

Still greater disparity in basal planthopper lineage: A new planthopper family Yetkhatidae (Hemiptera, Fulgoromorpha, Fulgoroidea) from mid-Cretaceous Myanmar amber

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ABSTRACT

A new family Yetkhatidae Song, Szwedo et Bourgoin fam. nov. from mid-Cretaceous amber of Myanmar is described. It is characterized by the tegmina with a triangular basal cell and in having the apex of the clavus closed, the female genitalia with robust endogonocoxal processes, the head capsule with trigones and foliated frontal margins, ridged lora (visible frontally) and by intermediate carinae on the mesonotum. Two new monotypic genera are described in this new family: *Yetkhata* Song, Szwedo & Bourgoin gen. nov., with *Yetkhata jiangershi* Song, Szwedo & Bourgoin sp. nov. and *Parwaina* Song, Szwedo & Bourgoin gen. nov. with *Parwaina liuyei* Song, Szwedo & Bourgoin sp. nov. A key to recognition of these genera is provided, and their morphological characters and disparity are briefly discussed.

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1. Introduction

The planthoppers, or Fulgoromorpha, form a very diversified unit of more than 13,600 species divided into 21 extant families plus 11 fossils ones (Bourgoin, 2019). They are an old hemipteran lineage known from fossils since the Early Permian, some 258 Ma (Shcherbakov, 2002; Szwedo et al., 2004; Szwedo, 2018). Mainly because monophyly of most major families and main lineages remains poorly supported (Urban and Cryan, 2007; Song and Liang, 2013; Bartlett et al., 2014), their phylogeny is still under discussion (Urban and Cryan, 2007; Bartlett et al., 2014; Song et al., 2018). Only few families have been reported from Cretaceous (Szwedo et al.,

2004; Bourgoin, 2019), including three extant families: Cixiidae (Fennah, 1987; Martins-Neto, 1989; Ren et al., 1998; Szwedo, 2001; Martins-Neto and Szwedo, 2007), Achilidae (Cockerell, 1917; Hamilton, 1990; Szwedo, 2004), and Dictyopharidae (Emeljanov, 1983); and six fossil ones: Lalacidae (Martins-Neto, 1988; Hamilton, 1990; Ren et al., 1995; Zhang, 2002), Mimarachnidae (Shcherbakov, 2007b, 2017; Szwedo, 2008; Szwedo and Ansoerge, 2015), Neazoniidae (Szwedo, 2007, 2009), Perforissidae (Shcherbakov, 2007a; Peñalver and Szwedo, 2010; Szwedo et al., 2013; Zhang et al., 2017), and the two recently described: Dorytocidae (Emeljanov and Shcherbakov, 2018) and Jubisentidae (Zhang et al., 2019). Particularly for these taxa belonging to the so-called “Cixiidae-like” complex (Bourgoin and Szwedo, 2008), their taxonomic positions need to be better substantiated.

While studying samples from Myanmar Cretaceous amber, we discovered two specimens that were not possible to classify among these already known Cretaceous taxa and in any other existing

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families of Fulgoromorpha, although both show some similarity with Dictyopharidae or Achilidae. However, from Achilidae the specimens lack the characteristic tegmina open clavus of the Achilidae–Derbidae lineage (Shcherbakov, 1981), although the character appeared to be quite diversely interpreted (Bourgoin et al., 2015), and lack distinct dilatation of membrane; nodal veinlets *rp-mp* and *mp-cua* at similar level, but postnodal veinlets not arranged in apical row (Shcherbakov, 1981); and from Dictyopharidae, the forking schema of main stems of the tegmina appears to be not characteristic of the family (Shcherbakov, 1981). In reverse, both new genera also share a set of characters of head capsule, thorax carinae, tegminal venation, and leg armature which arrangement and combination is new and specific to them, suggesting a new fossil family in planthoppers.

2. Material and methods

The material examined, burmite or Burmese (Myanmar) amber, come from deposits in the Hukawng Valley of Myanmar. The mining area is located at Noiye Bum, near Bum, close to Tanai Village (26°21'33.41" N, 96°43'11.88" E; palaeocoordinates 12.4° N, 93.8° E) (Kania et al., 2015; fig. 1; Thu and Zaw, 2017). These deposits were investigated and dated in detail by Cruickshank and Ko (2003) and Shi et al. (2012), which currently date the deposit to the earliest Cenomanian (ca. 98.8 ± 0.63 Ma). A slightly older age was postulated (Albian by Ross et al., 2010; late Albian by Zheng et al., 2018; Albian–Cenomanian boundary by Rasnitsyn et al., 2016), due to the fact that the amber shows evidence of redeposition (Grimaldi and Ross, 2017; Smith and Ross, 2018). Fossil resins were washed over from the forest floor and transported by rivers and deposited in a fluvial or estuarine environment at the sea margin, a process that may have taken months to a few hundred years (or a few thousand years at maximum), when finally buried and preserved in the sediment. According to Mao et al. (2018) the amber has not been transported over long distances, and the amber-producing plants were not far from the beach or just by the sea. Schmidt and Dilcher (2007) observed that pieces of resin at the water-air interface were nearly solidified after one week; whereas subaqueous bodies of resin formed a thin hardened skin after one to two days, while remaining liquid within. Therefore, as already suggested (Mey et al., 2018; Smith and Ross, 2018) centres of the resin pieces were still soft when pholadid bivalves bored into its surface, during a relatively short exposure time. Recently sessile organisms such as corals and oysters which can grow on the surface of amber were reported (Mao et al., 2018). These ambers may or may not be completely hardened, and their exposure time of several years or a few thousand years may not have a significant impact. The formation of the amber should be considered to be contemporaneous with the deposition of the bed, and the age of Burmese amber from Noiye Bum on northern Myanmar should be considered earliest Cenomanian, close to the boundary between the Albian and Cenomanian. Additional evidence, e.g. data from biostratigraphically-significant palynomorphs preserved in the amber would be needed to specifically date the original amber material.

Burmese amber preserves enormous diversity of plants, invertebrates and vertebrates (Ross, 2019), giving new insight into very important period of formation of modern faunistic complexes at mid-Cretaceous biotic re-organisation times (Szwedo and Nel, 2015). The mineralogical name burmite was introduced by Helm (1892, 1893) and now is widely used in literature concerning amber from Myanmar. The botanical affiliation of this resin remains unclear, but Cupressaceae gymnosperms, very likely *Metasequoia* or related taxa were the trees exuding the resin at time of burmite formation (Grimaldi and Ross, 2017).

The specimens studied in the course of this work are deposited in the following institutions, which are subsequently referred to by their acronyms: IZCAS, Institute of Zoology, Chinese Academy of Sciences, Beijing, China, and JSSNU, Jiangsu Second Normal University, Nanjing, China. The piece of amber containing the specimen was cut with a razor blade, polished with sand papers of different grain sizes and diatomite mud, and mounted on transparent plastic slides. Observations, measurements and photography were conducted under a Zeiss Discovery V12 stereomicroscope equipped with a Nikon D7000 digital camera. Some final images were compiled from multiple photographs using CombineZM image stacking software and improved with the Adobe Photoshop CS5 software. Morphological characters were observed and illustrated by a Zeiss Stemi SV II optical stereomicroscope with a drawing tube attached.

The morphological terminology and measurements used in this study follow mostly Anufriev and Emeljanov (1988); with Bourgoin (1993) for the female genitalia, and Bourgoin et al. (2015) for the tegminal venation.

Fourier Transformed Infrared Spectra (FT-IR) spectra of the amber specimens (Figs. 1A, B and 2A, B) were obtained in the Laboratory of the International Amber Association, Gdańsk, Poland with Nicolet iS10 Spectrometer with an ATR (Attenuated Total Reflectance; diamond crystal) accessory and the Jiangsu Key Laboratory of Bio-functional Molecule, JSSNU, Nanjing, China with Nicolet iS5 Spectrometer. Spectra were registered with resolution 4 cm^{-1} , baseline correction and advanced ATR correction were applied. Reference curve numbers in the collection archives are stored as registration number of the specimen, with suffix 'IR'. This procedure must be regarded now as obligatory for the museum material, especially holotypes, as recently proposed by Szwedo and Stroński (2017).

3. Systematic palaeontology

Order Hemiptera Linnaeus, 1758

Infraorder Fulgoromorpha Evans, 1946

Superfamily Fulgoroidea Latreille, 1807

Family Yetkhatidae Song, Szwedo & Bourgoin, fam. nov.

LSID: urn:lsid:zoobank.org:act:5247DD07-2CA2-444F-98E0-447E790BDE72

Type genus. *Yetkhata* Song, Szwedo & Bourgoin, gen. nov., here designated

Diagnosis. The new family belongs to the so-called intermediate planthopper families with the following combination of characters: vertex in its width shorter than pronotum, trigones present; frons with median carina extending on clypeus; anteclypeus without lateral carinae; antennae shorter than eyes, pedicel apically truncated; genae slightly visible in frontal view; rostrum long, surpassing middle of hind femora; pronotum with one longitudinal lateral carina between eyes and tegulae; mesonotum tricarinate in disc but posteriorly with a pair of short intermediate carinae; tegmina membranous, hyaline, and flat; pterostigmal area elongate; basal cell triangular, elongated; ScP + R and MP with a short common stem; ScP + R and CuA forking earlier than MP; MP forking late at nodal level with three to five branched distally; CuA two-branched; hindwings with simple venation and *mp-r* and *cua-mp* cross veins; hind tibiae with two to three lateral spines, the basal spine small; apical teeth of hind tarsomeres I and II with long platellae (thick subapical setae); ovipositor of fulgoroid type with strongly developed endogonocoxal process

Diversity and distribution. Yetkhatidae fam. nov. is an extinct Fulgoroidea family and comprises two monotypic genera: *Yetkhata* Song, Szwedo et Bourgoin gen. nov., type genus and *Parwaina* Song, Szwedo et Bourgoin gen. nov. known so far from mid-Cretaceous Burmese amber inclusions

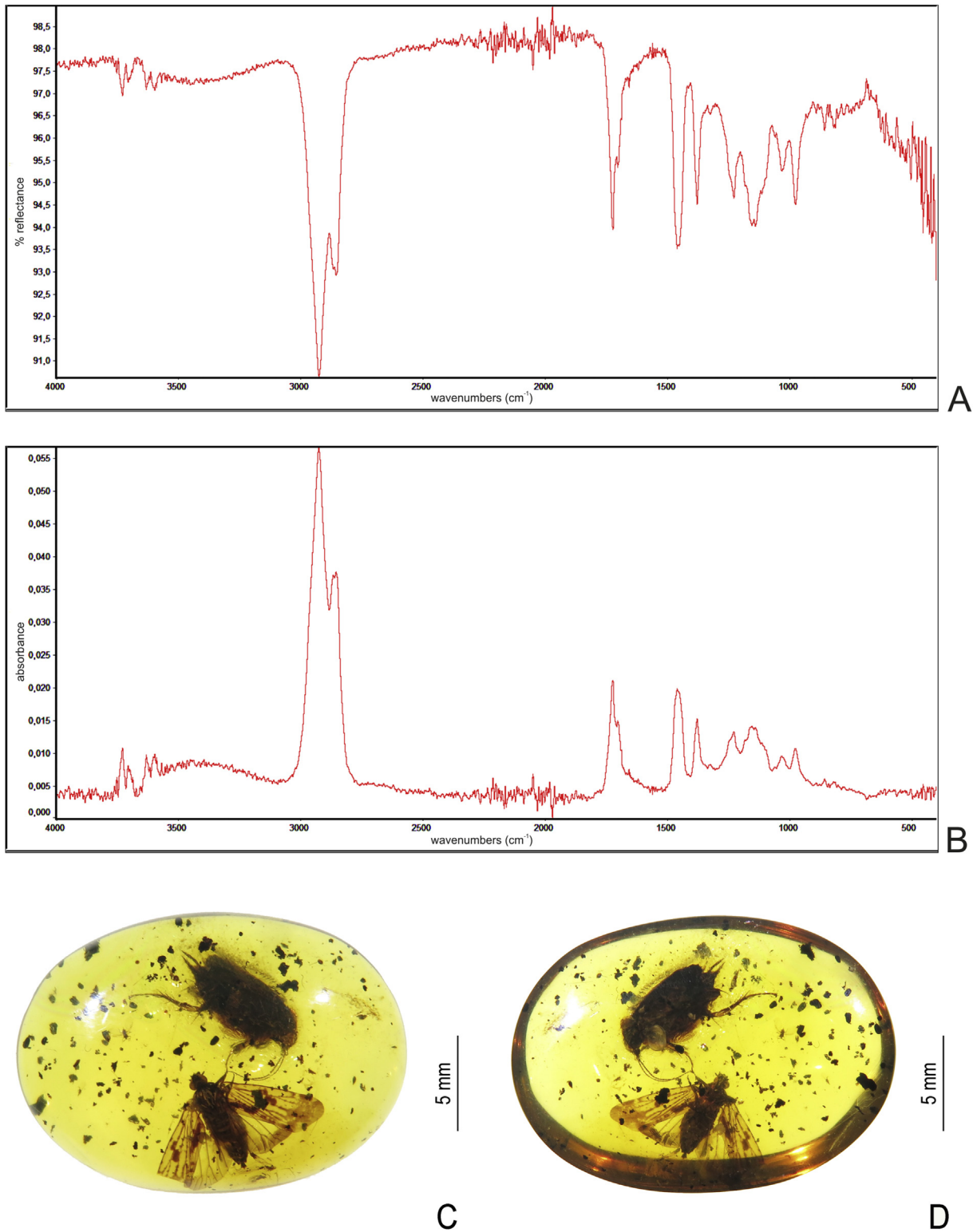


Fig. 1. A, B, FT-IR spectra of the amber specimen JSSNU-2018001: FT-IR spectrum JSSNU-2018001IR (IAA 14231) (A) and ATR corrected FT-IR spectrum with baseline corrected (B); C, D, piece of amber JSSNU-2018001 with inclusion of *Yetkhata jiangershii* Song, Szwedo & Bourgoin, gen. et sp. nov., dorsal (C) and ventral (D) sides.

Key to the genera of Yetkhatidae fam. nov.

1. Head with compound eyes narrower than pronotum; vertex as long in middle line as wide at base; pedicel elongate; fore and middle femora not flattened and dilated; hind tibiae with six apical teeth*Yetkhata* gen. nov.
- Head with compound eyes as wide as pronotum; vertex shorter in middle line than wide at base; pedicel subglobose; fore and middle femora flattened and dilated; hind tibiae with eight apical teeth*Parwaina* gen. nov.

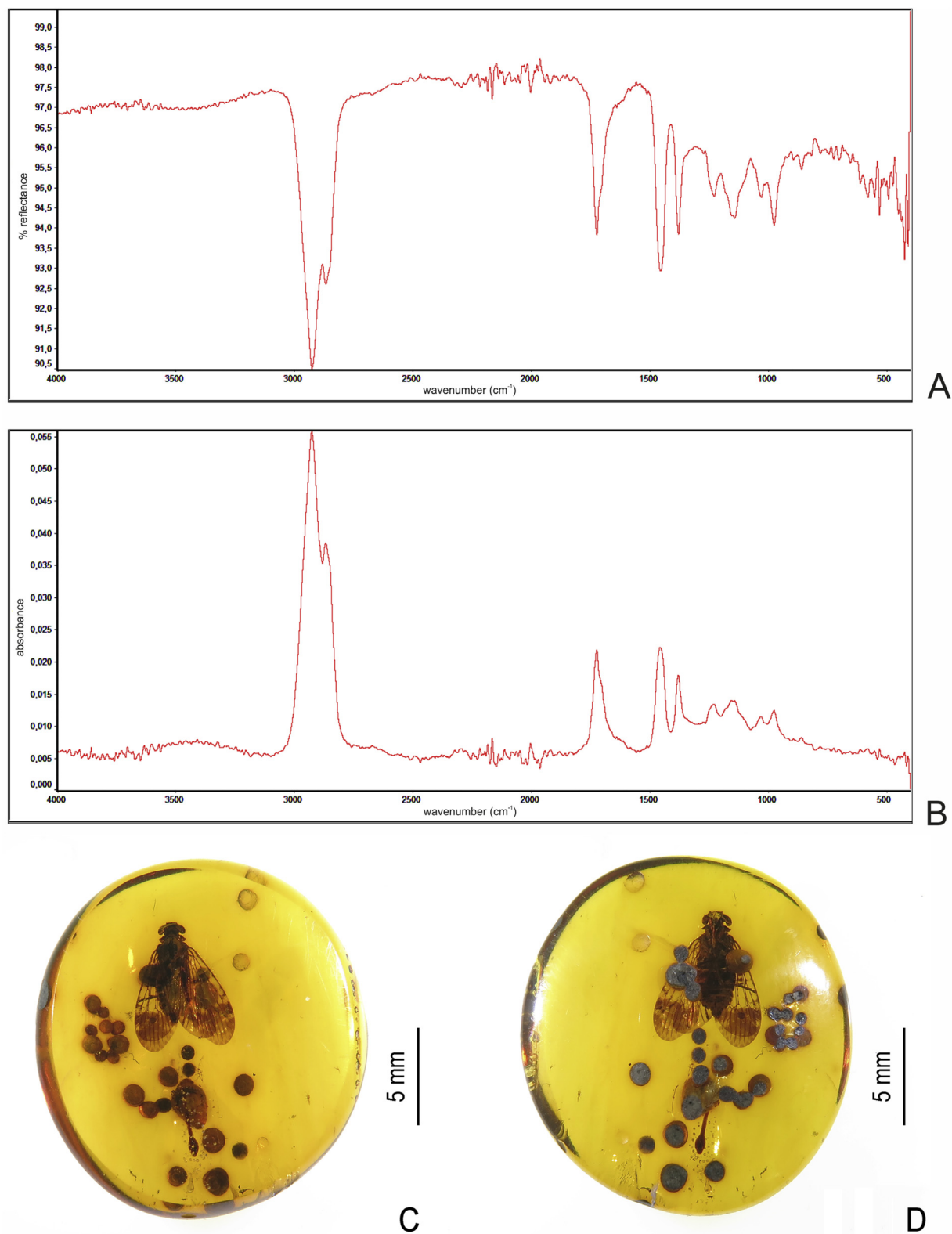


Fig. 2. A, B, FT-IR spectra of the amber specimen IZCAS-2018001: FT-IR spectrum (A) and ATR corrected FT-IR spectrum with baseline corrected (B); C, D, piece of amber IZCAS-2018001 with inclusion of *Parwaina liuyei* Song, Szwedo & Bourgoin, gen. et sp. nov., dorsal (C) and ventral (D) sides.

Genus **Yetkhata** Song, Szwedó & Bourgoin, gen. nov

LSID: urn:lsid:zoobank.org:act:3CC275D9-7D9B-4F64-9607-91E7F69E9B10

Type species: *Yetkhata jangershii* Song, Szwedó & Bourgoin, sp. nov., by monotypy and present designation

Etymology. The genus name is derived from the name of 'Yetkhat', a benevolent guardian of buried treasures hidden in tree roots in the Burmese mythology, referring to the origin of the specimen trapped in fossil plant resins in Myanmar. Gender feminine.

Diagnosis. The genus can be distinguished by the following combination of characters: vertex with lateral carinae foliaceous, anterior margin angularly convex at about 90° at apex, disc inflated in middle, with a pair of large lateral bulges; frons flat and elongate; lateral carinae strongly elevated and foliaceous, nearly parallel, and slightly expanded outward below antennae; median carina sharply ridged. Postclypeus cuneate, slightly convex medially, angularly concave at apex; lateral carinae elevated and foliaceous, converging anteriorly and ending at tip; median carina elevated and foliaceous. Anteclypeus foliaceous, median carina sharp and high. Compound eyes posteriorly elongate, median ocellus absent. Antennal pedicel large and elongate. Pronotum with central disc strongly elevated, anterior margin strongly protruded anteriorly, intermediate carinae nearly complete. Mesonotum with two additional intermediate carinae short forked from basal lateral margin. Hindwings with anal area large. Fore and middle femora narrow and elongate (not flattened and dilated), ventral margins with numerous small and acute spines; hind tibiae with six apical teeth.

Description. Head relatively narrow and elongate, central anterior margin of vertex distinctly projecting in front of eyes; width narrower than that of pronotum. Vertex as long as width; posterior surface on the same plane with anterior margin of pronotum; lateral carinae strongly ridged, foliaceous, and sub-parallel between eyes, linearly convergent forward in front of eyes, angularly convex at about 90° at apex; trigones large; posterior margin ridged and broadly angularly concave; disc inflated in middle, with a pair of big lateral bulges, median carina thin, ridged, and nearly complete. Frons flat and elongate; lateral carinae strongly elevated and foliaceous, nearly parallel, and slightly expanded outward below antennae; median carina sharply ridged. Fronto clypeal suture indistinct. Postclypeus cuneate, slightly convex medially, angularly concave at apex; lateral carinae elevated and foliaceous, converging anteriorly and ending at tip; median carina elevated and foliaceous. Anteclypeus foliaceous, without lateral carinae; median carina sharp and high. Lora distinctly sloped and visible in ventral view, dorsal margin carinated and oblique. Rostrum surpassing middle of hind femora; basal segment as long as distal one. Compound eyes large and posteriorly elongate, broadly emarginate below, without post ocular swelling. Ocelli relatively large. Antenna with pedicel elongate, with more than 25 distinct sensory plaque organs and many setae distributed over entire surface; flagellum long and setuliform.

Pronotum with a longitudinal lateral carina on each side; central disc strongly elevated, anterior margin strongly protruded anteriorly and arcuately convex, posterior margin arcuately concave, not notched; intermediate carinae distinct, nearly complete, and divergent posteriorly; median carina sharp and high. Mesonotum strongly arched, and tricarinate on disc; lateral carinae slightly incurved anteriorly in middle and straight forward; two additional intermediate carinae long and sharp.

Tegmen with common stem of ScP + R and MP as long as width of basal cell; stem ScP + R forked beyond basal half of tegmen, branch ScP + RA straight, terminal ScP + RA₁ slightly arcuate, branch RA₂ with two terminals, branch RP reaching margin with two terminals; stem MP forked near apical third and

distinctly posterior to CuA and ScP + R forkings, branches MP₁₊₂ and MP₃₊₄ forked side by side, branch MP₁₊₂ with two terminals and MP₃₊₄ three-branched terminally; stem CuA forked slightly basad of mid length, branch CuA₁ slightly curved medially in median portion then straight, branch CuA₂ straight in apical portion; CuP distally angulated bent to reach posterior margin at apex. Transverse veinlets sparse, $rp-mp_1$ and $mp_{3+4}-cua_1$ forming an incomplete nodal line with MP fork. Basal cell about 3 times as long as wide, elongately triangular. Pterostigmal area elongate and pigmented, without transverse veinlets. Cell C1 lanceolate, longer than cell C5. Cell C3 irregularly pentagonal, about $\frac{2}{3}$ rd of cell C1 length.

Hindwings with veins ScP + R and MP forming a short common stem at base and separating each other distinctly distally to basal cell; ScP + R bifurcating at level of wing-coupling lobe, RP two-branched distally; MP bifurcating MP₁₊₂ and MP₃₊₄ near apical third and distinctly posterior to CuA and ScP + R; CuA three-branched distally; CuP and Pcu unbranched, running close and parallel at their base, A₁ forks in A_{1a} and A_{1b} near middle, A₂ not visible if present. Transverse veinlet $mp_{3+4}-cua_{1a}$ slightly anterior to first bifurcation of MP.

Legs elongate, fore and middle femora narrow and long, not flattened and dilated, ventral margins with numerous small spines; hind tibiae with three (left) to four (right) lateral spines (the basal spine small) and six apical teeth (the outer tooth longest); hind tarsomeres I and II each with no more than eight apical teeth, internal teeth with platellae, lateral teeth without platellae.

Female genitalia with gonocoxae VIII with endogonocoxal lobe strongly developed, gonapophyses VIII hidden behind, not visible. Gonopods with lateral lobes large and sclerotized, with numerous long setae on ventral apical margin. Anal tube in dorsal view large, V-shaped, widening from base to apex, apex more or less projecting, ventral apical margin distinctly concave; anal style large and elongate, beyond the apical ventral margin of segment X.

Male unknown.

Yetkhata jangershii Song, Szwedó & Bourgoin, sp. nov.

LSID: urn:lsid:zoobank.org:act:D52BEEF7-B968-4352-A3A6-C25C15E97C72
(Figs. 3–6)

Diagnosis. Same as the genus as it is the only included species. In addition: tegmina with apical third including most pterostigmal area brown; two small spots along stem ScP + R and two bigger spots along MP, and a large fuscous streak between Pcu and A₁ in clavus

Description. Total length (from apex of head to tip of tegmina) about 7.8 mm; body length (excluding tegmina) about 6.3 mm; head length (from apex of cephalic process to posterior margin of eyes) 0.9 mm, width (including eyes): 1.1 mm; vertex length 0.5 mm, width 0.4 mm; eyes length 0.7 mm, width 0.3 mm; frons length 0.6 mm, width 0.4 mm; pronotum length in middle (from anterior margin to posterior margin) 0.4 mm, width 1.4 mm; mesonotum width 1.2 mm; tegmina length: 6.6 mm, width 2.1 mm

General colour dark brown. Head with vertex, frons, and clypeus dark brown, eyes dull ochraceous. Pronotum and mesonotum with carinae black. Tegmina membranous and hyaline, apical third including most pterostigmal area brown, numerous small patches along the veins, several large patches near basal third, and a large streak between Pcu and A₁ in clavus fuscous. Hindwings hyaline, without markings. Legs fuscous. Abdomen dorsally and ventrally black, posterior margins of pregenital segments pale ochraceous.

Head with eyes broad, narrower than width of pronotum. Vertex as long as width, trigones large. Frons broad, length a little longer



Fig. 3. *Yetkhata jiangershii* gen. et sp. nov., holotype (JSSNU-2018001), dorsal view.

than width (1.2:1). Tegmina elongate, slightly longer than abdomen, with ratio of length to width about 3.1:1.

Type material examined. Holotype. Female, a nearly complete specimen (No. JSSNU-2018001); the piece of amber containing the specimen was ground and polished to a $22.5 \times 16.2 \times 6.1$ mm cube (JSSNU). Reference FTIR curves JSSNU-2018001IR (Fig. 1A, B). The specimen is housed in the Zoological Collection, Jiangsu Second Normal University, Nanjing (JSSNU), which is available for study upon request the first author, Dr. Zhi-Shun Song (songzs@jssnu.edu.cn) from JSSNU.

Etymology. The specific epithet is derived from Chinese word “Jiangershishi”, a Chinese pronunciation of Jiangsu Second Normal University, Nanjing, China.

Type locality and stratigraphic horizon. Hukawng Valley, Kachin, Myanmar. Upper Cretaceous (lowermost Cenomanian).

Genus *Parwaina* Song, Szwedó & Bourgoin, gen. nov
LSID: [urn:lsid:zoobank.org:act:A5BD16DC-7498-4A09-8DF7-E1058354E0EF](https://zoobank.org/act:A5BD16DC-7498-4A09-8DF7-E1058354E0EF)

Type species: *Parwaina liuyei* Song, Szwedó et Bourgoin sp. nov., by monotypy and present designation

Etymology. The generic name is derived from the Burmese word parwain [□□□□□], meaning inclusion. Gender feminine.

Diagnosis. The genus can be distinguished by the following combination of characters: head short and broad, anterior margin slightly projecting in front of eyes; vertex with lateral carinae distinctly ridged and sub-parallel between eyes, anterior margin broadly angulately convex and posterior margin ridged and nearly straight, disc more or less flat with median carina distinct and nearly complete; frons flat, short, and broad, lateral carinae strongly elevated and foliaceous, nearly parallel, and slightly expanded outward below antennae, median carina sharply ridged; anteclypeus narrow and elongate; lora distinctly sloped and visible in ventral view; compound eyes very large and transversely

elongate, without postocular swelling; pronotum with intermediate carinae distinct in basal two thirds, median carina sharp and high; mesonotum with intermediate carinae short and indistinct; tegmina not deflexed, posterior margin at apical third slightly expanded, MP five-branched distally; fore and middle femora strongly flattened and dilated, ventral margin with numerous small and acute spines; hind tibiae with eight apical teeth; hind tarsomeres I and II each with six and eight apical teeth with platellae plus a pair of external ones larger.

Description. Head very short and broad, central anterior margin of vertex slightly projecting in front of eyes; width including eyes nearly as long as width of pronotum. Vertex wider than length, and basal width narrower than transverse diameter of eyes due to the latter being strongly elongate transversely; posterior surface on the same plane with anterior margin of pronotum; lateral carinae distinctly ridged and sub-parallel between eyes, a secondary carina bifurcating from subapex of lateral carinae, and joining to lateral carinae of frons forming triangular areolets (trigones); anterior margin broadly angulately convex and posterior margin ridged and nearly straight; disc more or less flat with median carina distinct and nearly complete. Frons flat, short, and broad; lateral carinae strongly elevated and foliaceous, nearly parallel, and slightly expanded outward below antennae; median carina sharply ridged. Frontoclypeal suture indistinct. Postclypeus cuneate, slightly convex medially, angularly concave at apex; lateral carinae elevated and foliaceous, converging anteriad and ending at tip; median carina elevated. Anteclypeus long lanceolate, without lateral carinae; median carina sharp and high. Lora strongly sloped and visible in ventral view, dorsal margin carinated and oblique. Rostrum long, surpassing middle of hind femora; basal segment as long as distal one. Compound eyes very large and transversely elongate, broadly emarginate below, without postocular swelling (callosity). Ocelli relatively large. Antenna with small scape; pedicel large and subglobose, with more than 15 distinct sensory plaque organs distributed over entire surface; flagellum setuliform.

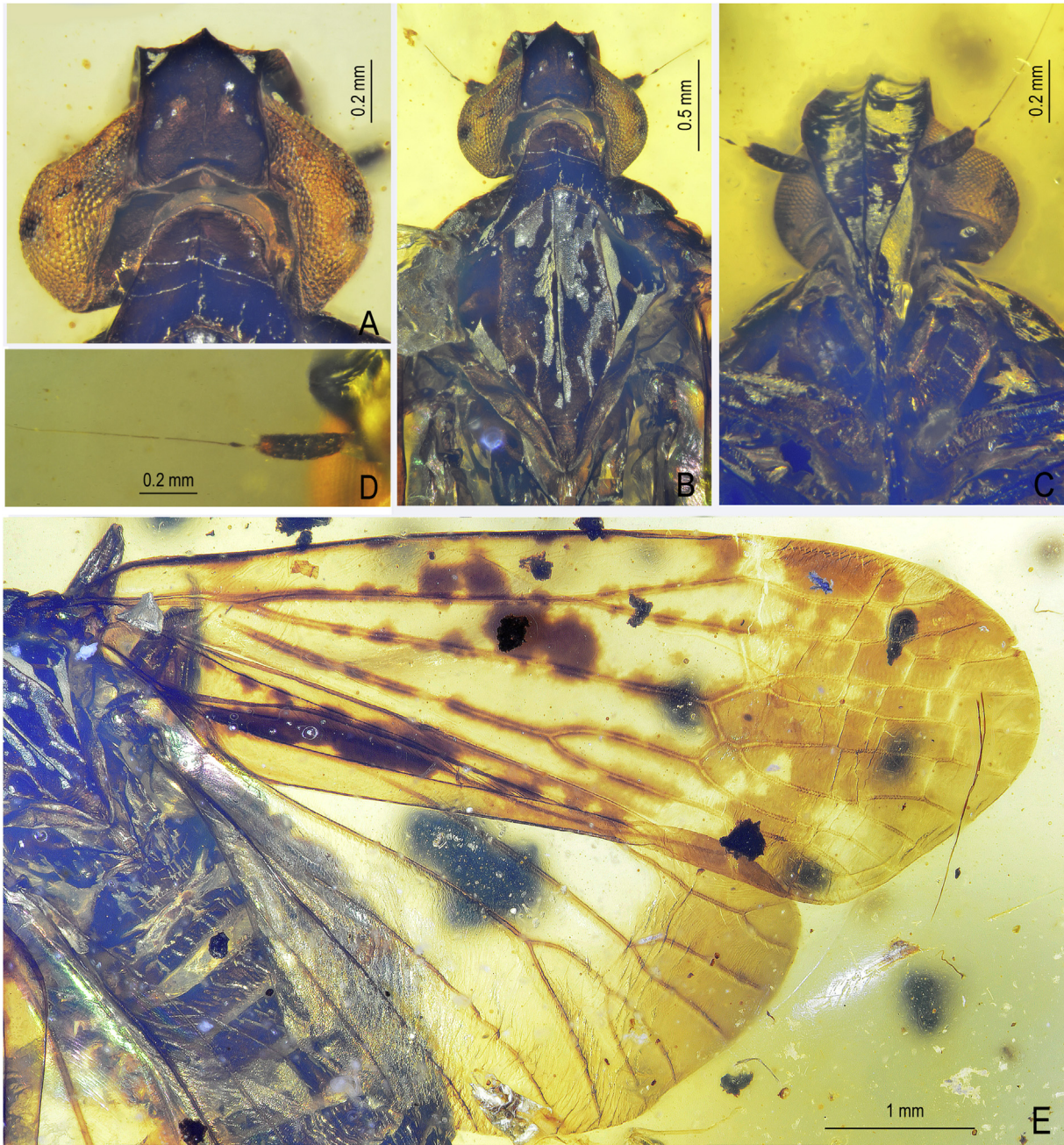


Fig. 4. *Yetkhata jiangershii* gen. et sp. nov., holotype (JSSNU-2018001). A, head, dorsal view; B, head, pronotum and mesonotum, dorsal view; C, head and pronotum, ventral view; D, antenna; E, right tegmen and hindwing.

Pronotum distinctly shorter than mesonotum medially, narrow anteriorly, divergent posteriorly; one longitudinal lateral carinae on each side between eyes and tegulae; anterior margin nearly straight and posterior margin arcuately concave, not notched; intermediate carinae distinct in basal two thirds, divergent posteriorly and slightly exceed the length of median carina; median carina sharp and high, without lateral pit; antero-lateral area lying behind eyes between intermediate carinae and lateral carinae distinctly excavated to accommodate posterior portion of eyes. Mesonotum strongly arched and tricarinate on disc; lateral carinae slightly incurved anteriorly toward median carina; two additional intermediate carinae short and indistinct, forked from basal lateral margin.

Tegmina membranous and hyaline, membrane flat; apices little overlapping at repose; costal margin slightly curved at base then

straight, anteroapical angle widely rounded, apex rounded and posterior margin straight, posteroapical angle widely angulate, and tornus (postclaval margin) straight; folding line (prolongation of claval furrow, claval plica) absent. Veins ScP + R and MP with a short common stem, as long as width of basal cell; stem ScP + R forked at basal half of tegmen, branch ScP + RA slightly arcuate, terminal ScP + RA₁ straight, branch RA₂ reaching margin with two terminals, branch RP reaching margin with three terminals; stem MP forked at the nodal level, near apical third of tegmen's length, and distinctly posterior to CuA and ScP + R forkings, branch MP₁₊₂ forked markedly apical of branch MP₃₊₄ forking, reaching margin with two terminals, branch MP₃₊₄ three-branched terminally; stem CuA forked slightly basad of half of tegmen's length, branch CuA₁ slightly curved mediad in median portion then straight, branch

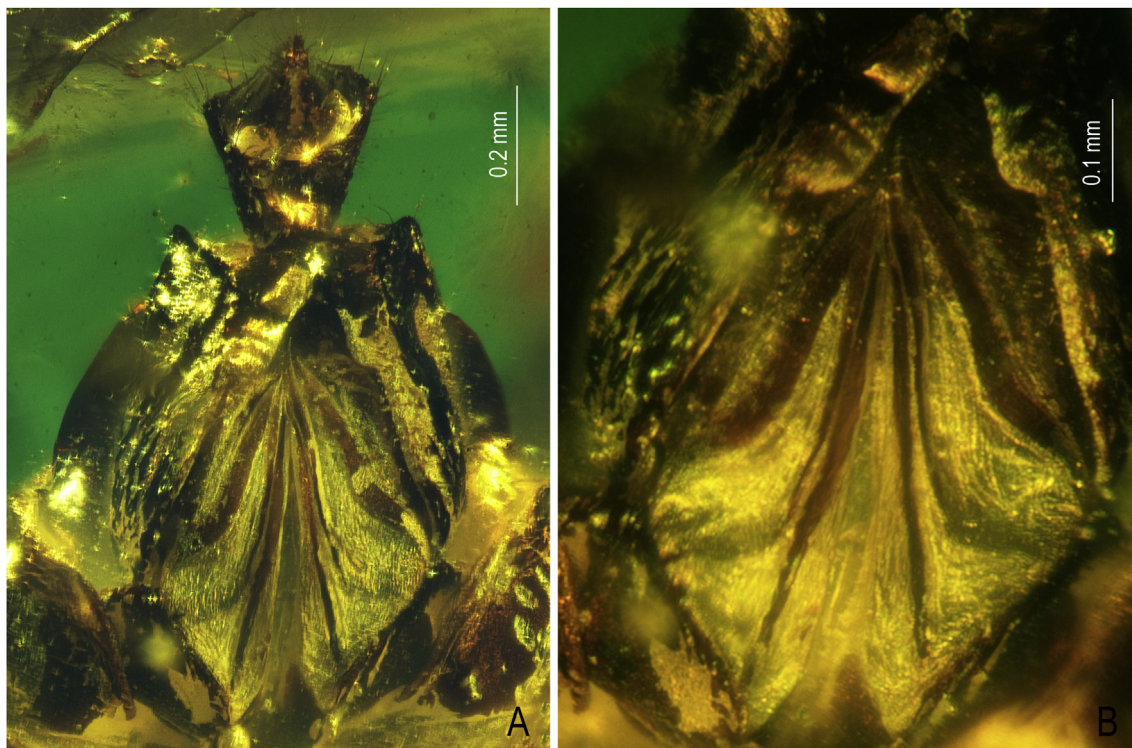


Fig. 5. *Yetkhata jiangershii* gen. et sp. nov., holotype (JSSNU-2018001). A, Tip of abdomen with female terminalia, ventral view; B, ovipositor, ventral view.

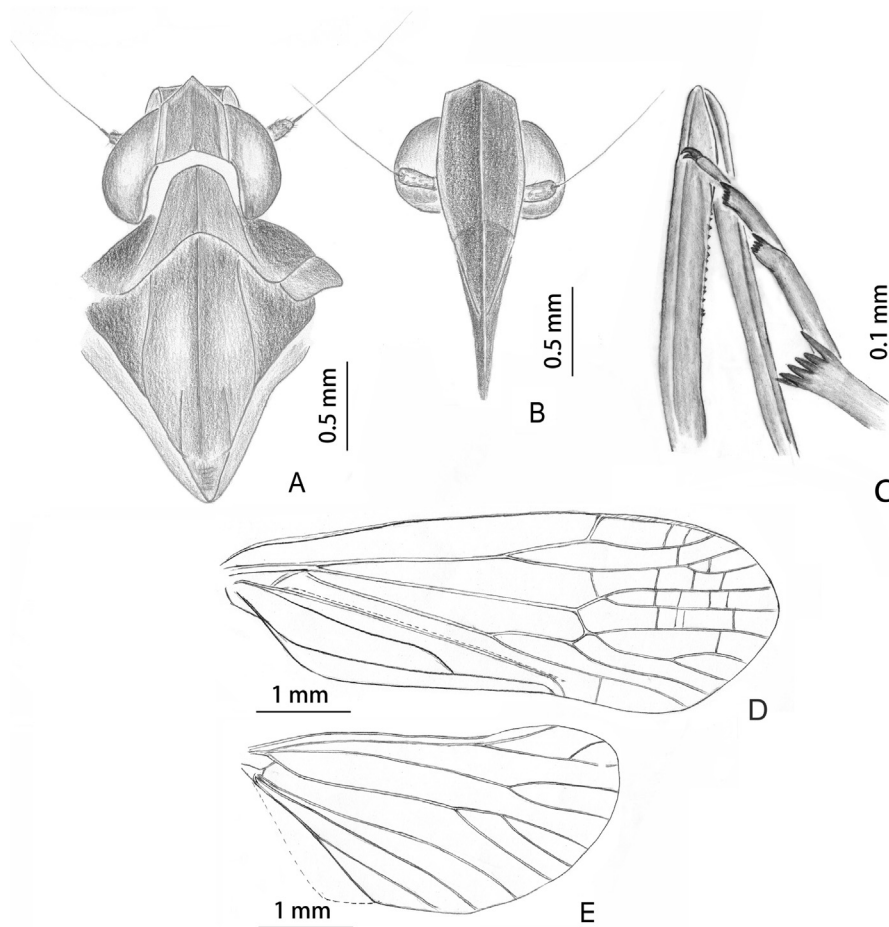


Fig. 6. *Yetkhata jiangershii* gen. et sp. nov., holotype (JSSNU-2018001). A, anterior portion of body, dorsal view; B, face, C, profemur, tip of metatibia and metatarsus; D, right tegmen. E, right hindwing.

CuA₂ straight in apical portion; CuP distally angulated bent to reach posterior margin at apex. Claval suture prolonged on membrane almost to *icu* veinlet level. Clavus closed, claval veins Pcu and A₁ connected to form stem Pcu + A₁ near middle of clavus, Pcu + A₁ reaching margin (A₂) slightly basad of claval apex. Transverse veinlets sparse, *rp–mp*₁ and *mp*₃₊₄–*cua*₁ forming an incomplete nodal line with MP fork. Basal cell about 4 times as long as wide, elongately triangular. Pterostigmal area elongate and pigmented, without veinlets. Cell C1 lanceolate, longer than cell C5. Cell C3 irregularly hexagonal, distinctly shorter than cell C1.

Hindwings hyaline, without folding line. Veins ScP + R and MP forming a short common stem at base and separating each other distinctly distally to basal cell; ScP + R bifurcating at level of wing-coupling lobe, RP two-branched distally; MP bifurcating MP₁₊₂ and MP₃₊₄ near apical third and distinctly posterior to CuA and ScP + R; CuA three-branched distally; CuP and Pcu unbranched, running close and parallel at their base, A₁ forks in A_{1a} and A_{1b} near middle, A₂ not visible if present. Transverse veinlets *rp–mp*₁₊₂ and *mp*₃₊₄–*cua*_{1a} slightly posterior to first bifurcation of MP.

Legs moderately elongate, fore and middle femora strongly flattened and dilated, ventral margin with numerous small and acute spines; hind tibiae with three lateral spines (the basal spine small) and eight apical teeth (the outer tooth longest); hind tarsomeres I and II each with eight and ten apical teeth, lateral apical teeth without platellae, and internal teeth with long platellae.

Female terminalia with strong endogonocoxal processes and gonapophyses VIII difficult to observe behind it. Gonapophyses IX not visible. Gonopods with lateral lobes much larger, sclerotized, with numerous long setae on external apical margin. A least a pair of longer dorsal setae. Anal tube in dorsal view small, V-shaped, widening from base to apex, apex more or less projecting, ventral

apical margin slightly concave; anal style large and elongate, beyond the apical ventral margin of segment X.

Male unknown.

Remarks. The new genus may be separated from *Yetkhata* gen. nov. by the vertex wider at base than long at base, the subglobose pedicel, the flattened and dilated fore and middle femora, the fore femora with row of small teeth ventrally, and the hind tibiae with eight apical teeth

Parwaina liuyei Song, Szwedo & Bourgoin, sp. nov

LSID: urn:lsid:zoobank.org:act:20F5AFF5-ED06-4335-BD39-D91F0C920B22

(Figs. 7–10)

Diagnosis. Same as the genus as it is the only included species. In addition: apical portion of tegmina smoky and lighter veins; an elongate irregular brown spot on clavus, two spots in in costal cell, two smaller spots on C2, brown spot on C4, these spots arranged in line; small irregular brownish patches along veins.

Description. Total length (from apex of head to tip of tegmina) about 7.4 mm; body length (excluding tegmina) about 5.6 mm; head length (from apex of cephalic process to posterior margin of eyes) 0.8 mm, width (including eyes): 1.5 mm; vertex length 0.3 mm, width 0.6 mm; eyes length 0.7 mm, width 0.4 mm; frons length 0.7 mm, width 0.8 mm; pronotum length in middle (from anterior margin to posterior margin) 0.3 mm, width 1.6 mm; mesonotum width 1.3 mm; tegmina length: 5.8 mm, width 2.3 mm.

General colour brownish. Head with vertex, frons, and clypeus dark brown, eyes dull ochraceous. Pronotum and mesonotum with carinae dark brown. Tegmina with apical third brownish, most



Fig. 7. A, B, *Parwaina liuyei* gen. et sp. nov., holotype (IZCAS-2018001), dorsal (A) and ventral (B) views.

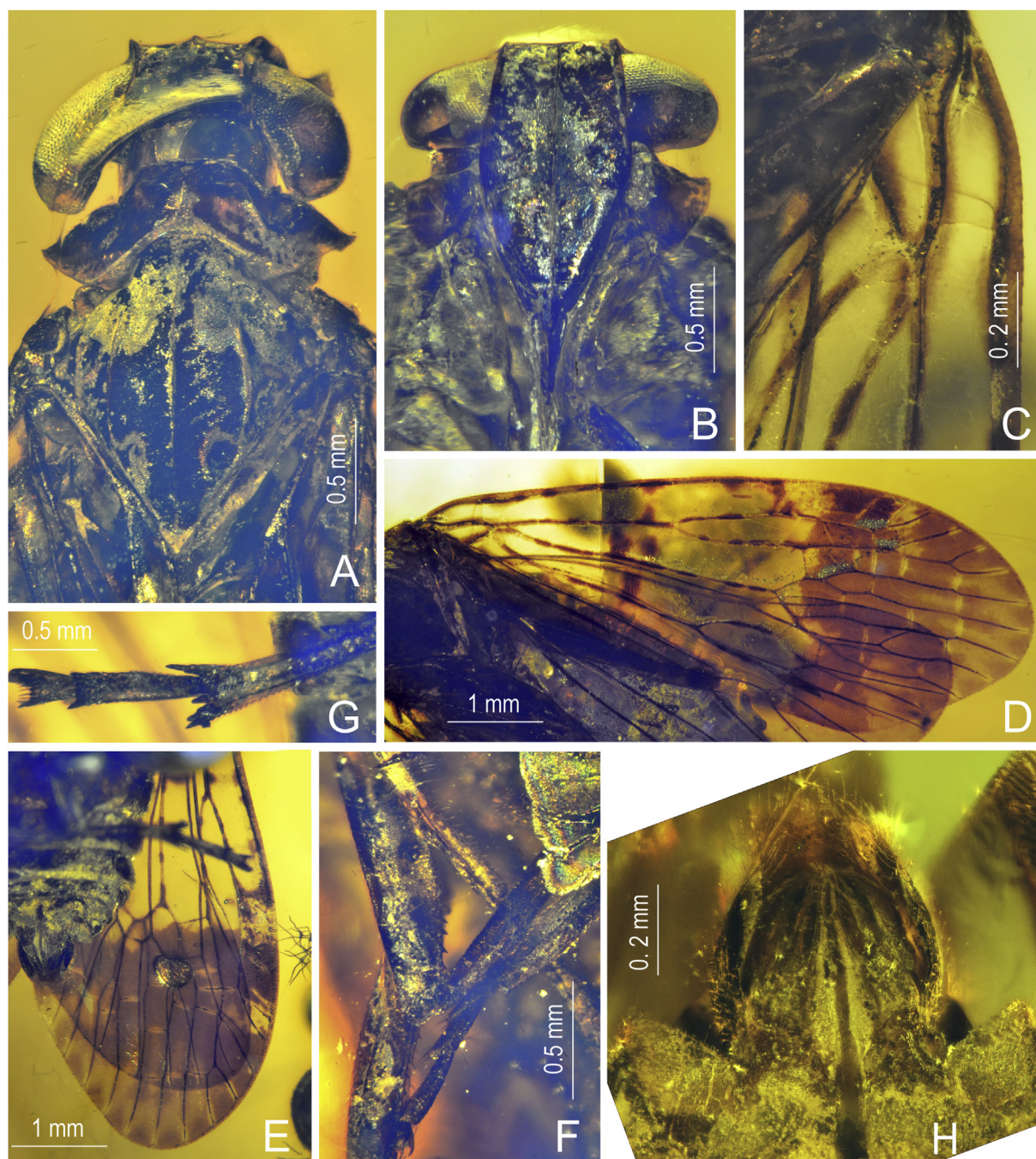


Fig. 8. *Parwaina liuyei* gen. et sp. nov., holotype (IZCAS-2018001). A, head, pronotum and mesonotum, dorsal view; B, head, ventral view; C, base of left tegmen, ventral view; D, right tegmen; E, apical portion of left hindwing; F, rostrum, profemur and protibia; G, metatibia with apical teeth and metatibial tarsomeres I and II; H, female terminalia.

pterostigmal area, numerous small patches along the veins, several large patches near third, and a large streak in clavus fuscous. Hindwings hyaline, without markings. Legs fuscous. Abdomen dorsally and ventrally dark brown, posterior margins of pregenital segments pale ochraceous.

Head with compound eyes very broad, nearly as wide as width of pronotum. Width of vertex at base nearly twice as long mid line; trigones distinct. Posterior margin of vertex deeply protruded anteriorly, to the level of half of compound eyes length. Frons broad, width a little longer than length (1.1:1). Tegmina much longer than abdomen, with ratio of length to width about 2.5:1.

Type material examined. Holotype. Female, a nearly complete specimen (No. IZCAS-2018001); the piece of amber containing the specimen was ground and polished to a $19.8 \times 18.2 \times 5.3$ mm ovoid cabochon. Reference FTIR curves IZCAS-2018001IR (Fig. 2A, B), compared with those published in Kosmowska-Ceranowicz (2015) and with IAA database. The specimen is currently housed in the Zoological Collection, JSSNU, and will eventually be deposited in Institute of Zoology Chinese Academy of Sciences, Beijing (IZCAS), when it can be available for study upon request to current owner, Mr. Ye Liu (liuyue198282@126.com) from IZCAS, or the first author, Dr. Zhi-Shun Song (songzs@jssnu.edu.cn) from JSSNU.

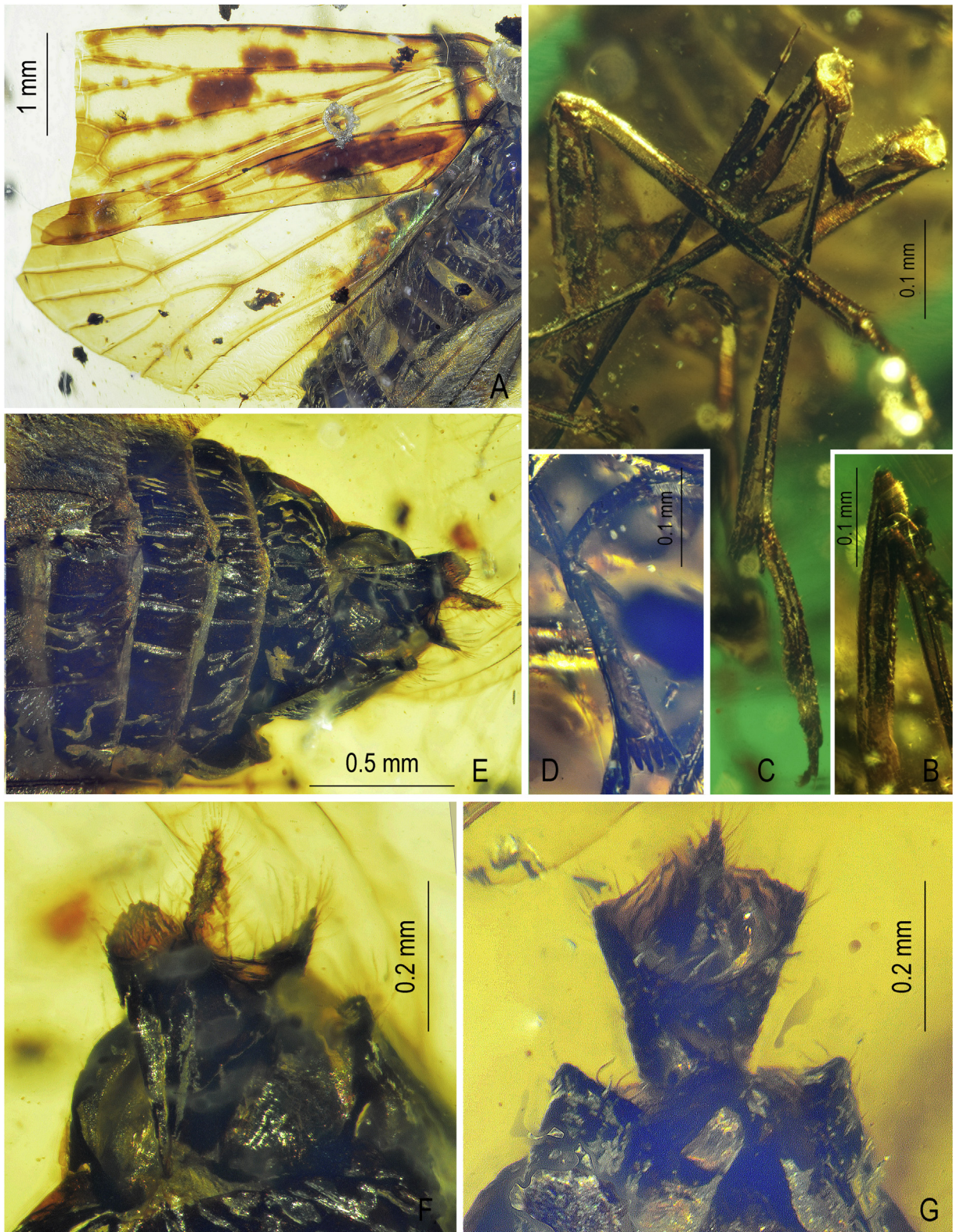


Fig. 9. *Parwaina liuyei* gen. et sp. nov., holotype (IZCAS-2018001). A, Left tegmen and hindwing; B, Forefemur and foretibia; C, Hind leg; D, Apex of hind tibia; E, Apical portion of abdomen, dorsal view; F, Anal tube, dorsal view; G, anal tube, ventral view.

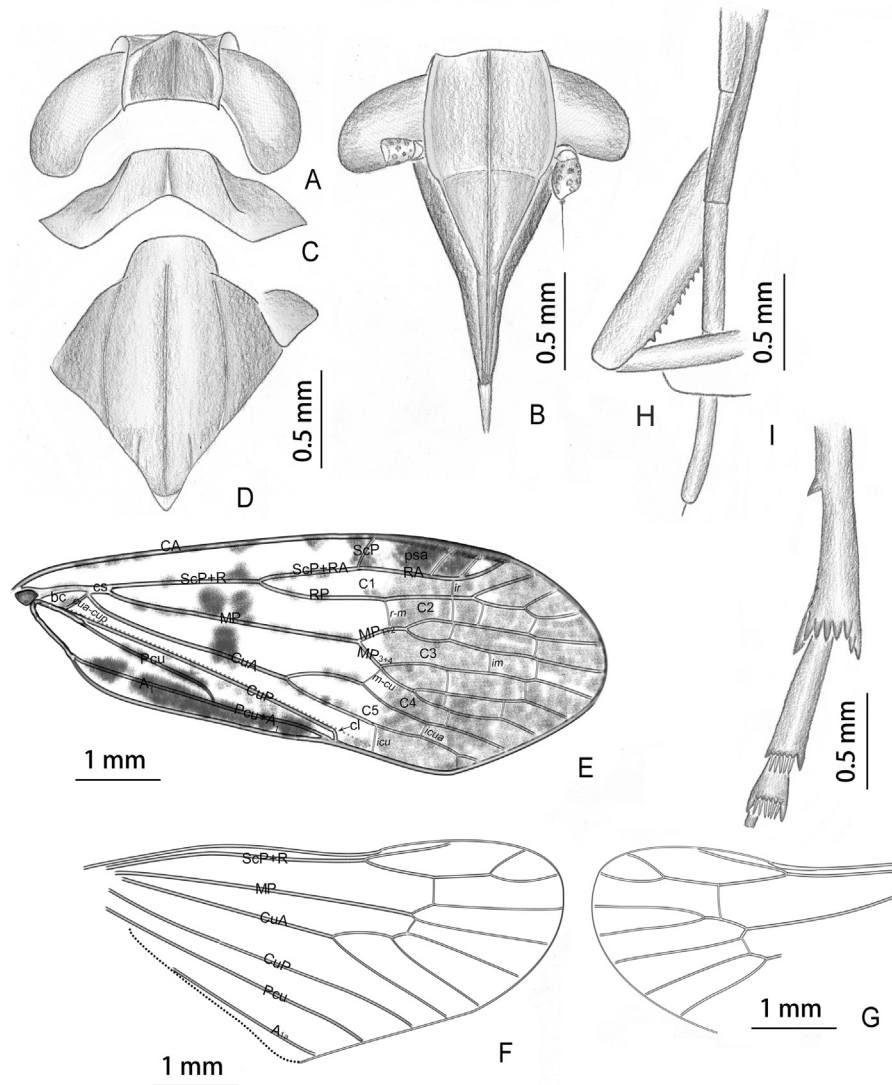


Fig. 10. *Parwaina liuyei* gen. et sp. nov., holotype (IZCAS-2018001). A, head; B, face; C, pronotum; D, mesonotum; E, right tegmen; F, right hindwing; G, apex of left hindwing; H, profemur and rostrum; I, metatibia with apical teeth and metatarsomeres I and II.

Etymology. The new species is named after Mr. Ye Liu, an entomologist and a good insect collector in China, who kindly offered the specimen for examination and to the scientific collection of IZCAS.

Type locality and stratigraphic horizon. Hukawng Valley, Kachin, Myanmar. Upper Cretaceous (lowermost Cenomanian).

4. Discussion

This new family exhibits interesting character states. The presence of the trigones is already known in several other planthopper families (Song et al., 2018), but their presence linked to foliated lateral margins of the frons remains exceptional, if even not unique. The disc of the pronotum is produced anteriorly as in many achilids. The tegminal venation is noticeable by the late forking of MP at the nodal level as in many Cixiidae (Emeljanov, 2015), Achilidae and in Dictyopharidae *Protachilus*, and by the unusual triangular and elongated basal cell – which remains, however, short as in any Fulgoromorpha (Shcherbakov, 1996) – which appears distally pointed to support the short common ScP + R + MP stem while CuA leaves the basal cell much proximally. The pterostigmal area is

slightly darker, but with no transverse veinlets, and with ambient vein slightly enlarged at its level. The clavus is distinctly closed, while claval fold (plica clavalis) indistinctly continues into the membrane as in Cixiidae (Andini for instance, Emeljanov, 2015); such prolongation of claval fold on membrane is very distinct in most of Achilidae, reaching to *icu* veinlet (Shcherbakov, 1981). The ovipositor is of fulgoroid type, with endogonocoxal lobe particularly well developed and robust. Interestingly the two new genera exhibit a similar pattern of colouration of forewings.

With more than 300 families described, Hemiptera represent by far the most diversified lineage among all insects orders (over 200 families in the megadiverse Coleoptera) (Bouchard et al., 2011; Szweo, 2018). The high morphological disparity that hemipteran lineages exhibit explains this figure which is probably linked with their successful co-evolution with plants (Li et al., 2017; Szweo, 2018). Yetkhatidae fam. nov. is yet another example of the great diversity of the planthopper lineages.

However, it also reflects the weakness of our understanding of the phylogeny of the group, a topic that remains almost untouched in planthoppers despite few molecular attempts (Bourgoin and Campbell, 2002; Urban and Cryan, 2007; Song and Liang, 2013),

which one remain difficult to associate with reliable comparative morphology framework. Indeed, by its general conformation, Yetkhatidae fam. nov. looks as a lineage intermediate between the Achilidae–Derbidae and Fulgoridae–Dictyopharidae ones. If separating Yetkhatidae fam. nov. as a lineage is supported by its unique combination of characters including possible autapomorphies (triangular distally pointed basal cell, closed clavus with achilid-like prolongation of claval fold) no synapomorphy were found allowing linking it with any other family. Further and deeper morphological investigations at the higher levels of the planthopper classification are strongly needed, particularly with exploring systematically new sets of characters. Such studies will give us the opportunity to analyse together fossil and extant taxa, while new molecular phylogenies, with a better and more accurate sampling, will allow us to better structure the phylogenetic framework of these needed researches.

5. Conclusions

A new family Yetkhatidae fam. nov. with two new genera and species from mid-Cretaceous amber of Myanmar is another example of the great diversity of the planthopper lineages. The taxa comprised within the family present unique combination of characters observed also among various planthopper families with autapomorphies. Yetkhatidae fam. nov. looks as a lineage intermediate between the Achilidae–Derbidae and Fulgoridae–Dictyopharidae ones. Fossils, like Yetkhatidae fam. nov. point the need of further and deeper morphological investigations at the higher levels of the planthopper classification, to better structure the phylogenetic investigations of fossil and extant taxa.

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