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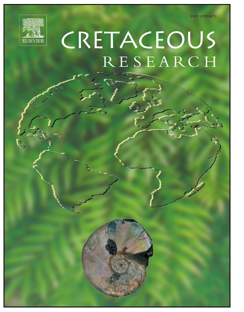

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A second species of *Dachibangus* (Hemiptera: Fulgoromorpha: Mimarachnidae) in mid-Cretaceous amber from northern Myanmar

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ABSTRACT

A fourth species of the mimarachnid planthoppers and a second species of *Dachibangus* is described and illustrated base on a well-preserved forewing in mid-Cretaceous amber of northern Myanmar. *Dachibangus formosus* sp. nov. can be distinguished from the type species *Dachibangus trimaculatus* Jiang, Szwedo et Wang, 2018 by the size of tegmen and its venation characters. Diagnostic features of the genus *Dachibangus* are reviewed. Our new discovery further increases the documented palaeodiversity and morphological diversification of the Cretaceous mimarachnids.

Keywords:

Planthopper

Burmese amber

New taxa

Palaeodiversity

Dachibangus formosus sp. nov.

1. Introduction

To date, more than eighty species of Hemiptera have been described from the mid-Cretaceous Burmese amber (Jiang et al., 2018; Ross, 2019). Among them, several fossil planthoppers belonging to the infraorder, Fulgoromorpha have been reported, including two extant families (Cixiidae Spinola, 1839 and Achilidae Stål, 1866) and four extinct families (Perforissidae Shcherbakov, 2007a, Mimarachnidae Shcherbakov, 2007b, Dorytocidae Emeljanov et Shcherbakov, 2018 and Jubisentidae Zhang, Ren et Yao, 2019) (Bourgoin, 2019; Ross, 2019).

Planthoppers are a group of diverse phytophagous insects, comprising more than 9000 described extant species and approximately 300 fossil species (Urban and Cryan, 2007). A small, extinct family named Mimarachnidae was originally established from the fossils of the Early Cretaceous deposits of Baissa, Transbaikalia (Shcherbakov, 2007b). Later, a few more taxa were reported from the Early Cretaceous lithographic limestones of Spain, and from Burmese amber (Shcherbakov, 2017; Jiang et al., 2018; Zhang et al., 2018). The family was placed in the group of 'cixiidae-like' planthoppers (Bourgoin and Szwedo, 2008; Szwedo, 2009; Szwedo and Ansorge, 2015). Mimarachnidae differ from most of other planthoppers in many important features, including the sensory pits retained in the adults, mesonotum with double median carinae, simplified venation with poorly longitudinal vein branches and irregular meshwork of cross veins, weakened or absent basal cell and narrow to absent costal area (Shcherbakov, 2007b; Jiang et al., 2018). Mimarachnidae is considered to be the earliest recognized spider-mimicking group, with coloration pattern resembling the spider-like dark silhouette and several small black eyespots of the tegmina (Shcherbakov, 2007b).

The biodiversity of mimarachnids is relatively low, with eight monotypic genera confined to the Cretaceous, distributed mostly in the Northern Hemisphere. They include *Mimarachne mikhailovi* Shcherbakov, 2007 and *Saltissus eskovi* Shcherbakov, 2007, which were described from the Lower Cretaceous of Baissa Zaza Formation at Vitim River, Buryatia, Russia (Shcherbakov, 2007b); *Nipponoridium matsuoi* Fujiyama, 1978, which was described from the Lower Cretaceous

Kuwajima Formation at Kaseki-kabe locality, Kuwajima, Japan (Fujiyama, 1978; Szwedo, 2008); *Mimamontsecia cretacea* Szwedo et Ansorge, 2015 and *Chalicoridulum montsecensis* Szwedo et Ansorge, 2015, which were described from the Lower Cretaceous La Pedrera de Rubies Formation at La Cabrúa outcrop, Sierra del Montsec, Spain; *Burmissus raunoi* Shcherbakov, 2017, *Dachibangus trimaculatus* Jiang, Szwedo et Wang and *Jaculistilus oligotrichus* Zhang, Ren et Yao, 2018, which were described from the mid-Cretaceous Burmese amber (Shcherbakov, 2017; Jiang et al, 2018; Zhang et al., 2018).

Here we describe a new species of Mimarachnidae, *Dachibangus formosus* sp. nov., from the mid-Cretaceous Burmese amber.

2. Material and methods

The type specimen is derived from amber deposits in the Hukawng Valley of Kachin Province, about 100 km southwest of the Village of Tanai, in northern Myanmar (Yin et al., 2018: fig. 1A). Radiometric U-Pb zircon dating (Shi et al., 2012) constrained the Burmese amber to a maximum age of 98.79 ± 0.62 Ma, which is equivalent to the earliest Cenomanian. However, biostratigraphic studies of the amber-bearing layers indicated an age of late Albian (Cruickshank and Ko, 2003). Therefore, the age of the Burmese amber was suggested generally assigned to the mid-Cretaceous (Mao et al., 2018).

The new species is described based on a single specimen, a piece of relatively clear yellowish amber (NIGP168935) with inclusion of a well-preserved forewing. Amber was wear down with abrasive papers and polished with polishing powder. The wing was observed and photographed with use of a Zeiss Discovery V16 stereomicroscope; photographic images were stacked using Helicon Focus 6 software; line drawings were drafted with CorelDRAW X7 graphic software and optimized using Photoshop CS6.

The venation terminologies and cell nomenclature used herein follows the standardized terminology of the forewing venation in Fulgoromorpha (Bourgoin et al., 2015). The following standards were used for measurements: tegmen length measured from the base to the apex of the tegmen; tegmen width measured at the widest part of the tegmen from costal margin to posterior margin. Measurements are given in millimeters. The nomenclatural acts established herein are registered under Zoo-Bank LSID urn:lsid:zoobank.org:pub: 6CA70245-EBD6-407D-88EB-C0DDACEB8959.

3. Systematic palaeontology

Order: Hemiptera Linnaeus, 1758

Suborder: Fulgoromorpha Evans, 1946

Superfamily: Fulgoroidea Latreille, 1807

Family: Mimarachnidae Shcherbakov, 2007

Genus: ***Dachibangus*** Jiang, Szwedo et Wang, 2018

Type species. *Dachibangus trimaculatus* Jiang, Szwedo et Wang, 2018; by original designation and monotype.

Diagnostic characters (revised based on Jiang et al., 2018). Pronotum with single median carina, not reaching anterior margin, arcuate furrow subparallel to anterior margin; mesonotum with double median carina, lateral carinae strongly diverging posteriad; tegmen with costal area narrow; Pc+CP long, more than two thirds of tegmen length; ScP+RA and RP very close, anterior portion of ScP+RA subparallel to costal margin and RP, posterior portion of ScP+RA weakened before margin, decurved; MP multi-branched; CuA_2 curved mediad at level of tornus.

Dachibangus formosus sp. nov.

Figs. 1, 2

Etymology. From Latin *formosus*, beautiful. The species is registered under LSID urn:lsid:zoobank.org:act:CF074E79-FA3A-422C-A4AB-BA8D27B451C8.

Holotype. NIGP166867, well-preserved forewing; deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China.

Locality and horizon. Burmese amber, from deposits near the Tanai Village in the Hukawng Valley of northern Myanmar. Upper Albian–Lower Cenomanian.

Diagnosis. Tegmen middle-sized; common stalk of ScP+R longer than basal cell; MP almost straight at base, with 5 terminals; CuA_1 almost straight, CuA_2 and CuP slightly curved; Pcu and A_1 fused proximad of midpoint of tegmen, free stem of Pcu slightly shorter than common part of Pcu+A_1; tegmen with irregular colour bands from base to apex, three spots present on the upper median section of tegmen.

Remarks. The species is distinguished from the type species, *Dachibangus trimaculatus* by following characters: 1) tegmen length near 18 mm (tegmen length near 30 mm in *D. trimaculatus*); 2) common stalk of ScP+R relatively long, slightly longer than basal cell (ScP+R only nearly half of basal cell length in *D. trimaculatus*); 3) MP with 5 terminals (MP with 6 terminals in *D. trimaculatus*); 4) CuA_2 and CuP slightly curved (CuA_2 and CuP strongly curved mediad at level of tornus in *D. trimaculatus*); 5) tegmen with three irregular spots present on the upper median section, almost in a line (tegmen with three round spots at base, placed in oblique line in *D. trimaculatus*).

Description. Tegmen length 17.6 mm and 6.4 mm wide, about 2.7 times as long as wide (Figs 1A, 2A), with distinct longitudinal veins and polygonal net of transverse veinlets; tegmen covered with distinct irregular colour bands from base to apex, three darker spots stained on the upper median section, almost in a line, lateral spots nearly round, median spot irregular elliptical-shaped; costal margin slightly arched at base, then almost straight; tornus distinct; costal area long and narrow, narrowing toward wing apex with transvers veinlets; arculus weak, tapered towards base, ca 1.5 mm long and 0.5 mm wide; Pc+CP nearly extend to apex, weakened in apical portion, along transverse veinlet and connected up to costal margin; common stalk of ScP+R about 1.3 times longer than basal cell, branching into ScP+RA and RP at 0.19 of tegmen length; anterior portions of ScP+RA and RP subparallel to costal margin and posterior portion of ScP+RA curved upward to apical margin, nearly submerging to RP; MP almost straight anteriorly, with 5 terminals, branching into MP_{1+2} and MP_{3+4} distinctly after bifurcation of CuA, reaching 0.66 of tegmen length; MP_{1+2} branched slightly after bifurcation of MP_{3+4}; CuA straight anteriorly, with two terminals, branching into CuA_1 and CuA_2 at 0.35 of tegmen length; very basal portion of CuA (‘arculus’) visible; CuA_1 almost straight, CuA_2 slightly sinuate; CuP straight anteriorly, and then curved at level of tornus; Pcu and A_1 fused proximad of tegmen mid-length, after CuA branched, reaching 0.39 of tegmen length, free stem of Pcu about 1.1 times longer than common part of Pcu+A_1; wing-coupling fore fold present, before tornus; cell C1 narrow, cell C3a slightly wider than cell C3b, cell C5 nearly 1.8 times longer than cell C3.

4. Discussion

Dachibangus formosus sp. nov. described above belongs to Mimarachnidae regarding the following features presented: tegmen with simplified venation, with simple, carinate longitudinal veins and irregular meshwork of cross veins, weakened basal cell and narrow costal area, ScP+R deeply forked, MP multi-branched, CuA_1 and CuA_2 simple. The new species can be assigned to *Dachibangus* Jiang, Szwedo et Wang, 2018 based on the following combination characters: tegmen with similar colour pattern and three darker spots; the anterior portion of ScP+RA subparallel to costal margin and RP, the posterior portion of ScP+RA decurved, almost submerging to RP; MP with at least 5 terminals; tornus distinct; CuA_2 curved mediad at level of tornus; wing-coupling fore fold present.

Interestingly, the tegmen of *Dachibangus formosus* sp. nov. resembles in several features *Jaculistilus oligotrichus* Zhang, Ren et Yao, 2018 from Burmese amber, including the similar tegmen size, Pc+CP subparallel to costal margin and ScP+RA, ScP+RA more close to RP than Pc+CP, MP multi-branched, CuA_1 not distinctly curved, visible basal portion of CuA – ‘arculus’ and wing-coupling fold. However, it distinctly differs from the later in tegmen venation details and coloration: 1) common stalk of ScP+R is relatively long, slightly longer than basal cell (ScP+R is short, only nearly half of basal cell length in *J. oligotricius*); 2) MP with 5 terminals (MP with 4 terminals in *J. oligotrichus*); 3) CuA_2 curved mediad at level of tornus (CuA_2 nearly straight in *J. oligotrichus*); 4) tornus distinct (posterior margin straight in *J. oligotrichus*); 5) tegmen covered with irregular colour bands from base to apex (tegmen without colour pattern in *J. oligotrichus*); 6) three black spots stained on the upper median section (only two black spots in apical area in *J. oligotrichus*).

Dachibangus Jiang, Szwedo et Wang, 2018 shares several critical characters of forewing with *Jaculistilus* Zhang, Ren et Yao, 2018, i.e. tegmen without marginal membrane (tegmen with narrow marginal membrane in *Mimamontsecia* Szwedo et Ansorge, 2015, *Mimarachne* Shcherbakov, 2007, *Burmissus* Shcherbakov, 2017 and *Chalicoridulum* Szwedo et Ansorge, 2015); narrow costal area, reaching anteroapical angle (costal area absent in *Mimarachne* and *Saltissus* Shcherbakov, 2007, costal area present only at base in *Chalicoridulum*, very narrow costal area reaching half of tegmen length in *Burmissus*); MP with at least 4 terminals (MP with three terminals in *Mimarachne*, two terminals in *Mimamontsecia*, *Saltissus*, *Chalicoridulum* and *Burmissus*); wing-coupling fore fold present (wing-coupling fore fold absent in other genera).

Regarding the venation patterns the three discussed above taxa seems to be closely related. The differences between them are expressed in details of venation, but mainly in other morphological features as size, form of head and body structure. *Dachibangus* differs from *Jaculistilus* mainly based on features of body, such as mesonotum lateral carinae bent mediad in contrast to lateral carinae nearly straight in *Jaculistilus* and metatibia without lateral spine in contrast to metatibia with a lateral spine at base in *Jaculistilus*. Due to *Dachibangus* lacks key features of the head and hind wings, the contrast between *Dachibangus* and *Jaculistilus* needs more complete specimens and further research. The new species described above, if more complete specimen will be found, could represent another morphological peculiarities, which deserve establishing a new (generic possibly) status for it. The known already extinct Mimarachnidae present high morphological variability on one side (mainly expressed in details of body structures) and relatively uniform and simple venation patterns, which makes the study of this group based on incomplete specimens more difficult. With eight monotypic genera, Mimarachnidae is a family only recorded from the Cretaceous, mainly from the middle to high latitudes of Russia, Japan and Spain, except for the mid-Cretaceous Burmese amber. Three fossil genera of mimarachnids, *Burmissus*, *Dachibangus* and *Jaculistilus* were recently described from Burmese amber, raising new questions about the palaeobiogeographic patterns and ecological plasticity of the group. The new species provides new insights into the palaeodiversity of Cretaceous mimarachnids and further understanding of the origin and evolution of this hemipteran family.

5. Conclusions

Dachibangus formosus sp. nov., an extinct planthopper of Mimarachnidae from Burmese amber, enriches the known diversity of this family to nine species, placed in eight genera, four of which are known from Burmese amber. It adds valuable information about the morphological diversity of the group, but raises some questions about taxonomic units within the family. It also provides important data to our knowledge of the documented palaeodiversity of Mimarachnidae.

Acknowledgments

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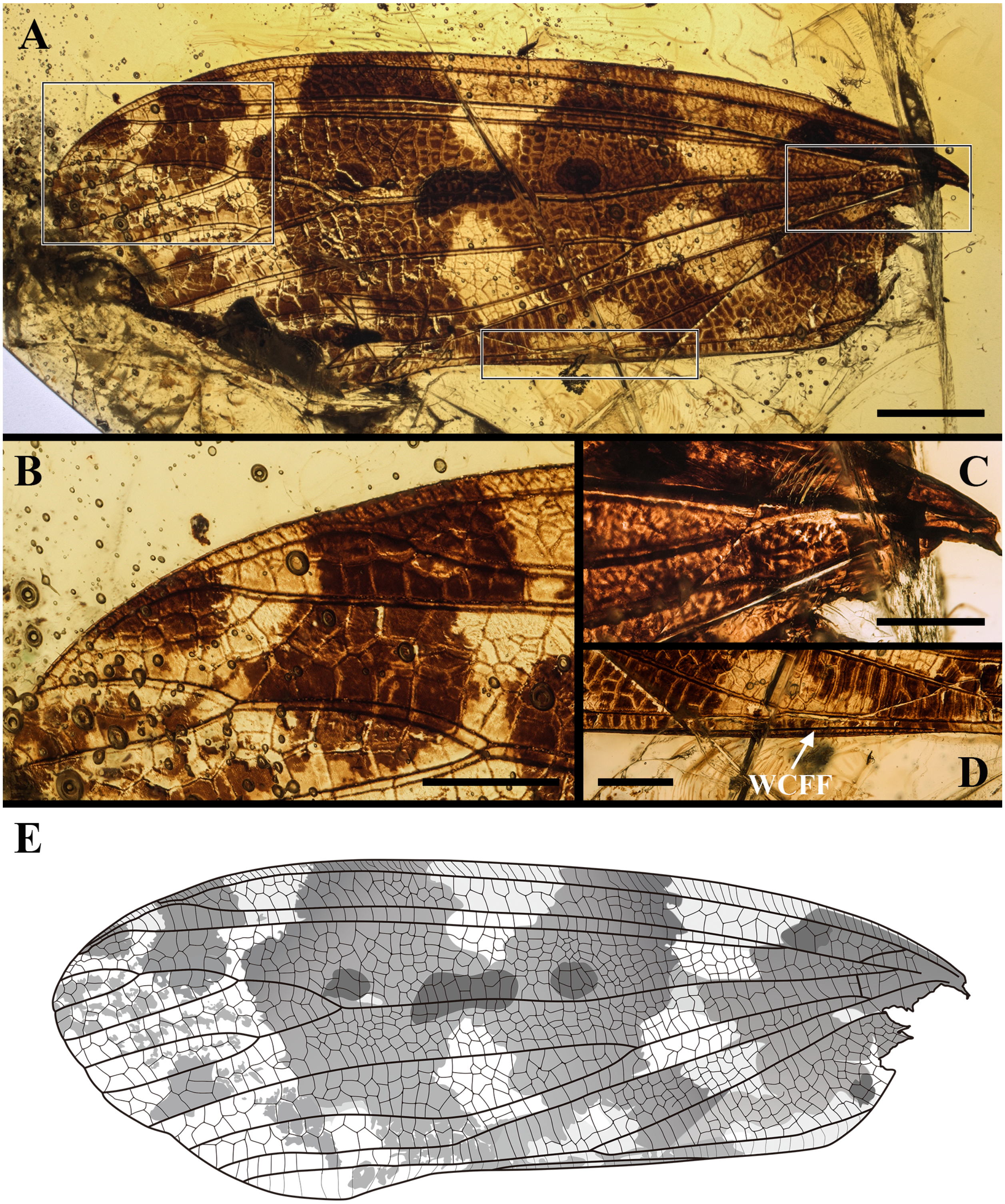
Fig. 1. Microphotographs of holotype (NIGP168935) of *Dachibangus formosus* sp. nov. from the mid-Cretaceous Burmese amber. A. Forewing. B. Enlargements of A, showing the details of Pc+CP, ScP+RA, RP and irregular veinlets. C. Enlargements of A, showing the details of basal cell. D. Enlargements of A, showing the details of WCFF (white arrow). E. Line drawing of *Dachibangus formosus* sp. nov. Scale bars: 2 mm in A, E; 1 mm in B–D. Abbreviation: WCFF, wing-coupling fore fold.

Fig. 2. Modified line drawings of three similar forewings of Mimarachnidae. A. *Dachibangus formosus* sp. nov. B. *Dachibangus trimaculatus* Jiang, Szwedo et Wang, 2018. C. *Jaculistilus oligotrichus* Zhang, Ren et Yao, 2018. Scale bar: 4 mm.


A
B
C
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WCFF
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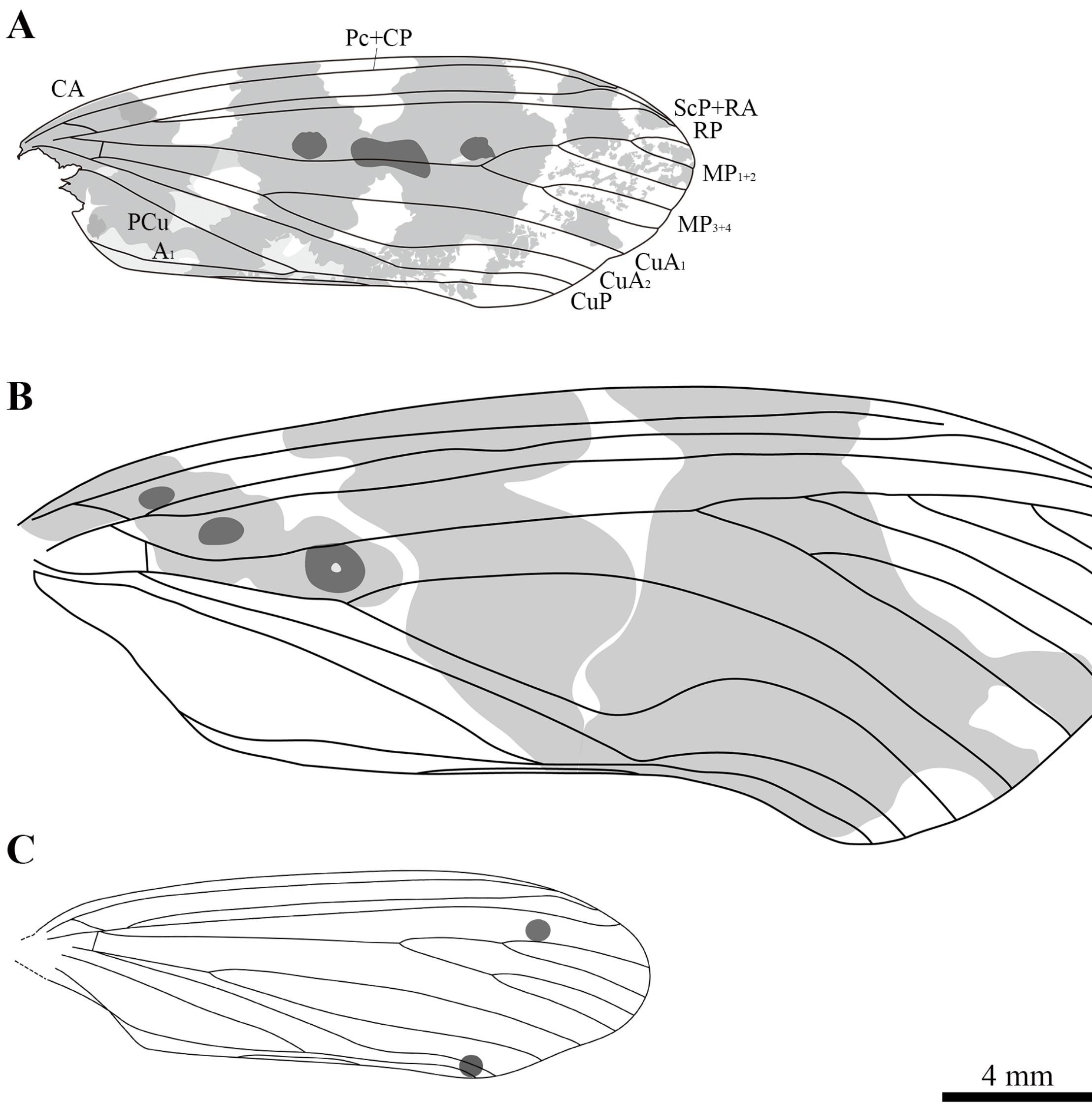
A
Pc+CP
CA
ScP+RA
RP
MP1+2
MP3+4
PCu
A1
CuA1
CuA2
CuP
B
C
4 mm