Cretaceous Research 107 (2020) 104270

Contents lists available at ScienceDirect

Cretaceous Research

journal homepage: www.elsevier.com/locate/CretRes

Short communication

# A new species of the extinct family Minlagerrontidae (Insecta: Hemiptera: Cicadomorpha) from mid-Cretaceous Burmese amber

Yanzhe Fu [a, b], Dany Azar [c], Diying Huang [a, *]

[a] State Key Laboratory of Palaeobiology and Stratigraphy, Center for Excellence in Life and Paleoenvironment, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, 210008, China
[b] University of Chinese Academy of Science, Beijing, 100049, China
[c] Lebanese University, Faculty of Sciences II, Department of Natural Sciences, P.O. Box: 26110217, Fanar, Matn, Lebanon

A R T I C L E I N F O

*Article history:*
Received 22 July 2019
Received in revised form
1 October 2019
Accepted in revised form 8 October 2019
Available online 11 October 2019

*Keywords:*
Myanmar
Mesozoic
New taxa
Palaeodiversity
*Minlagerron hongi* sp. nov

A B S T R A C T

The extinct family Minlagerrontidae bears unusual morphological characteristics and includes two close species within one genus from mid-Cretaceous Burmese (Myanmar) amber. Herein, a third species of *Minlagerron* Chen, Szwedo and Wang, 2019, *Minlagerron hongi* sp. nov. is characterized, described and illustrated based on a well-preserved specimen from the mid-Cretaceous Burmese amber. The new species can be distinguished from other species mainly by its wing venation characters. This discovery increases the knowledge on the palaeodiversity of this peculiar hemipteran family, and probably reflects the complexity of the region of Myanmar during the Cretaceous.



## 1. Introduction

The clade Clypeata, Qadri, 1967 unites all living Cicadomorpha (i.e. Cercopoidea, Cicadoidea, Myerslopioidea and Membracoidea) and the extinct superfamily Hylicelloidea (Wang et al., 2012; Szwedo, 2018; Fu and Huang, 2019). The Clypeata firstly originated in the latest Permian and gradually diversified and radiated during the early and middle Mesozoic. This clade is represented by some ancient groups such as Hylicellidae, Chiliocyclidae, Mesojabloniidae, Tettigarctidae, Archijassidae, Procercopidae, Sinoalidae and Cercopionidae (Hamilton, 1990; Shcherbakov and Popov, 2002; Chen et al., 2019).

The extinct and poorly-studied superfamily Hylicelloidea Evans, 1956 is considered as the common ancestor to all extant superfamilies of Cicadomorpha (Shcherbakov, 1996; Wang et al., 2012). To date, four families have been attributed to Hylicelloidea: Hylicellidae Evans, 1956 (occurred from the Middle Triassic (Ladinian) to the Early Cretaceous (Aptian)); Chiliocyclidae Evans, 1956 and Mesojabloniidae Storozhenko, 1992 (only known from the Late Triassic (Carnian); and Minlagerrontidae Chen et al., 2019 (only known from mid-Cretaceous Burmese amber (Szwedo, 2018; Chen et al., 2019). Minlagerrontidae is the latest representative of Hylicelloidea hitherto, bearing a set of extremely specialized morphological characters that are not recorded in other Clypeata (Chen et al., 2019). They include a highly specialized head with crown concave at anterior margin, angled in the middle; compound eyes produced; pronotum divided into two sections with anterior portion sharply constricted, protruded anteriorly, posterior side distinctly wider, forming a unique 'neck' and 'shoulder' structures; profemur with a row of teeth; and tegmen with cell C5 almost closed, cross veins including two ir and rp-mp (Chen et al., 2019). Nymphs of minlagerrontids were probably subterranean like modern cicadas and their adults might live on trees and bushes, using their specialized 'grasping' prolegs to anchor themselves to the bark or foliage (Chen et al., 2019).

Here we describe a new species of Minlagerrontidae, *Minlagerron hongi* sp. nov., from the mid-Cretaceous Burmese amber.

## 2. Material and methods

The amber comes from Hukawng Valley of Kachin Province, about 100 km southwest of the Village of Tanai, in northern

* Corresponding author. Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, 39 East Beijing Road, Nanjing, 210008, China.
*E-mail address:* dyhuang@nigpas.ac.cn (D. Huang).

https://doi.org/10.1016/j.cretres.2019.104270
0195-6671/

Myanmar (see Yin et al., 2018: fig. 1A). Burmese amber harbors probably the most diverse Mesozoic palaeobiota; among the burmite bioinclusions, fossil insects are the highest diverse (Ross, 2019). Available data suggest that the age of the Burmese amber turns around the Albian–Cenomanian boundary (Cruickshank and Ko, 2003; Grimaldi et al., 2005; Ross et al., 2010; Shi et al., 2012; Rasnitsyn et al., 2016; Grimaldi and Ross, 2017; Mao et al., 2018; Smith and Ross, 2018).

The studied specimen represents a well-preserved adult (NIGP170945), preserved in a piece of clear yellowish amber. The amber piece containing the inclusion was cut, shaped, and polished using emery papers of different grain sizes and rare earth polishing powder, before preparations between two coverslips and in a Canada balsam medium, in order to observe as many characters as possible, as described in Azar et al. (2003) and Sidorchuk and Vorontsov (2018). Photographs were taken with a Zeiss AxioZoom V16 stereoscope; photomicrographs with green background (Figs. 2A, B, D, E, G and 3A, C) are taken using green fluorescence as light source attached to a Zeiss Axio Imager 2 light microscope and a confocal laser scanning microscopy (CLSM) Zeiss LSM 710 with 10 objectives and using a laser at 488 nm (Figs. 2C, F and 3B) (Cai and Huang, 2014); stacked using Helicon Focus 6 software; line drawings were drafted with Adobe Illustrator CC 2018 graphic software. The material studied is housed in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China.

The taxonomic framework of fossil and living Hemiptera employed herein follows Szwedo (2018). Wing venation terminology and cell nomenclature largely followed Bourgoin et al. (2015) and Chen et al. (2019). All measurements were presented in millimeters. The nomenclatural acts established herein are registered under Zoo-Bank LSID urn:lsid:zoobank. org:pub:3C7FA708-E168-4BE6-B99F-A03BC396F46F.

## 3. Systematic palaeontology

Order: Hemiptera Linnaeus, 1758
Suborder Cicadomorpha Evans, 1946
Family: Minlagerrontidae Chen et al., 2019

Genus: ***Minlagerron*** Chen et al., 2019
Type species. *Minlagerron griphos* Chen et al., 2019; by original designation.

***Minlagerron hongi*** sp. nov.
Figs. 1–3

*Etymology*. The specific name honored Professor You-Chong Hong, the Chinese pioneer of Palaeoentomology, passed away on 4 July, 2019. The species is registered under LSID urn:lsid:zoobank.org:act: F3FA8C25-CDC8-4A6B-B990-CE19B2B5D0D4.
*Material.* Holotype, specimen number NIGP170945, adult, male; 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; mid-Cretaceous.
*Diagnosis*. The species is characterized by the following combination of characters: Anterior margin of crown concave in middle with widely angled (more angulate in *M. griphos*); tegmen sub-trapezoid (sub-ellipse in *M. griphos* and *M. onyxos*); prenodal veinlets inclined to costal margin, first prenodal veinlet basad of bifurcation of stem ScP+R+MP (prenodal veinlets almost perpendicular to costal margin in *M. griphos*, first prenodal veinlet as level of ScP+R+MP branching in *M. onyxos*); ScP+R branching into ScP+RA and RP distinctly basad of bifurcation of CuA (ScP+R branching as level of bifurcation of CuA in *M. griphos*); cell C1' much longer than C1, C2' broadest, C4 nearly twice as wide as C5 (C1' much shorter than C1 in *M. onyxos*, C2' as wide as C2 in *M. griphos* and *M. onyxos*, C4 relatively narrow in *M. onyxos*); proximal cross vein ir and rp-mp distinctly shorter than distal ones, and mp-cua much longer than proximal rp-mp (proximal ir and rp-mp longer than distal ones, and mp-cua nearly as long as proximal rp-mp in *M. griphos* and *M. onyxos*).
*Description*. Body length 6.6 mm; crown, pronotum, and mesonotum covered with small round punctures (Fig. 1A, B).
*Head*. (Figs. 1C, D, 2A, B, C). Length 1.2 mm, width with compound eyes 1.5 mm; crown with a slightly sinuate anterior margin, concave in middle, widely angulate; compound eyes large, spherical; three ocelli on crown (Figs. 1D, 2B, C), median ocellus oval, wider than long, lateral ocelli nearly globular; ecdysial suture convex; postclypeus bulging (Figs. 1C, 2A), 1.1 mm long and 0.8 mm wide, lateral margin converging ventrad; anteclypeus narrow, nearly 1/3rd of postclypeus (Figs. 1C, 2A); loral plates semilunar (Fig. 2A); antenna (Fig. 2D) with pedicel distinctly longer than flagellomere I, flagellum elongate with 7 segments, flagellomere I slightly thinner than pedicel and as wide as than flagellomere II and III, flagellomeres III–VII becoming progressively thinner, flagellomere III slightly longer than flagellomere I and II, about 1.4 times as long as flagellomere IV, and 1.8 times as long as flagellomere V; rostrum very short and thick (Fig. 2A), not extending to mesocoxae.
*Thorax*. Pronotum (Figs. 1D, 2B) nearly 1.5 times as wide as head; anterior portion sharply constricted, protruded anteriorly and constituting a 'neck'; anterior margin short, nearly straight; anterolateral margin concave medially with posterior part constituting a 'shoulders'; posterior margin widely acutely W-shaped, concave medially. Mesonotum with scutellum distinctly narrower than pronotum, mesoscutellum triangular. Prothoracic leg with protrochanter 0.38 mm long and 0.29 mm wide; profemur robust, armed with a row of three ventral tiny spines visible (Figs. 1C, 2A), 0.92 mm long and 0.34 mm wide; protibia widened apically, slightly longer than profemur; mesofemur nearly 1.3 times as long as profemur; metafemur (Fig. 2E) 1.25 mm long and 0.31 mm wide; metatibia (Fig. 2E) widened apically with apical rows of teeth, nearly 1.3 times as long as metafemur.
*Tegmen*. (Figs. 1E, 3C, D, 4A). sub-trapezoid, distinctly exceeding the tip of abdomen, length 5.6 mm, width 2.1 mm, with length/width ratio about 2.7; basal portion of clavus with piliferous granules, membranous; costal margin and longitudinal veins covered with two rows of tiny hairs (Figs. 1F, 3B); Pc+CP thickened, exceeding 2/3rd of tegmen length; basal cell narrow, at basal 0.18 of tegmen length; ScP fused to stem R+MP+CuA nearly at half of basal cell length; common stalk of ScP+R+MP+CuA branching into stem ScP+R+MP and CuA from basal cell; ScP+R about 1.7 times as long as ScP+R+MP, branching into ScP+RA and RP slightly at mid-wing length; ScP+R+MP, ScP+R and ScP+RA totally with seven and eight terminal prenodal veinlets in right and left tegmen respectively, prenodal branches of ScP+R+MP single, almost perpendicular to costal margin, and additional prenodal branches of ScP+R and ScP+RA inclined to costal margin; RP single-branched, connecting ScP+RA by two cross vein ir, distal ir about 1.5 times as long as proximal one; MP with 2 branches, branching into $MP_{1+2}$ and $MP_{3+4}$ at basal 0.71 of tegmen length; two cross vein rp-mp present, distal rp-mp about 1.5 times as long as proximal one; CuA strongly curved anteriorly, branching into $CuA_1$ and $CuA_2$ after bifurcation of ScP+R and distinctly basad to bifurcation of MP; cross vein mp-cua as level of rp-mp, about 1.6 times as long as rp-mp; CuP curved anteriorly, and then nearly

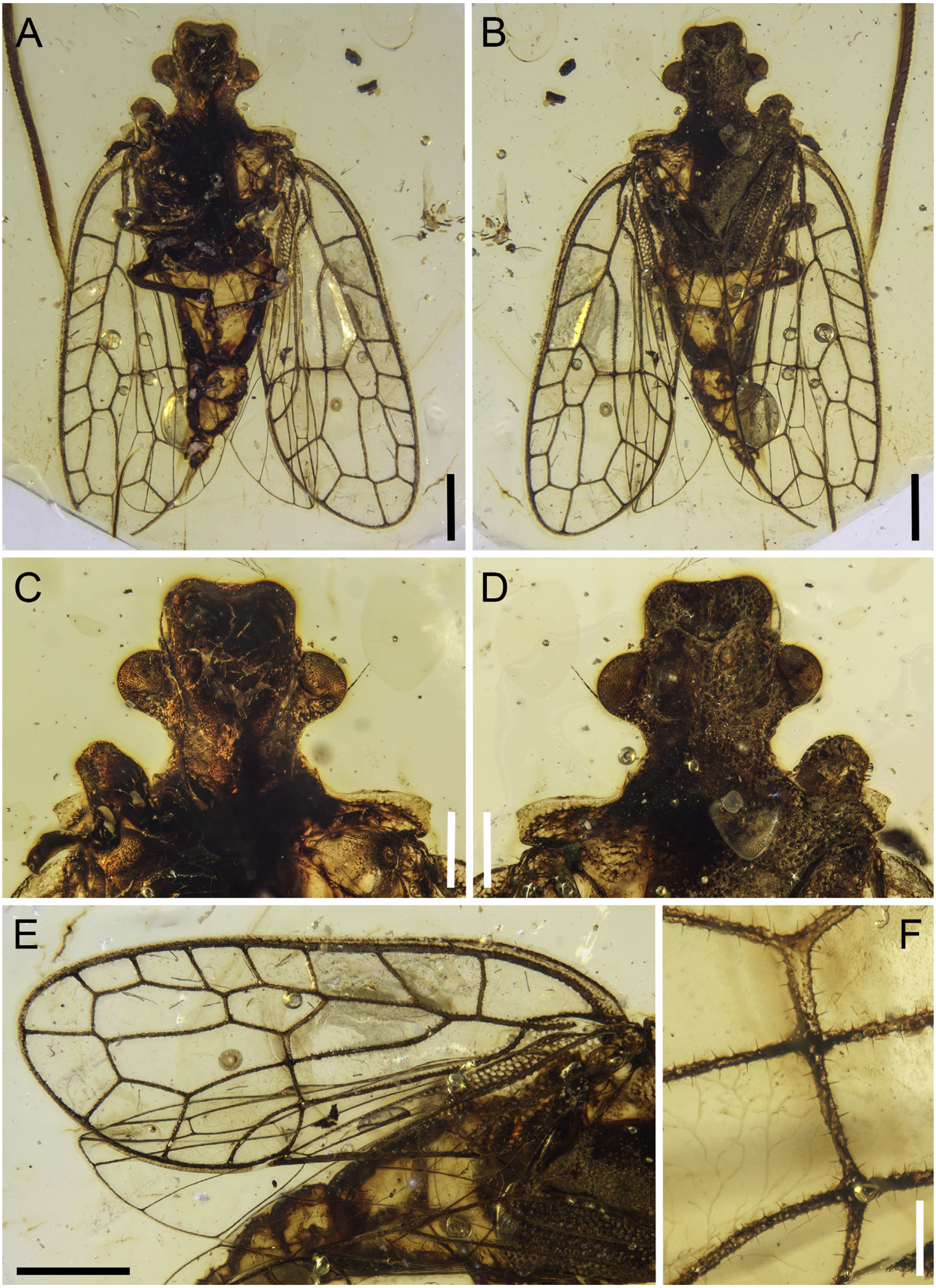


**Fig. 1.** Microphotographs of holotype (NIGP170945) of *Minlagerron hongi* sp. nov. from the mid-Cretaceous Burmese amber, under normal reflected light. A. ventral view, showing general habitus; B. dorsal view, showing general habitus; C. compound eyes, clypeus, antenna and fore leg; D. head structure and pronotum; E. right tegmen and hind wing; F. tegmen venation with hairs. Scale bars: 1 mm in A, B, E; 500 μm in C, D; 200 μm in F.

straight, terminating just basad of $CuA_2$ termination; Pcu subparallel to CuP; A1 slightly arcuate; cell C1' about 1.4 times as long as C1, cell C2' about 1.8 times wider than cell C2; peripheral membrane present (Fig. 3A). Hind wings (Figs. 1E, 3E) with membrane with tiny grains, peripheral membrane narrow (Fig. 3A); appendix narrow; RA, RP and MP single-branched; CuA with 2 branches; corss vein ir, rp-mp and mp-cua present. *Abdomen*. Abdomen tapered, segments III broadest. Male genitalia (Fig. 2F, G) with genital valve, genital plates and pygofer fused, anal tube elongate, widening caudad.

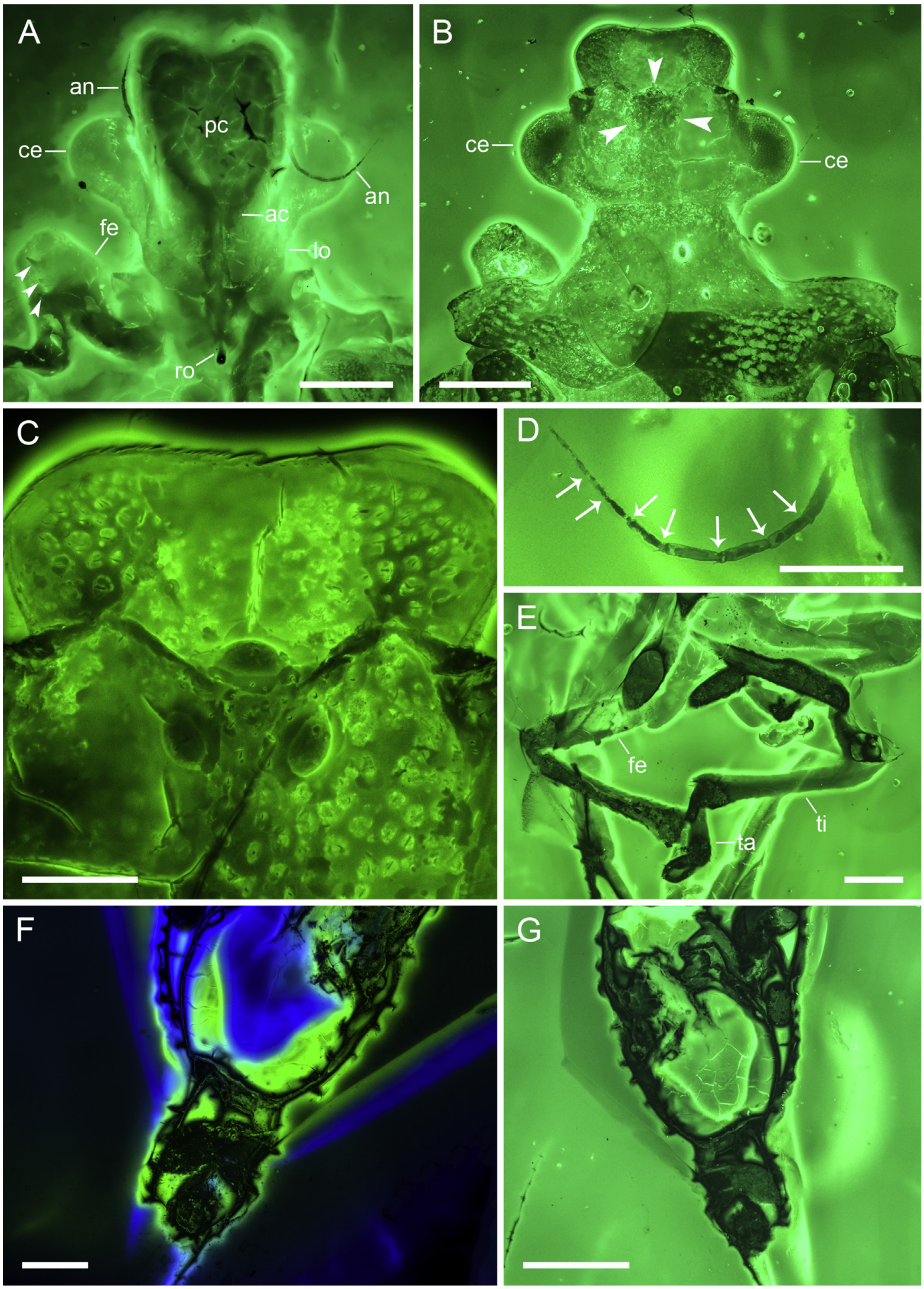


**Fig. 2.** Microphotographs of holotype (NIGP170945) of *Minlagerron hongi* sp. nov. A. showing details of clypeus, lora, antenna, rostrum and profemur with teeth (white arrows), under green fluorescence; B. showing details of head structure with three ocelli (white arrows) and pronotum, under green fluorescence; C. showing details of three ocelli and sutures, under confocal laser scanning microscopy; D. showing details of antenna, under green fluorescence; E. showing details of hind legs, under green fluorescence; F. showing details of genital, under confocal laser scanning microscopy; G. showing details of genital, under green fluorescence. Scale bars: 500 μm in A, B, E, G; 200 μm in C, D, F. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article).

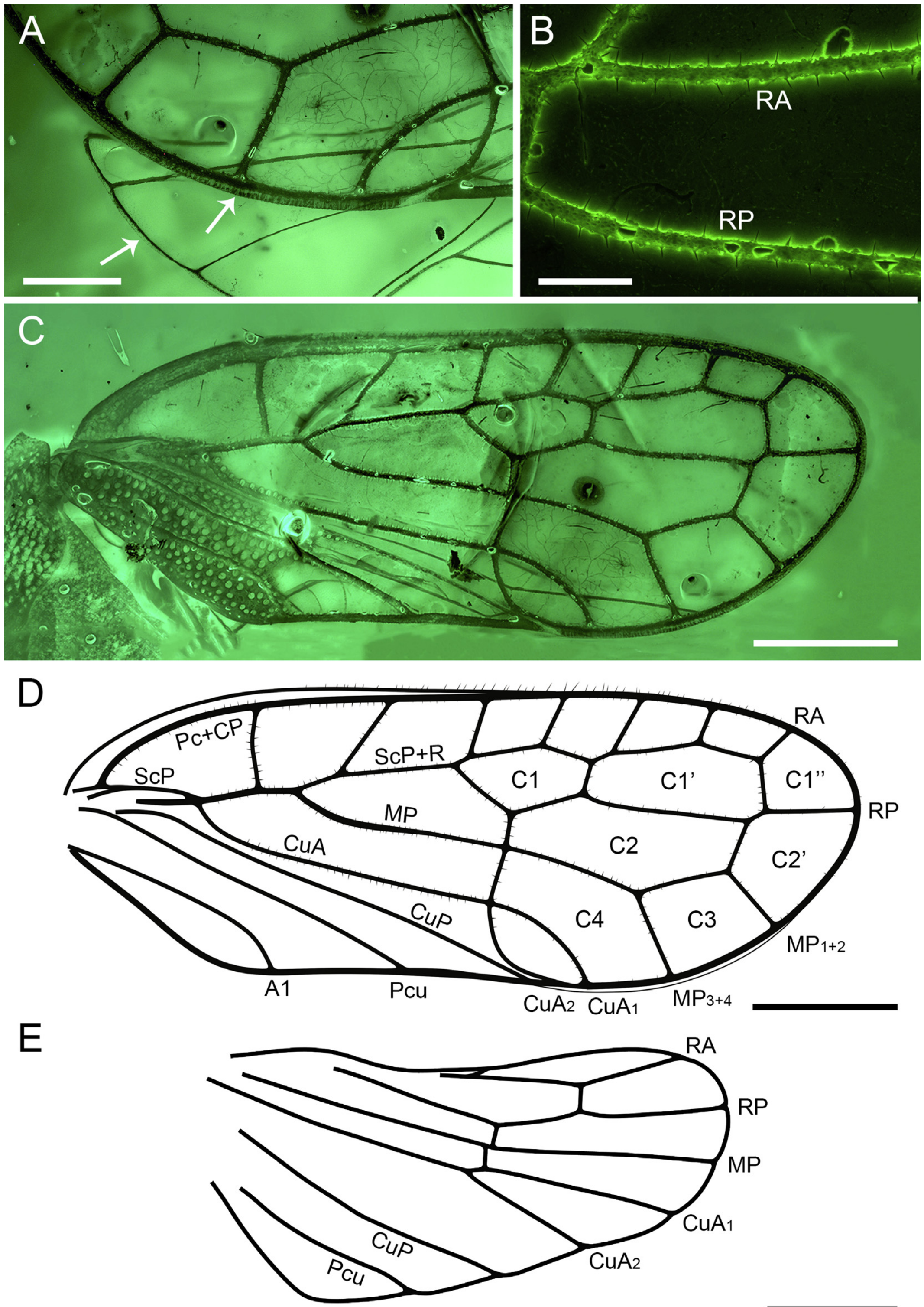


**Fig. 3.** Right wings of holotype (NIGP170945) of *Minlagerron hongi* sp. nov. A. showing details of peripheral membrane, under green fluorescence; B. showing details of vein RA and RP with hairs, under confocal laser scanning microscopy; C. showing details of tegmen, under green fluorescence; D. line drawing of tegmen; E. line drawing of hind wing. Scale bar: 1 mm in C–E; 500 μm in A; 200 μm in B. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article).

## 4. Discussion

The first records of superfamily Hylicelloidea can be traced back from the latest Permian, occurring throughout the Triassic and Jurassic, and declining in the Cretaceous with only two families (i.e. Hylicellidae and Minlagerrontidae) with a few species. The systematic position, early evolution and paleoecology of Hylicelloidea are poorly-known (Li et al., 2010). Knowledge on body structures of this superfamily is still limited, and most of them are described only on the basis of wing fragments (Evans, 1956; Shcherbakov, 2012; Fu and Huang, 2019).

Ross (2019) suggested that an amazing diversity of fossil insects is preserved in mid-Cretaceous Burmese ambers. However, Fossil records of the infraorder Cicadomorpha from Burmese amber are comparatively rare, with only 11 genera and 12 species attributed into 5 families, comprising 3 extant families (i.e. Cicadoidea: Cicadidae and Tettigarctidae; Cicadelloidea: Cicadellidae) and 2 extinct families (i.e. Cercopoidea: Sinoalidae and Hylicelloidea: Minlagerrontidae, representing the latest record respectively) (Ross, 2019; Chen et al., 2019). Minlagerrontidae previously included two species with relatively limited morphological differences from the Burmese amber (Fig. 4). The new species *Minlagerron hongi* sp. nov. we are describing herein belongs to Minlagerrontidae owing to the following combination of characters: head with crown angled in the middle, compound eyes extremely produced, pronotum highly specialized, forming a 'neck' and a 'shoulder' structures, profemur armed with a row of teeth, tegmen with cell C5 almost closed, and cross veins including two ir and rp-mp (Chen et al., 2019).

The new species *Minlagerron hongi* mostly resembles *Minlagerron onyxos* Chen et al., 2019 from mid-Cretaceous Burmese amber. It shares with *M. onyxos* several head and venational characters, including the anterior margin of crown widely angled (roundly angled in type species *Minlagerron griphos* Chen et al., 2019); lora short and broad (lora long and narrow in *M. griphos*); tegmen with prenodal veinlets inclined to costal margin (prenodal veinlets almost perpendicular to costal margin in *M. griphos*); tegmen with ScP+R branching into ScP+RA and RP distinctly basad of bifurcation of CuA (ScP+R branching as level of bifurcation of CuA in *M. griphos*). However, *M. hongi* differs from *M. onyxos* by following characters: 1) tegmen with the first prenodal veinlet basad of stem ScP+R+MP branching (first prenodal veinlet as level of ScP+R+MP branching in *M. onyxos*); 2) cell C1' about 1.4 times as long as C1 (C1' much shorter than C1 in *M. onyxos*); 3) cell C2' much wider than C2 (C2' as wide as C2 in *M. onyxos*); 4) cell C4 broad, nearly twice as wide as C5 (C4 relatively narrow, slightly wider than C5 in *M. onyxos*); 5) proximal cross vein ir and rp-mp shorter than distal ones, and mp-cua much longer than proximal rp-mp (proximal ir and rp-mp almost twice as long as distal ones, and mp-cua as long as proximal rp-mp in *M. onyxos*).

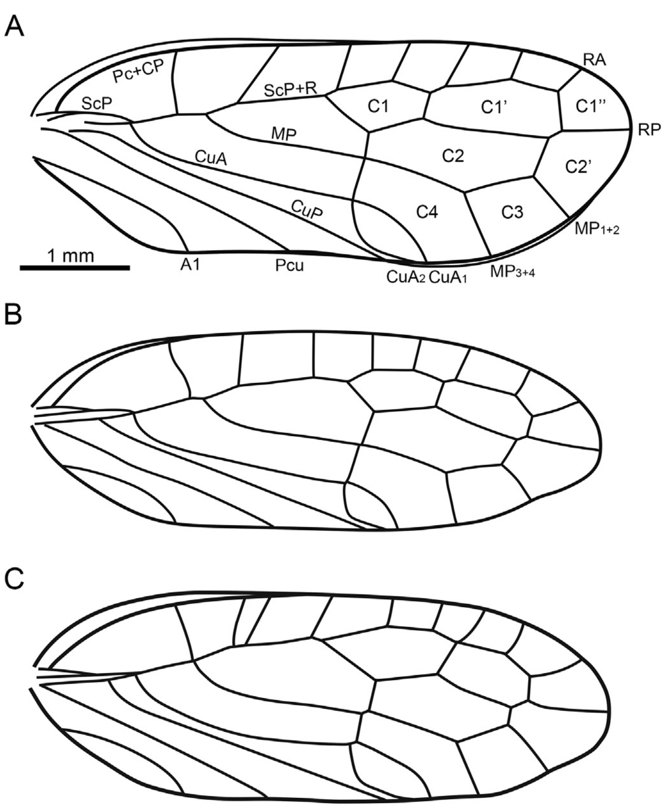


**Fig. 4.** Modified comparative line drawings of forewings of Minlagerrontidae. A. holotype (NIGP170945) of *Minlagerron hongi* sp. nov.; B. *Minlagerron griphos*; C. *Minlagerron onyxos*. Scale bar: 1 mm.

## 5. Conclusions

Our discovery of a new fossil species of the extinct family Minlagerrontidae, *Minlagerron hongi* sp. nov., increases the known diversity of this family to three species, all of which are from Burmese amber, indicating that minlagerrontids were rare but likely diverse in the Cretaceous of Myanmar. Myanmar block probably split from Gondwanan in the Early Jurassic, forming an island drifting northward, completely isolated from any continental landmasses (Cruickshank and Ko, 2003; Seton et al., 2012; Oliveira et al., 2016). Available data suggest that the locality of Burmese amber's forest producer was on a marine shore during the mid-Cretaceous, widely remote geographically from other ecosystems (Mao et al., 2018; Smith and Ross, 2018; Yu et al., 2019). Ancestral group of minlagerrontids could have appeared at least in the Late Triassic, and lived in Myanmar block to the mid-Cretaceous. Due to the possible complex topography of the island, minlagerrontids further differentiate into multiple species.

## Acknowledgments

This work was supported by the Second Tibetan Plateau Scientific Expedition and Research (2019QZKK0706), Strategic Priority Research Program of the Chinese Academy of Sciences (XDB26000000 and XDB18000000), and the National Natural Science Foundation of China (41688103).

## References

Azar, D., Perrichot, V., Neraudeau, D., Nel, A., 2003. New psychodid flies from the Cretaceous ambers of Lebanon and France, with a discussion about *Eophlebotomus connectens* Cockerell, 1920 (Diptera, Psychodidae). Annals of the American Society of America 96, 117–127.

Bourgoin, T., Wang, R., Asche, M., Hoch, H., Soulier-Perkins, A., Stroinski, A., Yap, S., Szwedo, J., 2015. From micropterism to hyperpterism: recognition strategy and standardized homology- driven terminology of the forewing venation patterns in planthoppers (Hemiptera: Fulgoromorpha). Zoomorphology 134, 63–77.

Cai, C., Huang, D., 2014. The oldest micropepline beetle from Cretaceous Burmese amber and its phylogenetic implications (Coleoptera: Staphylinidae). Naturwissenschaften 101, 813–817.

Chen, J., Szwedo, J., Wang, B., Zheng, Y., Jiang, H., Jiang, T., Wang, X., Zhang, H., 2019. A new bizarre cicadomorph family in mid-Cretaceous Burmese amber (Hemiptera, Clypeata). Cretaceous Research 97, 1–15.

Cruickshank, R.D., Ko, K., 2003. Geology of an amber locality in the Hukawng Valley, northern Myanmar. Journal of Asian Earth Sciences 21, 441–455.

Evans, J.W., 1946. A natural classification of leaf-hoppers (Jassoidea, Homoptera). Part 1. External morphology and systematic position. Transactions of the Royal Entomological Society of London 96, 47–60.

Evans, J.W., 1956. Palaeozoic and Mesozoic Hemiptera (Insecta). Australian Journal of Zoology 4, 164–258.

Fu, Y., Huang, D., 2019. New Early Cretaceous hylicellids (Insecta: Hemiptera: Cicadomorpha) from Southwest Beijing, China. Palaeoentomology 2, 17–21.

Grimaldi, D., Engel, M.S., 2005. Evolution of the Insects. Cambridge University Press, New York, p. 755.

Grimaldi, D.A., Ross, A.J., 2017. Extraordinary Lagerst€atten in amber, with particular reference to Cretaceous of Burma. In: Fraser, N., Sues, H.D. (Eds.), Terrestrial Conservation Lagerstätten: Windows into the Evolution of Life on Land. Dunedin Academic Press, Edinburgh, pp. 287–342.

Hamilton, K.G.A., 1990. Homoptera. In: Grimaldi, D.A. (Ed.), Insects from the Santana Formation, Lower Cretaceous of Brazil. Bulletin of the American Museum of Natural History 195, pp. 82–122.

Li, S., Wang, Y., Ren, D., Szwedo, J., Pang, H., 2010. Froghoppers, leafhoppers, planthoppers and their allies from the Mesozoic of Northeastern China (Hemiptera: Cicadomorpha and Fulgoromorpha). Earth Science Frontiers 17, 250–251.

Linnaeus, C., 1758. Systema naturae per regna tria naturae, secundum classes, ordinus, genera, species, cum characteribus, differentiis, synonymis, locis., tenth ed., vol. 1. Holmiae Salvii. 824 pp.

Mao, Y., Liang, K., Su, Y., Li, J., Rao, X., Zhang, H., Xia, F., Fu, Y., Cai, C., Huang, D., 2018. Various amberground marine animals on Burmese amber with discussions on its age. Palaeoentomology 1, 91–103.

Oliveira, I.S., Bai, M., Jahn, H., Gross, V., Martin, C., Hammel, J.U., Zhang, W., Mayer, G., 2016. Earliest Onychophoran in amber reveals Gondwanan migration patterns. Current Biology 26, 2594–2601.

Qadri, M.A.H., 1967. Phylogenetic Study of Auchenorrhyncha, vol. 4. University Studies (Karachi), pp. 1–16.

Rasnitsyn, A.P., Bashkuev, A.S., Kopylov, D.S., Lukashevich, E.D., Ponomarenko, A.G., 2016. Sequence and scale of changes in the terrestrial biota during the Cretaceous (based on materials from fossil resins). Cretaceous Research 61, 234–255.

Ross, A.J., 2019. Burmese (Myanmar) amber checklist and bibliography 2018. Palaeoentomolog 2, 22–84.

Ross, A.J., Mellish, C., York, P., Crighton, B., 2010. Burmese amber. In: Penney, D. (Ed.), Biodiversity of Fossils in Amber from the Major World Deposits. Siri Scientific Press, Manchester, pp. 208–235.

Seton, M., Müller, R.D., Zahirovic, S., Gaina, C., Torsvik, T., Shephard, G., Talsma, A., Gurnis, M., Turner, M., Maus, S., Chandler, M., 2012. Global continental and ocean basin reconstructions since 200 Ma. Earth Science Reviews 113, 212–270.

Shcherbakov, D.E., 1996. Origin and evolution of the Auchenorrhyncha as shown in the fossil record. In: Schaefer, C.W. (Ed.), Studies on Hemipteran Phylogeny, Thomas Say Publications in Entomology. Entomological Society of America, Lanham, pp. 31–45.

Shcherbakov, D.E., 2012. A new subfamily of Mesozoic Hylicellidae (Homoptera: Cicadomorpha). Russian Entomological Journal 21, 441–444.

Shcherbakov, D.E., Popov, Y.A., 2002. Superorder Cimicidea Laicharting, 1781 order Hemiptera Linné, 1758. The bugs, cicadas, plantlice, scale insects, etc. In: Rasnitsyn, A.P., Quicke, D.L.J. (Eds.), History of insects. Kluwer, Dordrecht, pp. 152–155.

Shi, G., Grimaldi, D.A., Harlow, G.E., Wang, J., Wang, J., Wang, M., Lei, W., Li, Q., Li, X., 2012. Age constraint on Burmese amber based on U-Pb dating of zircons. Cretaceous Research 37, 155–163.

Sidorchuk, E.A., Vorontsov, D.D., 2018. Preparation of small-sized 3D amber samples: state of the technique. Palaeoentomology 1, 80–90.

Smith, R.D.A., Ross, A.J., 2018. Amberground pholadid bivalve borings and inclusions in Burmese amber: implications for proximity of resin-producing forests to brackish waters, and the age of the amber. Transactions of the Royal Society of Edinburgh: Earth and Environmental Science 107, 239–247.

Storozhenko, S.Y., 1992. New Mesozoic Grylloblattid insects (Grylloblattida) from Central Asia. Paleontological Journal 26, 85–95.

Szwedo, J., 2018. The unity, diversity and conformity of bugs (Hemiptera) through time. Earth and Environmental Science Transactions of the Royal Society of Edinburgh 107, 109–128.

Wang, B., Szwedo, J., Zhang, H., 2012. New Jurassic Cercopoidea from China and their evolutionary significance (Insecta: Hemiptera). Palaeontology 55, 1223–1243.

Yin, Z., Cai, C., Huang, D., 2018. A potentially diverse fauna of springtail-hunting scydmaenines during the late Mesozoic (Coleoptera, Staphylinidae, Scydmaeninae). Cretaceous Research 90, 163–167.

Yu, T., Kelly, R., Mu, L., Ross, A., Kennedy, J., Brolyh, P., Xia, F., Zhang, H., Wang, B., Dilcherk, D., 2019. An ammonite trapped in Burmese amber. Proceedings of the National Academy of Sciences 116, 11345–11350.