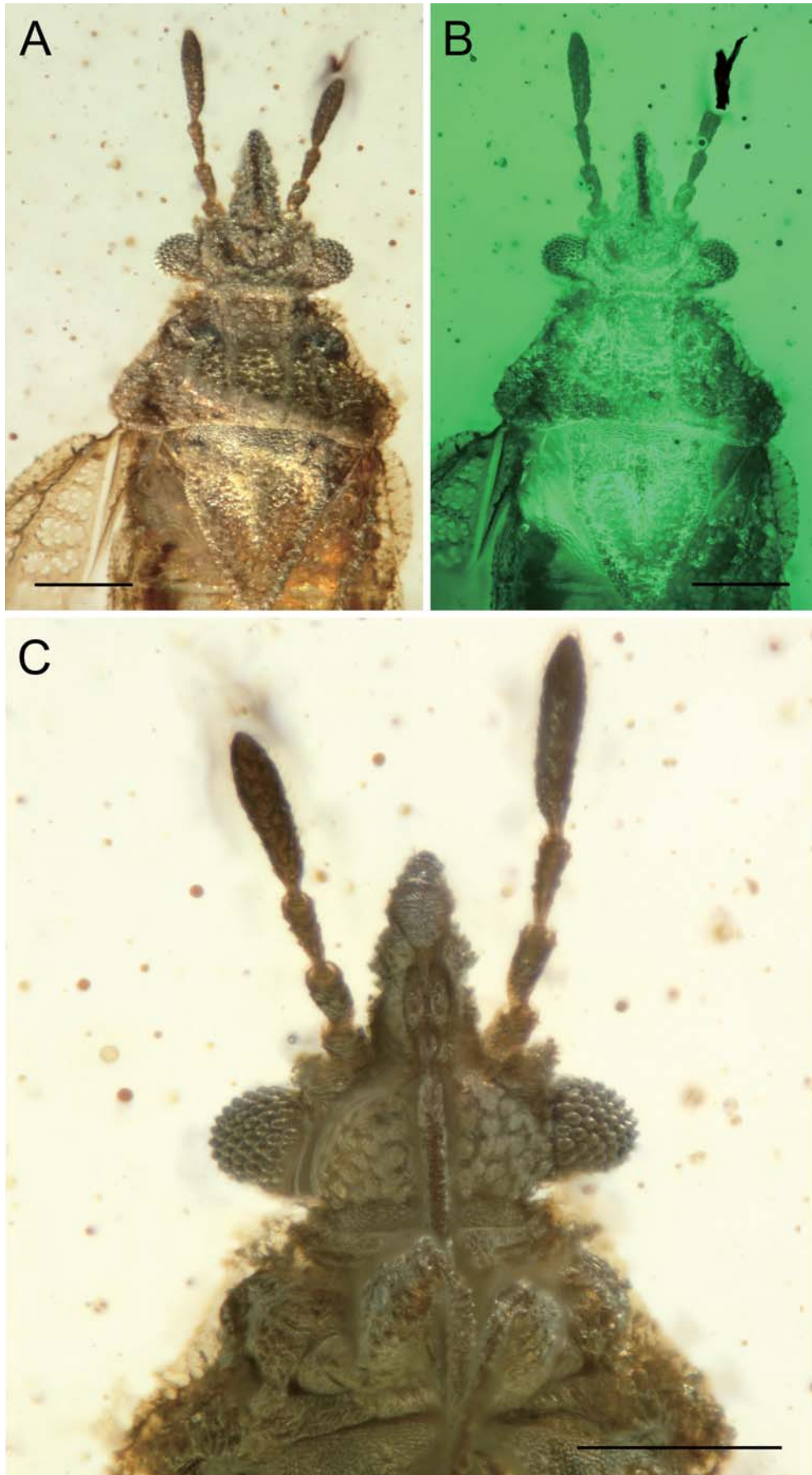


FIGURE 9. *Cretopiesma engelgrimaldii* sp. nov., holotype, specimen number NIGP172152, male; head. **A**, Dorsal view. **B**, Dorsal view under fluorescence. **C**, Ventral view. All scale bars = 0.2 mm.

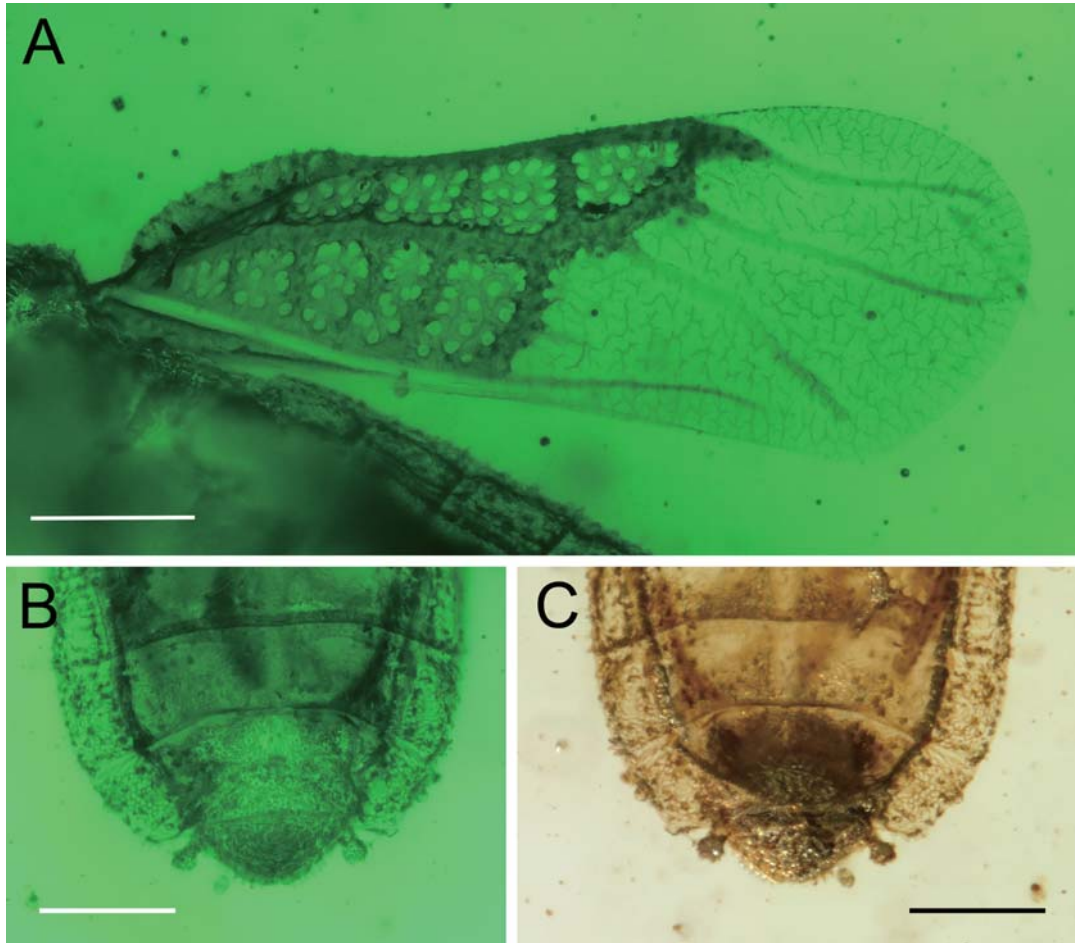


FIGURE 10. *Cretopiesma engelgrimaldii* sp. nov., holotype, specimen number NIGP172152, male. **A**, Forewing under fluorescence. **B**, Ventral view of terminalia under fluorescence. **C**, Dorsal view of terminalia. Scale bars = 0.2 mm.

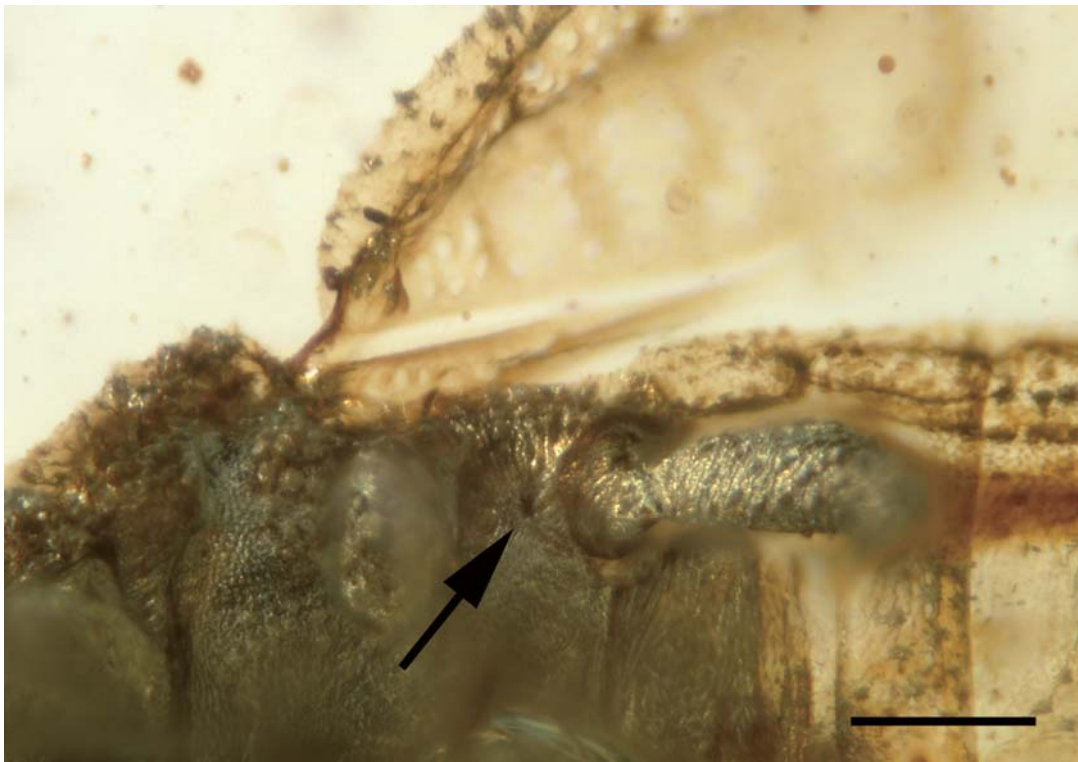


FIGURE 11. *Cretopiesma engelgrimaldii* sp. nov., holotype, specimen number NIGP172152, male. Metathoracic scent gland. Scale bars = 0.1 mm.