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Short communication

New sinoalids in mid-Cretaceous amber from northern Myanmar (Insecta: Hemiptera: Cercopoidea)

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ABSTRACT

Here we describe two new genera and two new species of the extinct froghopper family Sinoalidae, *Paraornatiala daidaleos* gen. et sp. nov., and *Ctetosinoala tetraspina* gen. et sp. nov., from the mid-Cretaceous amber of Myanmar. *Cretosinoala* resembles *Sinoala* from the Middle–Upper Jurassic (ca. 165 Ma) Daohugou beds (Yanliao biota, China) based on its wing venation. *Paraornatiala* shares several characters with *Ornatiala* and *Jiaotouia* but provides two peculiar features that are unknown in Sinoalidae: apex of metafemur armed with a distal spine, and vein RA of tegmen single-branched. Additionally, our discovery increases the documented palaeodiversity of sinoalids, confirming the high morphological disparity of Sinoalidae in mid-Cretaceous.

1. Introduction

Burmese amber harbors probably the most diverse Mesozoic palaeobiota and its inclusions have been studied for more than a century. Insects known from Burmese amber are abundant and highly diverse, and the number of species has risen exponentially over the past two decades (Ross, 2019). Recently, a few species of the cicadomorphan families, such as Cicadellidae, Tettigarctidae, and an extinct family of Cercopoidea (Sinoalidae) have been reported from the Burmese amber (Chen et al., 2018; Poinar and Brown, 2018; Fu et al., 2019; Chen et al., 2019a,b,c; Wang et al., 2019).

Cercopoidea Leach, 1815, known as froghoppers (adults) or spittlebugs (nymphs), is the second largest superfamily in the Cicadomorpha, comprising over 2600 described recent species (Dietrich, 2002; Bartlett et al., 2018; Paladini et al., 2018). Cercopoidea includes five extant families (i.e., Cercopidae, Aphrophoridae, Clastopteridae, Machaerotidae and Epipygidae) and three extinct families (i.e., Procercopidae, Cercopionidae, and Sinoalidae) have been reported from the Mesozoic (Shcherbakov and Popov, 2002; Wang et al., 2012; Szwedo, 2018).

Sinoalidae, one of the early representative of Cercopoidea, originally established from the Middle–Upper Jurassic Daohugou beds, Inner Mongolia, northern China, differs distinctly from other cercopoid families mainly in the tegmen having only the costal area and clavus covered with punctures, hind wing lacking peripheric membrane and the metatibia bearing two rows of spines (Wang et al., 2012). Up to now, 13 genera and 17 species have been attributed to Sinoalidae, occurring in the Middle–Upper Jurassic of China and the mid-Cretaceous Burmese amber. Among them, 13 species attributed to 9 genera have been described from the Jiulongshan Formation (= Longmen Formation) and the Haifanggou Formation of China (Hong, 1983; Wang et al., 2012; Chen et al., 2017; Fu et al., 2017; Fu and Huang, 2018, 2019). Additionally, 4 genera and 4 species have been recently described from the mid-Cretaceous amber, northern Myanmar. They include *Fangyuania xiai* Chen et al. (2018), *Mesodorus orientalis* Chen et al. (2019a), *Ornatiala amoena* Chen et al. (2019b), and *Jiaotouia minuta* Chen et al. (2019c). Meanwhile, the phylogenetic relationship within Sinoalidae was proposed by Chen et al. (2019a,b,c), using a Bayesian analysis based on 34 morphological characters.

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Herein we describe and illustrate the fourth and fifth sinoalids froghopper, *Paraornatiala daidaleos* gen. et sp. nov., and *Cretosinoala tetraspina* gen. et sp. nov., from Burmese amber.

2. Material and methods

Two new genera and two new species are described based on two well-preserved adults. Both specimens are preserved in clear yellowish ambers, displaying many fine details, including antenna, ocelli, tibia, and tarsus. They are derived from amber deposits in the Hukawng Valley of Kachin in northern Myanmar (Yin et al., 2018: Fig. 1A). The age of the Burmese amber was generally assigned to be around the Albian–Cenomanian boundary (Cruickshank and Ko, 2003; Ross et al., 2010; Shi et al., 2012; Rasnitsyn et al., 2016; Smith and Ross, 2018; Mao et al., 2018).

Amber pieces used for photomicrography were cut using a handheld engraving tool, and polished using emery papers of different grain sizes and rare earth polishing powder, as described in detail in Azar et al. (2003) and Sidorchuk and Vorontsov (2018). Observations and photographs were made using a Zeiss Discovery V16 stereoscope; photomicrographs with colored background (Fig. 3) are taken using a confocal laser scanning microscopy (CLSM) Zeiss LSM 710 with 10 objectives and using a laser at 488 nm (Cai and Huang, 2014); photomicrographs confocal images were made using Helicon Focus 6 software; line drawings were drafted with CorelDRAW X7 graphic software and optimized using Photoshop CS6. The material studied here is deposited at the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China.

Wing venation terminology and cell nomenclature followed Nel et al. (2012) and Bourgoin et al. (2015). All measurements were presented in millimeters. The nomenclatural acts established herein are registered under Zoo-Bank LSID urn:lsid:zoobank.org:pub:02580F8B-2862-4994-99D0-13DDA9BC9738.

3. Systematic palaeontology

Order: Hemiptera Linnaeus, 1758
Suborder: Cicadomorpha Evans, 1946
Superfamily: Cercopoidea Leach, 1815
Family: Sinoalidae Wang and Szwedo, 2012

Genus: ***Paraornatiala*** gen. nov.
Type species: *Paraornatiala daidaleos* gen. et sp. nov.; by original designation and monotype.

Etymology. The generic name is prefixed *para-* indicating that the new genus is the overall similarity to *Ornatiala* (a genus described from the Myanmar amber) in the characters of forewing. Gender: feminine. The genus is registered under LSID urn:lsid:zoobank.org:act:8F96BB4F-3575-45EA-B3A1-D59E282626D8.
Diagnosis. The genus is characterized by the following combination of characters: head triangular, wider than longer; antennae filiform, flagellum bearing 4 segments; anteclypeus with a median longitudinal carina; apex of metafemur armed with a distal conical

Fig. 1. Photographs of *Paraornatiala daidaleos* gen. et sp. nov., holotype (NIGP170165), from the mid-Cretaceous Burmese amber. A. dorsal view; B. ventral view. Scale bars: 1 mm.

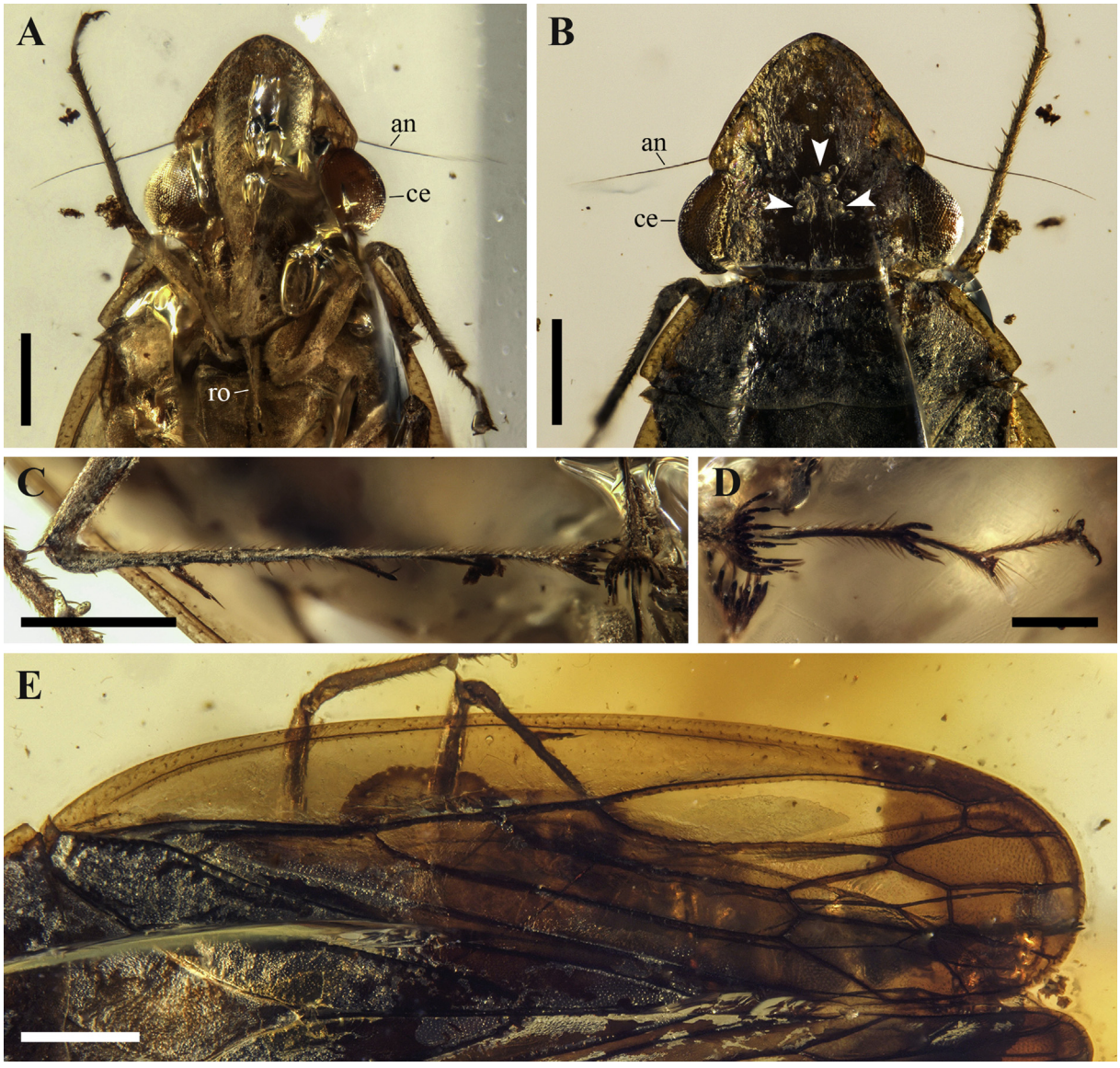

Fig. 2. Enlargements of holotype (NIGP170165) of *Paraornatiala daidaleos* gen. et sp. nov. A. showing details of compound eyes, clypeus, antenna and rostrum; B. showing details of head structure with three ocelli (white arrows) and pronotum; C. showing details of metatibia; D. showing details of metatarsus and claw; E. showing details of forewing. Scale bars: 500 μm in A–C, E; 200 μm in D.

spine; Pc+CP extremely long; stem ScP+R+MP+CuA branching into ScP+R+MP and CuA leaving basal cell; RA single-branched; MP branching into MP_{1+2} and MP_{3+4} nearly as level of bifurcation of CuA; and MP_{3+4} connecting CuA_1 by fusing into a common stalk.

Comparison. Paraornatiala resembles *Ornatiala* Chen, Wang and Zhang (2019a), 2019b, 2019c and *Jiaotouia* Chen and Wang, 2019 from the Burmese amber by some distinct body structures and wing venation. However, it differs distinctly from other known genera in Sinoalidae by: 1) apex of metafemur armed with a distal conical spine instead of it is absent in other genera; 2) vein RA of tegmen single-branched instead of RA with 2–4 branches in other genera. Additionally, *Paraornatiala* still differs from *Ornatiala* as follow: 1) head wider than longer (head slightly longer than wider in *Ornatiala*); 2) pronotum relatively short, length/width ratio about 0.35 (pronotum with length/width ratio about 0.6 in *Ornatiala*); 3) Pc+CP extremely long, extending to anterior cubital area as ambient vein (Pc+CP just extending to termination of $ScP+RA_1$ in *Ornatiala*); 4) MP branching into MP_{1+2} and MP_{3+4} nearly as level of bifurcation of CuA (MP branching basal of bifurcation of CuA in *Ornatiala*); 5) crossvein mp-cua absent (mp-cua present in *Ornatiala*).

Paraornatiala differs from *Jiaotouia* as follow: 1) flagellum with only 4 segments (flagellum with at least 7 segments in *Jiaotouia*); 2) tegmen dotted with distinct colour pattern (tegmina ornaments absent in *Jiaotouia*); 3) stem ScP+R+MP+CuA branching into ScP+R+MP and CuA leaving basal cell (ScP+R+MP+CuA branching into ScP+R and MP+CuA leaving basal cell in *Jiaotouia*); 4) MP branching into MP_{1+2} and MP_{3+4} nearly as level of bifurcation of CuA (MP branching distinctly after bifurcation of CuA in *Jiaotouia*).

Paraornatiala daidaleos sp. nov.

Figs. 1–4

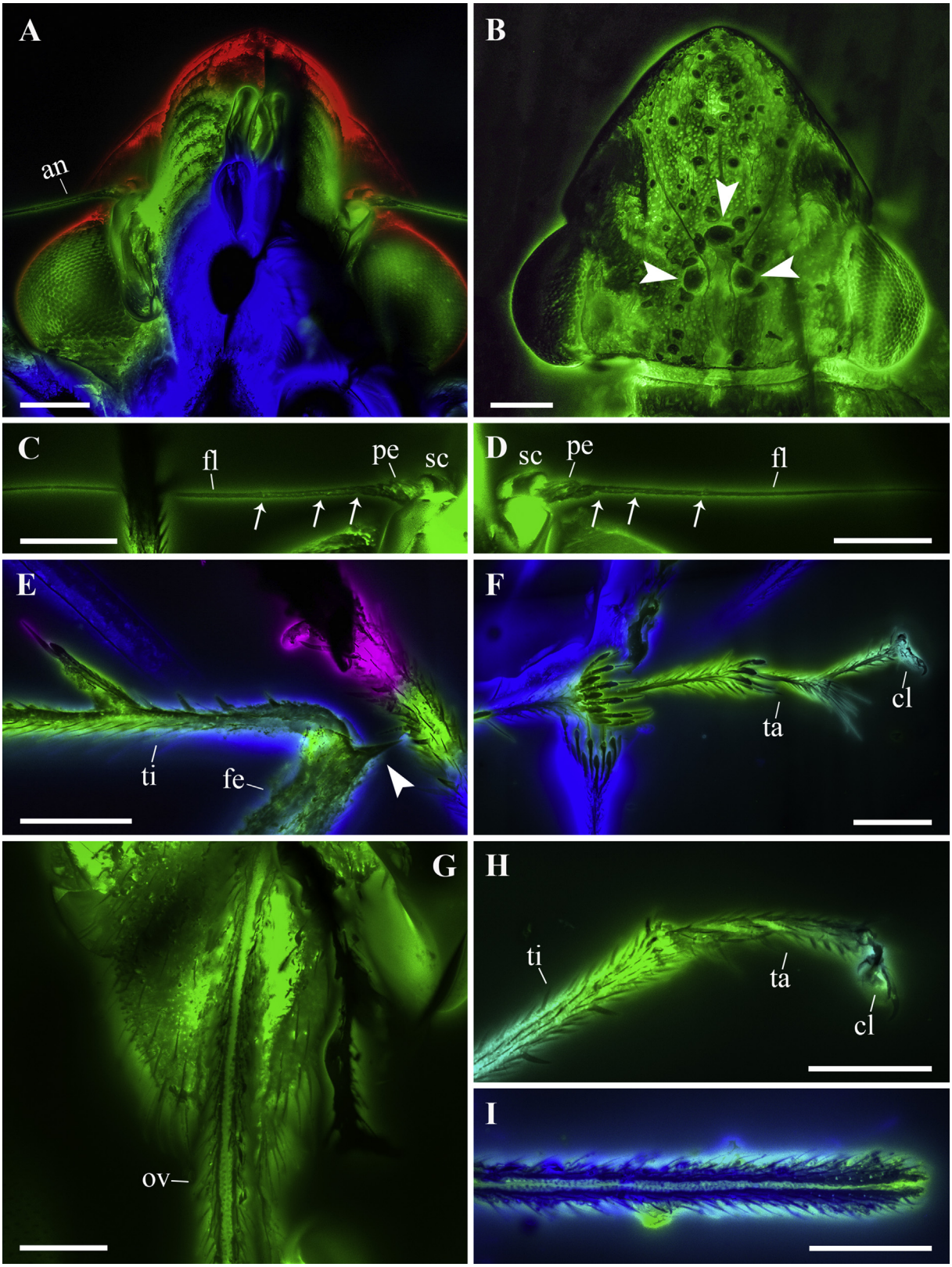

Fig. 3. Microphotographs of *Paraornatiala daidaleos* gen. et sp. nov., under confocal laser scanning microscopy. A. showing details of compound eyes, clypeus and antenna; B. showing details of head structure with three ocelli (white arrows); C. showing left antenna; D. showing right antenna; E. showing details of spine on metatibia and apex of metafemur; F. showing details of metatarsus and claw; G. showing details of tergite VIII and IX; H. showing details of protarsus and claw with arolium; I. showing details of ovipositor. Scale bars: 0.2 mm.

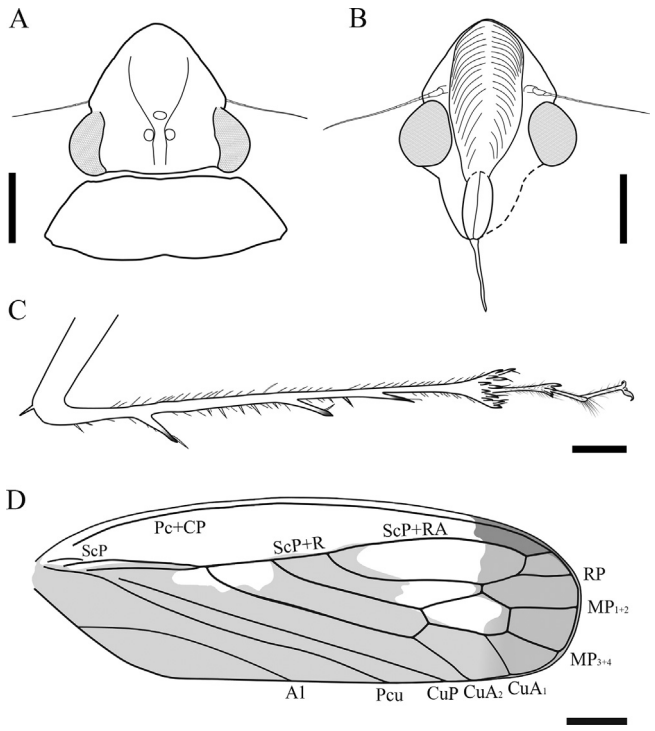

Fig. 4. Line drawing of *Paraornatiala daidaleos* gen. et sp. nov. A. head and pronotum in dorsal view; B. head in ventral view; C. hind legs; D. tegmen. Scale bars: 0.5 mm in A, B, D; 200 μm in C.

Etymology. The specific epithet derives from the Greek, *daidaleos*, meaning, "spotted" or "dappled", and is a generalized reference to the patterning of the tegmina. The species is registered under LSID urn:lsid:zoobank.org:act:D0346767-5D02-4E5D-A75A-FED10A86367A.

Holotype. NIGP170165, well-preserved adult female; 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. As for the genus (*vide supra*) with some additional characters: tegmen dotted with distinct colour pattern, stained on the lower median section and apical 1/4th area; crossvein rp-mp extremely short.

Description. Total length (including wings in repose) about 6.4 mm, body with small round punctures (Fig. 1).

Head. (Figs. 2A, B, 3A, B, 4A, B). Head with tiny granular punctures; length about 1.13 mm, width about 1.32 mm; crown produced anteriorly, anterior margin acutely angled in middle; compound eyes ovoid; three ocelli on crown, median ocellus oval, lateral ocelli nearly globular; ecdysial suture convex; antenna (Figs. 3C, D) about 1.02 mm long, scape large but short, much thicker than pedicel, flagellum filiform, with 4 segments visible, flagellomeres I–IV becoming progressively thinner, flagellomere I very short, thinner than pedicel but much thicker than flagellomere II, flagellomere II nearly as long as flagellomere III and almost twice longer than flagellomere I; postclypeus bulging (Fig. 4B), about 1.02 mm long and 0.53 mm wide, with transverse grooves; anteclypeus triangularly elongate, with a median longitudinal carina (Fig. 4B); rostrum relatively short, not extending to mesocoxae.

Thorax. Pronotum (Fig. 4A) about 1.35 times as wide as head, with length/width ratio about 0.35, widest at lateral angle; anterior margin nearly straight; lateral angles obtuse; posterior margin sinuous, concave medially. Mesonotum narrower than pronotum, mesoscutellum triangular. Legs covered with setae, especially tibia. Prothoracic leg with procoxae enlarged; profemur about 0.81 mm long and 0.18 mm wide; protibia nearly as long as profemur; protarsus (Fig. 3H) about 0.34 mm long. Mesothoracic leg with mesocoxae about 0.35 mm wide; mesotrochanter cylindrical in shape, about 0.24 mm long and 0.17 mm wide; mesofemur nearly 1.4 times as long as profemur; mesotibia slightly longer than mesofemur. Metathoracic leg with metacoxae robust, metafemur slightly shorter than mesofemur, apex of mesofemur armed with a conical spine (Figs. 3E, 4C); metatibia (Figs. 2C, 4C) slender, nearly 1.7 times as long as mesotibia and 1.9 times as long as metafemur, armed with two rows of three piliferous spines (Figs. 3E, 4C), one and two in number for each row, widened apically, armed with two rows of apical teeth, teeth of apical row with long setae; metatarsus (Figs. 2D, 3F, 4C) about 0.78 mm long, covered with densely setae, basitarsomere much longer than mid- and apical tarsomeres, basitarsomere armed with one row apical teeth with long setae at apex; tarsal claws robust (Figs. 2D, 3F), sharp apically; arolium present.

Tegmen. (Figs. 2E, 4D). Length about 4.6 mm, width about 1.5 mm, with length/width ratio about 3.0; surface with colour pattern stained on the lower median section and apical 1/4th area, with apex of radial area between costal margin and RA much darker; clavus and longitudinal veins covered with regular granules; costal margin smoothly arched at base; apical margin rounded; posterior margin nearly straight; postcostal cell extending to termination of RA; basal cell long and narrow with apex sharp, nearly 0.28 of tegmen length; Pc+CP thickened, extending to anterior cubital area as ambient vein; ScP short, fusing with stem ScP+R+MP+CuA at 1/4th of basal cell length; stem ScP+R+MP+CuA branching into ScP+R+MP and CuA reaching 0.32 of tegmen length; ScP+R+MP branching into ScP+R and MP reaching 0.44 of tegmen length; ScP+R straight and short, branching into ScP+RA and RP slightly beyond mid-wing length; ScP+RA slightly curved, about 3.4 times as long as ScP+R; RP single-branched, curved anteriorly, connecting RA_1 by crossvein ir; MP with 2 branches, branching into MP_{1+2} and MP_{3+4} nearly as level of bifurcation of CuA; crossvein im about 3.2 times as long as rp-mp; MP_{3+4} connecting CuA_1 by fusing into a common portion; CuA curved anteriorly, and then nearly straight, branching into CuA_1 and CuA_2 reaching 0.71 of tegmen length; CuP nearly straight, Pcu slightly sinuous, sub-parallel to CuP; A1 strongly curved, relatively long.

Abdomen. Abdomen flat, segment II broadest, nearly as wide as pronotum, segments II to VIII becoming progressively narrower; tergite VIII and IX with densely setae (Fig. 3G); ovipositor setiferous (Fig. 3I), about 1.38 mm long, reaching level of tips of tegmina.

Genus: ***Cretosinoala*** gen. nov.

Type species: *Cretosinoala tetraspina* gen. et sp. nov.; by original designation and monotype.

Etymology. The genus name is composed of the prefix *Creto-* derived from the Cretaceous and "*Sinoala*", the type genus of the Sinoalidae. Gender: feminine. The genus is registered under LSID urn:lsid:-zoobank.org:act:600E0C42-81A6-4874-A254-D2F27B5D4497.

Diagnosis. The genus is characterized by the following combination of characters: head slightly longer than wide; crown extremely extended; metatibia armed with 4 lateral spines; basal cell reduced, nearly 1/7th of wing length; postcostal cell extremely narrow, the widest part as wide as cell C1; and ScP+RA distinctly curved, more than 7 times longer than ScP+R.

Comparison. *Cretosinoala* differs distinctly from other known genera in Sinoalidae by metatibia armed with 4 lateral spines (metatibia armed with 3 lateral spines in *Fangyuania*, *Jiaotouia*, *Mesodorus*, *Ornatiala*, and 5–8 lateral spines in *Sinoala*, *Jiania*, *Luanpingia*,

Stictocercopis, *Parasinoala*). *Cretosinoala* is probably related to the type genus of Sinoalidae, *Sinoala* Wang and Szwedo, 2012 from the Middle–Upper Jurassic Daohugou beds, northeastern China. However, it differs from *Sinoala* in the following traits: 1) body small, length about 6.5 mm (body length more than 10 mm in *Sinoala*); 2) crown extremely produced anteriorly, anterior margin acutely angled in middle (head rounded apically in *Sinoala*); 3) metatibia armed with 4 lateral spines (5–7 lateral spines in *Sinoala*); 4) stem ScP+R+MP+CuA branching into ScP+R and MP+CuA leaving basal cell (ScR+R, MP and CuA leaving basal cell at common point in *Sinoala*).

Cretosinoala tetraspina sp. nov.
Figs. 5, 6

Etymology. The compound adjective comprises tetra-, meaning four, and spina, having spines. This word refers to the spination of the metatibia. The species is registered under LSID urn:lsid:zoobank.org:act:4B76393D-4B1F-4EB3-9201-14BEE7832158.

Holotype. NIGP170166, adult, male; deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China.

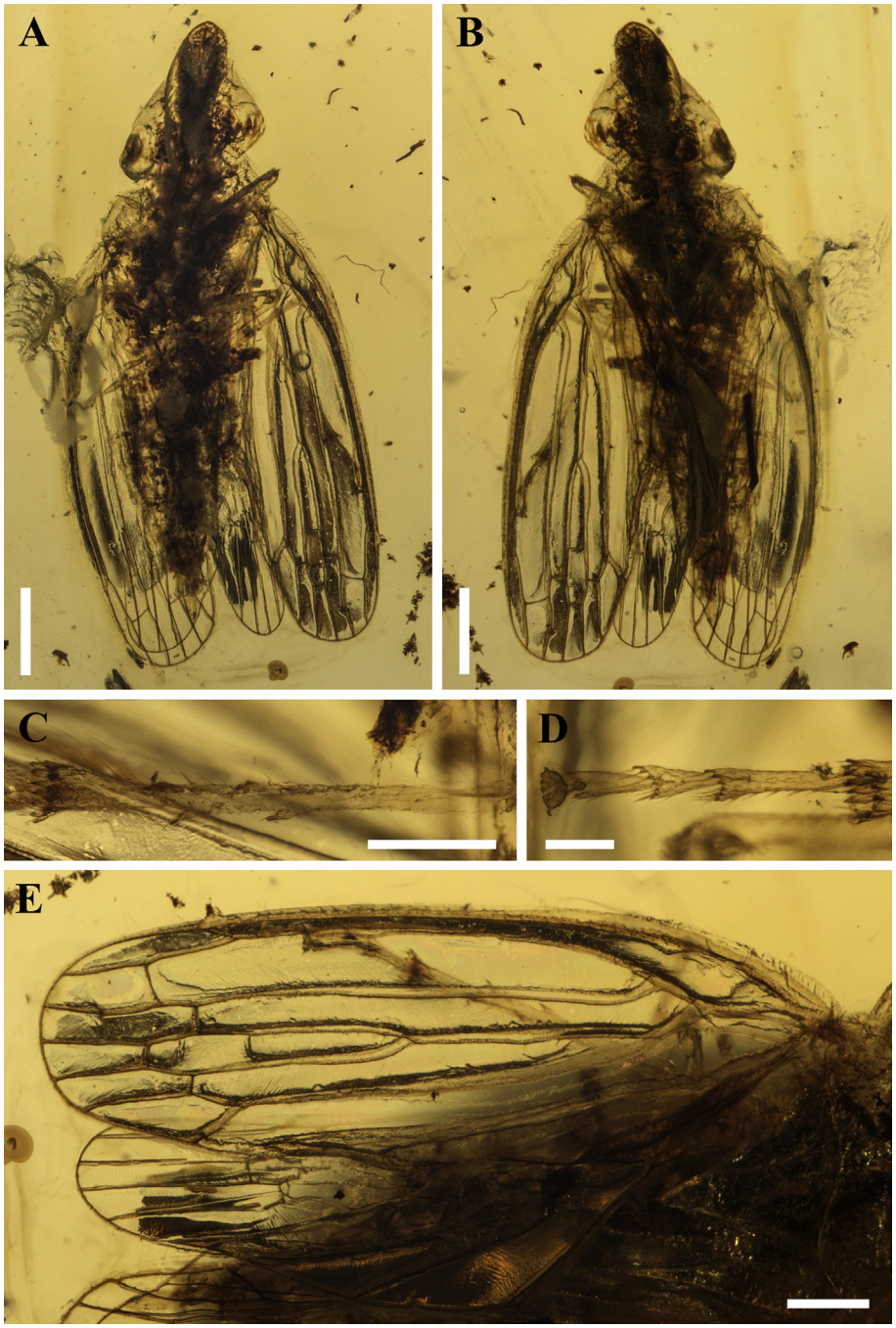

Fig. 5. Photographs of holotype (NIGP170166) of *Cretosinoala tetraspina* gen. et sp. nov. from the mid-Cretaceous Burmese amber. A. dorsal view, showing general habitus; B. ventral view, showing general habitus; C. showing four spines on metatibia; D. showing details of metatarsus and claw with arolium; E. showing details of right forewing and hind wing. Scale bars: 1 mm in A, B; 500 μm in C, E; 200 μm in D.

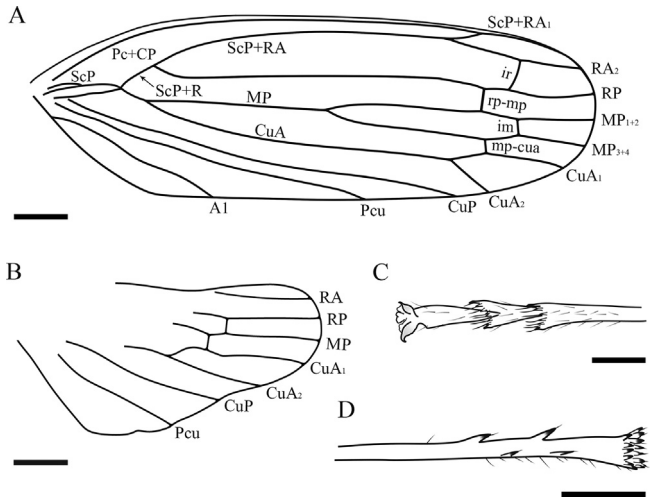

Fig. 6. Line drawings of *Cretosinoala tetraspina* gen. et sp. nov. A. tegmen; B. hind wing; C. metatarsus; D. metatibia. Scale bars: 500 μm in A, B, D; 200 μm in C.

Locality and horizon. Burmese amber, from deposits near the Tanai Village in the Hukawng Valley of northern Myanmar; mid-Cretaceous.

Diagnosis. As for the genus (*vide supra*) with some additional characters: body length about 6.5 mm; metatibia with two rows of apical teeth (six and eight visible in number for each row); crossvein ir of tegmen longer than other crossveins.

Description. Total length (including wings in repose) about 7.4 mm, body with small round punctures (Figs. 5A, B).

Head. Length about 2.03 mm, width about 1.89 mm; crown extremely produced anteriorly, anterior margin acutely angled in middle; compound eyes large, ovoid; three ocelli on crown, median ocellus oval; antenna inserted in deep cavities between the eyes, scape large, pedicel much thinner than scape, flagellum obscure; postclypeus long and broad, widest at middle, with a median longitudinal carina and transverse grooves; anteclypeus oval, with a median longitudinal carina; rostrum obscure.

Thorax. Pronotum irregularly hexagonal, nearly 1.2 times as wide as head, widest at lateral angle; relatively short, with length/width ratio about 0.24; anterior margin almost straight; lateral angles relatively obtuse; posterior margin distinctly concave medially. Mesonotum distinctly narrower than pronotum. Prothoracic leg with profemur with distinct ridges; protibia more slender than profemur. Mesothoracic leg with mesocoxae thick; mesofemur about 0.98 mm long, nearly twice thicker than mesotibia. Metathoracic leg with metatibia (Figs. 5C, 6D) about 1.87 mm long, longer and thinner than other tibiae; metatibia with two rows of four piliferous spines (two and two in number for each row), widened apically, with two rows of apical teeth (six and eight visible in number for each row), teeth of apical row with long setae; metatarsus 3-segmented (Figs. 5D, 6C), about 0.93 mm long, basitarsomere armed with one row of seven apical teeth with long setae at apex, much longer than mid- and apical tarsomeres; midtarsomere widened apically, armed with one row of eight apical teeth with long setae at apex; tarsal claws robust, sharp apically; arolium present.

Tegmen. (Figs. 5E, 6A). Tegmen exceeds the tip of abdomen, length about 5.0 mm and width about 1.6 mm, with length/width ratio about 3.1; basal portion of clavus and longitudinal veins covered with regular granules; costal margin smoothly arched at base, and then almost straight; claval margin arched; posterior margin nearly straight; postcostal cell narrow, length/width ratio about 6.2; C1 cell broad, widest near middle, about 3.2 mm long and 0.4 mm wide; basal cell nearly 1/7th of tegmen length; Pc+CP thickened, extending beyond of termination of ScP+RA_1, almost parallel to costal margin; basal portion of ScP very short, fusing with stem R+MP+CuA at middle of basal cell length; stem ScP+R+MP+CuA smoothly curved, branching into ScP+R and MP+CuA reaching 0.16 of tegmen length; ScP+R branching into ScP+RA and RP slightly after bifurcation of MP+CuA; ScP+RA distinctly curved, about 7.4 times as long as ScP+R, branching into ScP+RA_1 and RA_2 reaching 0.73 of tegmen length; ScP+RA_1 short; RA_2 straight; RP single-branched, curved anteriorly, connecting RA_1 by crossvein ir; MP with 2 branches, straight anteriorly, and then branching into MP_{1+2} and MP_{3+4} nearly at mid-wing length; crossvein im as level of ir, nearly 1/2 as long as ir; cell C3 nearly 2.5 times as long as cell C3'; CuA smoothly curved, branching into CuA_1 and CuA_2 distinctly after bifurcation of MP, reaching 0.75 of tegmen length; CuA_1 about 2.3 times as long as CuA_2; CuP slightly sinuous, Pcu sub-parallel to CuP; A1 long, slightly sinuous.

Hind wing. (Figs. 5E, 6B). Nearly complete, distinctly shorter than tegmen; marginal membrane absent; RA single-branched; RP single-branched and straight, connecting MP by crossvein rp-mp; MP single-branched, connecting CuA_1 by crossvein mp-cua; CuA with 2 branches, branching into CuA_1 and CuA_2 basal of bifurcation of R; CuA_1 much longer than CuA_2, CuA_2 nearly straight.

Abdomen. Segments II to VIII becoming progressively narrower. Genitalia partly visible, pygofer short and wide, genital styles long, curved distally in ventral view.

4. Discussion

Fossil record of Cercopoidea comprises all families except Machaerotidae from Mesozoic to Miocene (Szwedo, 2018). Sinoalidae is the most diverse among the three Mesozoic families within the superfamily Cercopoidea at a generic level (Chen et al., 2019b). Up to now, 13 genera have been attributed to Sinoalidae from the Middle–Upper Jurassic of northern China and the mid-Cretaceous Burmese amber (Hong, 1983; Wang et al., 2012; Chen et al., 2017, 2018, 2019a, b, c; Fu et al., 2017; Fu and Huang, 2018, 2019). Sinoalidae, early representatives of Cercopoidea, is related to Procercopidae, shareing some plesiomorphic traits with the ancient Clypeata, such as Hylicellidae and Archijassidae, and possessing some unique morphological features (Wang et al., 2012). Two new genera described herein from the Burmese amber can be placed in Sinoalidae based on the following morphological characters: tegmina having only costal area, clavus and longitudinal veins punctate, crossvein im present, hind wings lacking peripheral membrane, and metatibia armed with two rows of at least three lateral spines (Wang et al., 2012). Chen et al. (2019b) suggested that Sinoalidae can be divided into three clades based on their phylogenetic reconstruction: Clade I (*Chengdecercopis* + *Stictocercopis*) from the Middle–Upper Jurassic of northern China, representing a primitive lineage of Sinoalidae; Clade II (*Huabeicercopis* + *Luanpingia* + *Sinoala* + *Jiania* + *Shufania*) from the Middle–Upper Jurassic of northern China, which was considered to be a transitional form between the Jurassic Clade I and Cretaceous Clade III; and Clade III (*Fangyuania* + *Jiaotouia* + *Mesodorus* + *Ornatiala*) from the mid-Cretaceous Burmese amber. The two new genera here described share two critical characters with the Clade III, including crown produced anteriorly with anterior margin angled in the middle and metatibia slender with piliferous spines reduced in number (no more than 4), which are distinguishable from the Jurassic sinoalids of northern China.

Paraornatiala gen. nov. shares several critical characters with *Ornatiala* Chen, Wang and Zhang (2019a), 2019b, 2019c from the

Burmese amber, including anteclypeus with a median longitudinal carina, tegmen dotted with distinct colour pattern, stem ScP+R+MP+CuA branching into ScP+R+MP and CuA leaving basal cell, and basal portion of MP fused with ScP+R instead of CuA. *Paraornatiala* is also similar to *Jiaotouia* Chen and Wang, 2019 from the Burmese amber based on the following characters: head wider than longer, similar shape of pronotum, Pc+CP extending to apical margin as ambient vein, and MP_{3+4} connecting CuA_1 by fusing into a common stalk instead of crossvein mp-cua. However, *Paraornatiala* bears the following two peculiar characters previously unknown in Sinoalidae, including apex of metafemur armed with a distal conical spine, which is similar to *Cretotettigarcta burmensis* belongs to Tettigarctidae from Burmese amber; and vein RA of tegmen single-branched, but RA with at least 2 branches in other genera.

Cretosinoala gen. nov. is probably related to the type genus of Sinoalidae, *Sinoala* Wang and Szwedo, 2012 from the Middle–Upper Jurassic Daohugou beds (Yanliao biota, northeastern China) by sharing a similar wing venation, including basal cell nearly 1/7th of wing length, the widest part of postcostal cell as wide as cell C1, Pc+CP extending beyond of termination of $ScP+RA_1$, ScP+RA more than 7 times longer than ScP+R, MP branching into MP_{1+2} and MP_{3+4} nearly at mid-wing length, and cell C3 much longer than cell C3'. Like sinoalids, some particular groups from the Middle–Upper Jurassic Yanliao biota also dramatically appeared in the Burmese amber but absent in the Early Cretaceous Jehol biota in northern China (Huang, 2015, 2016; Huang et al., 2018; Fu et al., 2019). These similarities mentioned above further confirm the close relationship between the Yanliao and Burmese amber biotas.

5. Conclusions

Our discovery of two new genera and two new species of sinoalids from the mid-Cretaceous Burmese amber enriched the known palaeodiversity of this extinct family to 19 species, placed in 15 genera, 6 genera of which being known from Burmese amber. These well-persevered specimens provide detailed morphological features that have never been observed in the compression fossils of sinoalids, (e.g., apex of metafemur armed with a distal spine and metatibia armed with 4 spines), adding valuable information about the morphological disparity of the group, and contributing to future phylogenetic studies of this extinct family.

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