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An additional new taxon belonging to the small Cretaceous lacewing family Babinskaiidae  
(Insecta: Neuroptera: Myrmeleontoidea) from the Burmese amber

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## ABSTRACT

Babinskaiidae is an extinct lacewing family of the superfamily Myrmeleontoidea. Hitherto, ten species of seven genera are described from the Lower and mid-Cretaceous periods. Here *Pseudoneliaria makarkini* gen. et sp. nov., a new genus and species of Babinskaiidae from the Cretaceous Burmese amber is characterized, described, illustrated and its taxonomic position discussed. Based on the known palaeo-distribution of the family in Brazil and Myanmar of Gondwanian origin, and Siberia of Laurasian origin, we suggest that this family appeared much earlier than the Aptian period, its oldest fossil record.

### *Keywords:*

Neuroptera

Diversity

gen. et sp. nov.

mid-Cretaceous

Myanmar

## **1. Introduction**

Babinskaiidae Martins-Neto and Vulcano, 1989 is a small extinct Cretaceous family among the Neuroptera, currently considered to belong to the superfamily Myrmeleontoidea Latreille, 1802 (Makarkin et al., 2017). Babinskaiidae were only recorded in the Lower Cretaceous of Brazil (Crato Formation) and Russia (Zaza Formation), and the mid-Cretaceous of Myanmar (for a list of taxa, see Hu et al., 2018). The family shows a rather high diversity in the wing venation compared to low number of species (ten) in seven genera. In this paper, with examination of more specimens of Babinskaiidae from the Burmese amber, a new genus and species is reported based on one female specimen.

## **2. Material and methods**

The specimen is preserved in a piece of clear translucent, yellow Birmite (Burmese amber). The amber piece was cut and polished before being examined and photographed. The material was legally acquired in Myanmar from local traders with government registration, and legally exported according to the official regulations in Myanmar.

The fossil was examined and measured using incident light stereomicroscopes Olympus SZX9 and Nikon SMZ 1500, and a Leitz Wetzlar binocular microscope. Photographs were taken using a Zeiss Discovery V20 stereomicroscope system. Optical instruments were equipped with camera lucida and digital cameras. The raw digital images were processed with Helicon focus stacking software, and figure plates prepared with Adobe Photoshop™.

The nomenclature of the babinskaiid wing venation used in this paper is based on the interpretations of Lu et al. (2017). Abbreviations used for wing veins are: A, anal vein; C, costa; Cu, cubitus; CuA, cubitus anterior; CuP, cubitus posterior; M, media; MA, media

anterior; MP, media posterior; R, radius; RA, radius anterior; RP, radius posterior; ScP, subcostal posterior; ps, presectorial crossveins (i.e., r-mp crossveins).

Fossil-bearing amber was collected from the Hukawng Valley in northern Myanmar (formerly known as Burma) with nearly 1200 species described (Ross, 2019 in press). For an overview of the amber deposit and its geological setting see, e.g., Zherikhin and Ross (2000), Grimaldi et al. (2002), Cruickshank and Ko (2003), Ross et al. (2010), and Mao et al. (2018). Radiometric U-Pb zircon dating (Shi et al., 2012) constrained this amber to an age of  $98.79 \pm 0.62$  Ma, which is equivalent to the earliest Cenomanian, but Mao et al. (2018) considered that due to the limits of this radiometric method, the current given zircon U-Pb SIMS age may be younger than the reality and proposed an age close to the boundary between the Albian and Cenomanian, or even late Albian.

The original habitat of the amber forest is still controversial, in fact it has originally been assumed to be a tropical araucarian forest (Grimaldi et al., 2002; Poinar et al., 2007), possibly with Dipterocarpaceae as another source for the fossil resin. However, the first detailed report on the macromolecular nature and palaeobotanical affinity of Birmite (Dutta et al., 2011), based on gas chromatography - mass spectrometry, rejected Araucariaceae and Dipterocarpaceae in favour of Pinaceae as the Burmese amber producing tree, but Tappert et al. (2013) proposed a cupressacean origin. Grimaldi and Ross (2017) considered that it was formed by a conifer, possibly by *Metasequoia* (Taxodiaceae) or a close relative.

The new genus and species are registered in Zoobank under the urn: lsid:xxxx.

### **3. Systematic palaeontology**

Class Insecta Linnaeus, 1758

Order Neuroptera Linnaeus, 1758

Superfamily Myrmeleontoidea Latreille, 1802

Epifamily Nymphidoidae Rambur, 1842

Family Babinskaiidae Martins-Neto & Vulcano, 1989

Genus *Pseudoneliانا* gen. nov.

*Type species. Pseudoneliانا makarkini* sp. nov.

*Diagnosis.* In both wings, two or three crossveins between stem of RP and M; in fore wing, four presectorial crossveins; RP originating far distal to termination of CuP; AA1 simple; CuA with rather long branches; in hindwing, three presectorial crossveins; RP originating far distal to termination of CuA; one crossvein in radial space in outer gradate series; RP with three to five branches; MP2 with rather long branches.

*Etymology.* Named after the genus *Neliانا*.

*Pseudoneliانا makarkini* sp. nov.

Figs. 1–3

*Holotype.* NIGP169868 (a nearly complete specimen, only the apical parts of the fore wings are incomplete), deposited at the Nanjing institute of Geology and Palaeontology.

*Etymology.* Named after our colleague Dr. Vladimir N. Makarkin, specialist of fossil and extant Neuroptera.

*Locality and horizon.* Myanmar, Burmese amber (Hukawng Valley). Lower Cretaceous: upper Albian/Upper Cretaceous: lowest Cenomanian.

*Diagnosis.* Branches of CuA in fore wing all simple; branches of MP2 in hindwing all simple.

*Description.* Body 6.9 mm long. Head orthognathous, subtriangular, 0.76 mm long. Compound eyes large, semi-globular; ocellus absent. Antenna filiform (Fig. 1A), 5.42 mm long, with 56 antennomeres, the last one being conical, antennomeres with dense short setae; scape wider but shorter than pedicel; flagellomeres much shorter and narrower than scape and pedicel. Mouthparts chewing mandibulate; labrum invisible; mandibles discernible, acutely

pointed distad; maxilla discernible, maxillary palp long. Thorax 1.39 mm long, prothorax nearly as long as but narrower than head; meso- and metathorax robust. Wings elongated, transparent, immaculate. Fore wing (Figs 1A, 2A): costal space about twice as wide as subcostal space, but much narrower than radial space, with 16 simple crossveins in preserved part; subcostal crossveins absent; four presectorial crossveins present; RP+MA originated from R 3.3 mm from wing base; MA diverging from RP 1.4 mm distal base of RP+MA; two branches of RP+MA; MP long and nearly straight, with 11 crossveins between MP and CuA, no oblique vein (i.e., stem of MP2) present; CuA and CuP diverging near wing base; CuA feebly zig-zagged along its stem and pectinately branched (nine branches present), max. distance between CuA and posterior wing margin 0.7 mm; CuP seems to have only one curved branch and to be 'prolonged' by a gradate series of five veinlets and four cells; six cua-cup crossveins present; A1 simple, apparently one cup-a1 crossvein present; A2 and A3 fused on distal half. Hindwing (Figs 1A, 2B, 2C): costal space nearly as wide as subcostal space, with 13 simple crossveins on proximal 5/6 and 10 simple crossveins on distal 1/6; subcostal crossveins absent; RP+MA originated from R 3.0 mm from wing base; three presectorial crossveins present; MP1 and MP2 diverging near wing base; MP1 almost straight, with five simple branches and one marginally forked branch; MP2 stem long, distally zigzagged, with 10 simple branches; max. distance between MP2 and posterior wing margin 0.5 mm; nine mp1-mp2 crossveins present; CuA short, with three simple branches, one mp2-cua crossvein present; CuP and A1 possible fused as CuP+A1, short and simple. Legs slender, with dense short setae; no specialized setae present; tarsus five-segmented; total length of tarsomeres 2-5 almost as long as tarsomere 1. Abdomen 4.81 mm long, slender on proximal half and apparently widened on distal half. Female genitalia (Fig. 3): tergum 7 broad; sternum subtriangular, tergum 9 smaller than tergum 8; a pair of hook-like gonocoxites 9 present; ectoprocts paired, ovoid, with large callus cerci.

#### 4. Discussion

After the key to babinskaiid genera of Makarkin et al. (2017), this fossil would fall in the genus *Neliana* (replacement name for *Nelia* Martins-Neto and Vulcano, 1989) because of the following characters: hindwing normal, ovate, not strongly narrowed; RP originating much distal of termination of CuP in fore wing; RP originating much distal of termination of CuA in hindwing. Makarkin et al. (2017: 159) indicated as character ‘RP originating much distal of termination of CuP in both wings’ vs. ‘RP originating approximately at level of termination of CuP’, which is erroneous for the hindwings. Also *Baisonelia vitimica* Ponomarenko, 1992 is based on a hindwing in which CuP is not preserved but probably in a very basal position, after its revision in Makarkin et al. (2017).

After the key to species of Lu et al. (2017), *Pseudoneliana makarkini* gen. et sp. nov. would fall in the species *Pseudobabinskaia martinsnetoi* (Lu et al., 2017) (originally in the genus *Babinskaia*) because of the following characters: fore wing with four presectorial crossveins; hindwing slightly narrower than fore wing, with apex not produced. Thus, there is a contradiction between the two hypotheses. We need to discuss further the differences between this fossil and the other Babinskaiidae.

Makarkin et al. (2017) indicated that: ‘The configuration of CuP in the fore wing of Babinskaiidae is hardly determined with certainty as its distal part is strongly zigzagged and continues in a gradate series between the branches of CuA.’ ... ‘CuP in *Babinskaia* and *Neliana* is pectinate, but with only one or two branches.’ ... ‘CuP in other babinskaiids is strongly pectinate (more than four branches) ...’ The difficulty is to determine at which point CuP is ending and where the gradate series begins. Nevertheless in our fossil, CuP seems to have only one curved branch and to be ‘prolonged’ by a gradate series of five veinlets and four cells, even if the situation is ambiguous. Thus *Pseudoneliana makarkini* would be more



related to *Babinskaia* and *Neliana* than to the other taxa. After Makarkin et al. (2017), *Pseudobabinskaia* Makarkin et al., 2017 would differ from *Babinskaia* in the fore wing vein AA1 simple, while it would be forked in *Babinskaia*, but Martins-Neto (2000) figured a forked AA1 for *Babinskaia pulchra* Martins-Neto and Vulcano, 1989 and, apparently, a simple one for *Babinskaia formosa* Martins-Neto and Vulcano, 1989, which would render the character. In *Pseudoneliana makarkini*, AA1 is simple as in *Pseudobabinskaia martinsnetoi*. *P. martinsnetoi* has an area between MP2 and posterior wing margin in its basal part distinctly narrower than in *Pseudoneliana makarkini*, with four crossveins between the level of apex of CuA and that of base of RP instead of only two in *Pseudoneliana makarkini*. It has also branches of fore wing CuA shorter than in *Pseudoneliana makarkini*, and distinctly longer branches of RP. The wing venations of *Neliana maculata* (Martins-Neto and Vulcano, 1989) and of *Neliana impolluta* (Martins-Neto, 1997) are very similar to that of *Pseudoneliana makarkini*, except in the number of presectorial crossveins in fore wings, only four in *Pseudoneliana makarkini* instead of more than six in *Neliana* (Martins-Neto, 2000: fig. 8B). *Pseudoneliana makarkini* and *N. impolluta* differs from *Neliana maculata* in the RP in hindwing with three branches. *N. impolluta* has a very short fore wing CuP, unlike *Pseudoneliana makarkini*.

Thus *Pseudoneliana makarkini* differs from the three genera *Neliana*, *Babinskaia*, and *Pseudobabinskaia*, even it would be closer to the later genus, also from the Burmese amber.

Among the other Babinskaiidae, *Pseudoneliana makarkini* differs from *Electrobabinskaia burmana* Lu et al., 2017 in the fewer and shorter branches of RP (four instead of eight), the shorter hindwing CuA (with only three posterior branches instead of eight), and the broader area between ScP+RA and costal margin in its distal part (Lu et al., 2017; Hu et al., 2018). *Parababinskaia elegans* Makarkin et al., 2017 has a longer hindwing CuA reaching the level of the base of RP, and a longer MP2 with 12 posterior branches

instead of nine in *Pseudoneliana makarkini* in hindwing (Makarkin et al., 2017). *Parababinskaia makarkini* Hu et al., 2018 has also a longer hindwing CuA with seven branches plus a more curved ScP+RA at wing apex. *Burmobabinskaia tenuis* Lu et al., 2017 has very narrow areas between MP2, CuA and posterior wing margin in hindwing, and a very broad area between CuA and posterior wing margin in fore wing, unlike *Pseudoneliana makarkini*. *Baisonelia vitimica* Ponomarenko, 1992 differs from *Pseudoneliana makarkini* in the longer CuA, reaching the level of the base of RP, the longer branches of RP, and the longer MP2 with 12 posterior branches instead of nine in *Pseudoneliana makarkini* in hindwing (Makarkin et al., 2017).

## **5. Conclusion**

The discovery of *Pseudoneliana makarkini* gen. et sp. nov. increases our knowledge on the palaeobiodiversity of the extinct myrmeleontoid small family Babinskaiidae Martins-Neto and Vulcano, 1989 known in the palaeontological record from the lower and mid Cretaceous of Brazil (Crato Formation) and Russia (Zaza Formation), and the mid-Cretaceous of Myanmar. Based on the known palaeodistribution of the family in Brazil and Myanmar of Gondwanian origin, and Siberia of Laurasian origin, we suggest that this family was global during the lower and mid Cretaceous and appeared much earlier than the Aptian period, its oldest fossil record.

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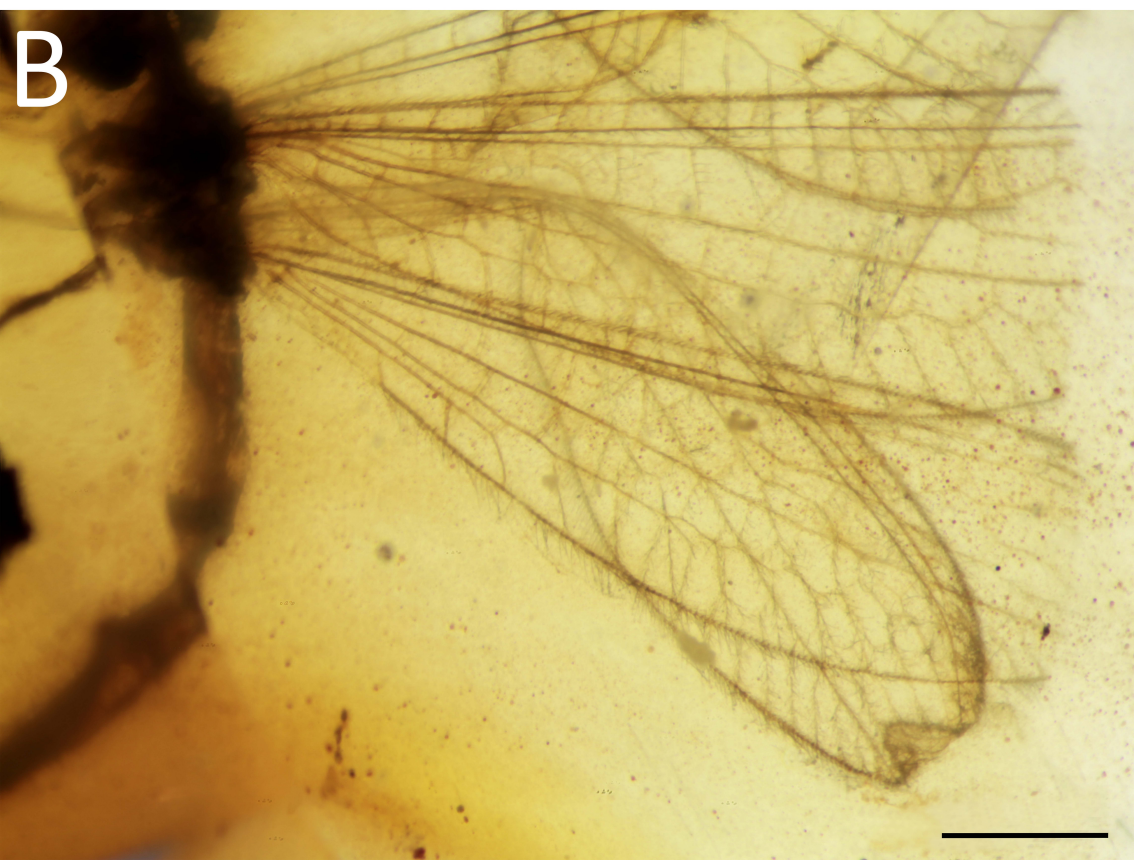
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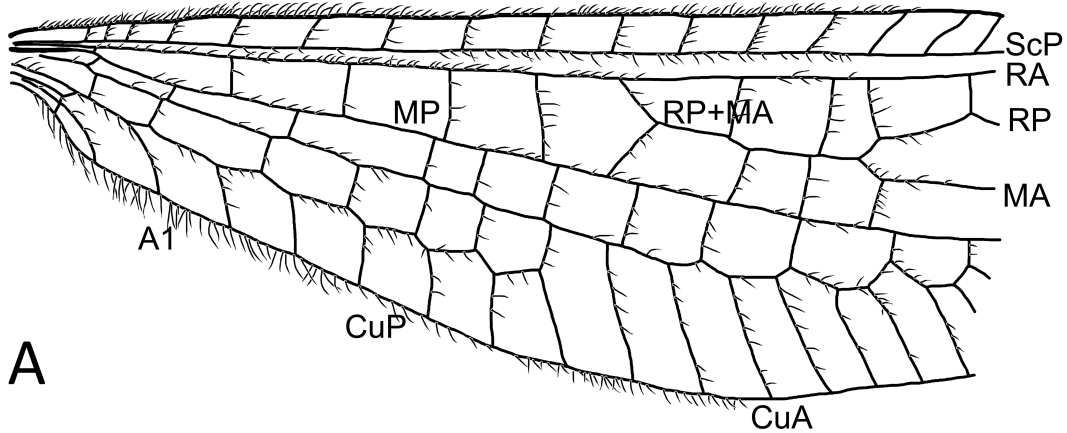
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**Fig. 1.** *Pseudoneliana makarkini* gen. et sp. nov., holotype NIGP169868, microphotographs. (A), general habitus; (B), wing details. Scale bars = 1 mm.

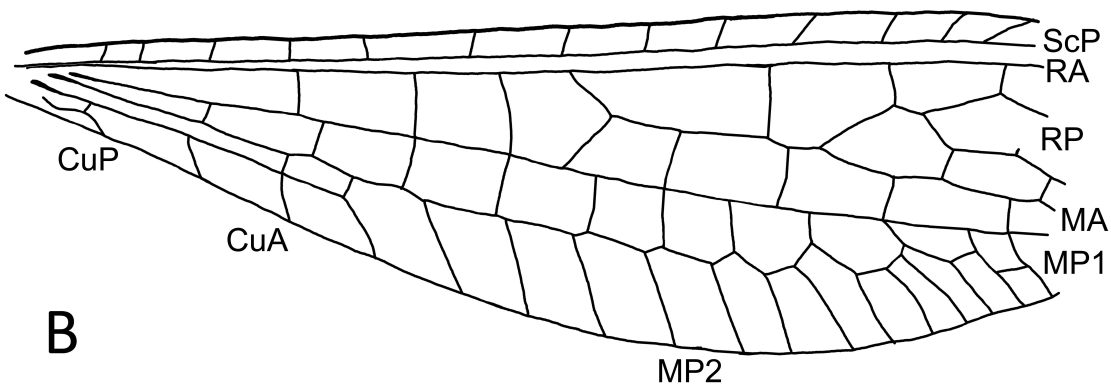
**Fig. 2.** *Pseudoneliana makarkini* gen. et sp. nov., holotype NIGP169868, line drawings. (A), fore wing; (B), hindwing; (C), hindwing apex. Scale bar = 1 mm.

**Fig. 3.** *Pseudoneliana makarkini* gen. et sp. nov., holotype NIGP169868. Terminalia. (A), microphotograph; (B), reconstruction (ep. ectoproct; gn. gonocoxite). Scale bars = 1 mm (A), 0.5 mm (B).

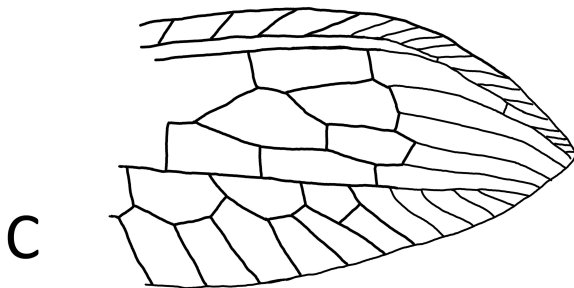




A



B

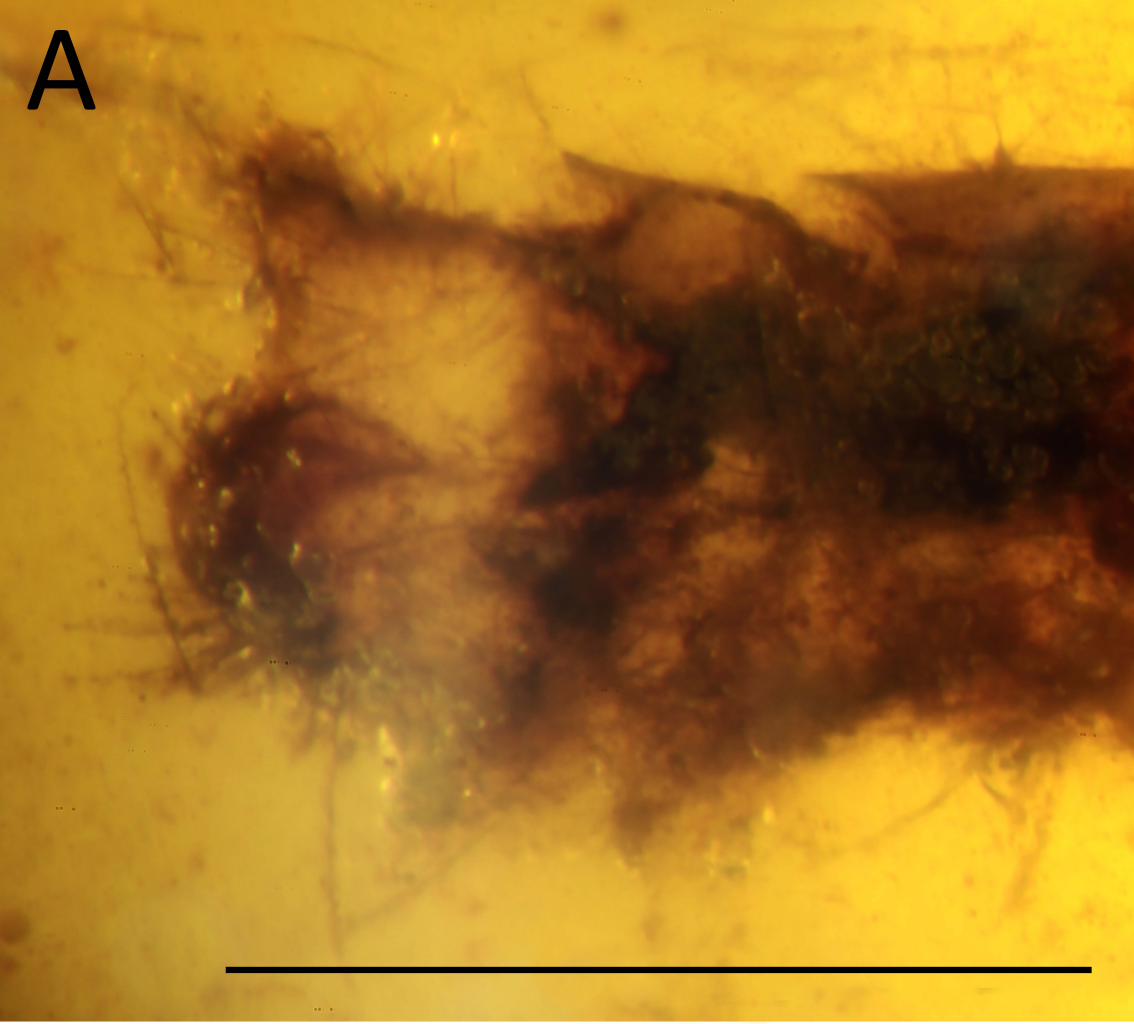


C





A



B

