

Short communication

A new genus and species of Mimarachnidae (Hemiptera: Fulgoromorpha: Fulgoroidea) from mid-Cretaceous Burmese amber

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ARTICLE INFO

Article history:

Received 21 January 2018

Received in revised form

31 March 2018

Accepted in revised form 17 April 2018

Available online 19 April 2018

Keywords:

Planthopper
Auchenorrhyncha
head elongate
Mesozoic
fossil

ABSTRACT

A new genus and species of Mimarachnidae, *Jaculistilus oligotrichus* gen. et sp. nov. with strongly produced head is described from the mid-Cretaceous Burmese amber. Unique morphological characters such as head process, sensory pits and setigerous pectens of hind leg are discussed. The similarities of Mimarachnidae and Fulgoridae may indicate a close relationship between them.

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1. Introduction

Mimarachnidae Shcherbakov, 2007 are a small extinct family of distinctive planthoppers characterized by the sensory pits retained in the adults, mesonotum with double median carinae, wing with poorly longitudinal vein branches and irregular meshwork veinlets. This peculiar group is currently placed in the 'cixiidae-like' planthoppers (Szwedo and Ansoerge, 2015).

Records of fossil mimarachnids are very scarce and only seven monospecific genera have been described from the Cretaceous: *Mimarachne mikhailovi* Shcherbakov, 2007 and *Saltissus eskovi* Shcherbakov, 2007 from the Lower Cretaceous of Baissa (Russia); *Nipponoridium matsuoii* (Fujiyama, 1978) from the Lower Cretaceous of Japan (Szwedo, 2008a); *Mimamontsecia cretacea* Szwedo and Ansoerge, 2015 together with *Chalicoridulum montsecensis* Szwedo and Ansoerge, 2015 from the Lower Cretaceous of Spain; *Burmissus raunoi* Shcherbakov, 2017 and *Dachibangus trimaculatus* Jiang et al., 2018 from mid-Cretaceous Burmese amber. Among them, *M. mikhailovi* and *S. eskovi* were considered to be spider mimicry species for the spider-like dark silhouette and black eyespots with pupils on tegmina (Shcherbakov, 2007). Several other undescribed fossils also included in this family were from the Lower Cretaceous of Chita Region, Mongolia and Khabarovsk Region, and Upper Cretaceous of Kazakhstan (Shcherbakov, 2007; Szwedo and Ansoerge, 2015).

Herein we describe a new genus and species of Mimarachnidae preserved in the mid-Cretaceous Burmese amber, providing more evidence of morphological characters: an elongate head and sensory pits retained in adult, but subapical setae on hind leg pectens absent. To date, planthoppers reported from Burmese amber are very rare, only some achilids, dorytocids, mimarachnids and perforissids have been described (Szwedo, 2004; Zhang et al., 2017b; Shcherbakov, 2017; Emeljanov and Shcherbakov, 2018).

2. Materials and methods

The type specimen described herein is from the Burmese amber. This amber deposit is located in Kachin (Hukawng Valley), approximately 100 km southwest of the Village of Tanai, in northern Myanmar (Fig. 1) (Li et al., 2017). Age estimates place it in the earliest Cenomanian (98.79 ± 0.62 Ma) (Shi et al., 2012). There have been about 30 orders, 294 families and 566 species of insects known from Myanmar amber (Ross, 2018), with a very high diversity, such as dermapterans (Ren et al., 2017), archaeognathans (Zhang et al., 2017a), hemipterans (Liu et al., 2018), ephemeropterans (Lin et al., 2018), among others, and the recorded species numbers continue to grow. The amber studied herein is housed in the Key Lab of Insect Evolution and Environmental Changes, College of Life Sciences, Capital Normal University in Beijing, China.

The type amber specimen was examined and photographed under Nikon SMZ 25 microscope with an attached Nikon DS-Ri 2

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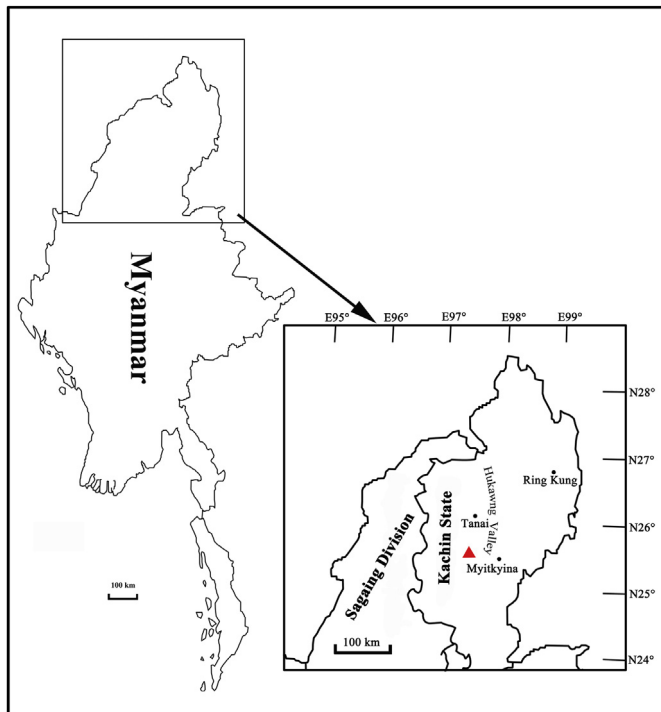


Fig. 1. Map of the amber locality near Tanai Village in Hukawng Valley (Li et al., 2017). ▲ Amber locality.

digital camera system. The figures of line drawings were drawn by using Adobe Illustrator CS6 and Photoshop CS6. The venational terminologies used here follow the interpretations presented by Szwedo and Żyła (2009), and Nel et al. (2012). The ZooBank LSID record for this publication is: urn:lsid:zoobank.org:pub:C0133F95-9FE3-44BC-BD89-906526B4969A.

3. Systematic palaeontology

Order Hemiptera Linnaeus, 1758

Suborder Fulgoromorpha Evans, 1946

Superfamily Fulgoroidea Latreille, 1807

Family Mimarachnidae Shcherbakov, 2007

Genus *Jaculistilus* gen. nov.

(urn:lsid:zoobank.org:act:95585AC7-CD07-4790-86B9-5041FF8EA783)

Etymology. The generic name is a combination of the Latin '*jacul-*' meaning 'projection' and '*stilus*' meaning 'pillar', the name refers to the strongly produced head. Gender masculine.

Type species. *Jaculistilus oligotrichus* sp. nov.

Included species. Type species only.

Diagnosis. Head strongly produced, tegmen M with four terminals, and metatibia with a lateral spine at base (these characters autapomorphic for new genus). Median and lateral carinae on frons present, median ocellus present, many small sensory pits present on anterior pronotum, mesonotum lateral carinae straight, tegmen with narrow costal area, narrow marginal membrane beyond claval apex absent. Hind wing CuA forked proximad of ScP + R forking.

Remarks. The proposed apomorphies for Mimarachnidae are: deeply forked stem ScP + R, less deeply forked stem CuA, abundant irregular veinlets on fore and hind wing, mesonotum with double median carinae (Szwedo and Ansoerge, 2015). The new genus belongs to the family Mimarachnidae based on these unique characters, and this genus is distinguished from the other genera of

Mimarachnidae mainly by the combination of characters: head strongly produced (head without modifications in *Mimarachne*, *Saltissus*, *Burmissus* and *Chalicoridulum*); mesonotum lateral carinae nearly straight (lateral carinae bent mediad in *Mimamontsecia*, *Dachibangus*, *Burmissus* and *Chalicoridulum*); tegmen costal area distinct along costal margin (costal area only present at base in *Chalicoridulum*); M with four terminals (six terminals in *Dachibangus*, three terminals in *Mimarachne*, two terminals in *Mimamontsecia*, *Saltissus*, *Burmissus* and *Chalicoridulum*); tegmen without narrow marginal membrane (tegmen with narrow marginal membrane in *Mimamontsecia*, *Mimarachne*, *Burmissus* and *Chalicoridulum*); hind wing CuA forked proximad of ScP + R forking (CuA forked distad of ScP + R forking in *Nipponoridium*); metatibia with a lateral spine at base (metatibia without lateral spine in *Mimamontsecia*, *Dachibangus* and *Chalicoridulum*).

Dorytocus ornithorhynchus Emeljanov and Shcherbakov, 2018 only based on nymphs of Dorytocidae from Burmese amber, also with a long head process, but can be easily distinguished from mimarachnids by pronotum strongly inverted V-shaped, much displaced anteriorly and deeply incised posteriorly, median carina of mesonotum single, foliaceous fore and mid tibiae. And it clearly differs from new species in metatibia without lateral spine, setigerous hind tarsal pectens and the shape of head process.

Jaculistilus oligotrichus sp. nov.

(urn:lsid:zoobank.org:act:5717CAF3-FC19-48DC-A623-676E5541C817)

(Figs. 2–4)

Etymology. The new specific name is from a Latin word '*oligo-*' meaning 'lacking hair', referring to subapical setae on hind leg pectens absent.

Type material. Holotype, CNU-HOM-MA2017005, gender unknown, a well preserved specimen, but abdomen missing.

Locality and horizon. Hukawng Valley, Kachin State, Northern Myanmar; mid-Cretaceous, lowermost Cenomanian.

Diagnosis. Junction between frons and clypeus curved downward, rostrum long, extending beyond hind coxae, pronotum with distinct Y-shaped median carina, mesonotum median carinae not reaching scutellum. Tegmen RP single, arculus very weak, CuP reaching wing margin, two large spots present on the apical portion of tegmen, hind wing CuA with two terminals. Hind tibio-metatarsal formula 6(6): 7(7): 7(7).

Description. A well-preserved specimen but abdomen absent, gender unknown, total length of insect about 22 mm.

Head. Head including compound eyes about 2 mm wide, nearly half as wide as pronotum, length of head with process shorter than thorax, head process straight in lateral view, vertex lateral margins carinate, slightly convergent, dorsal surface of head process without median carina. Frons narrow, lateral margin forming a marked keel, median carina incomplete, present toward top of head process, not reaching frontoclypeal suture, lateral carinae weakly ridged, only present in basal part, several small sensory pits on anterior portion of head process. Marginal carinae of frons extending to clypeus, median carina of postclypeus complete, rostrum very long, reaching far beyond hind coxae, apical segment longer than wide. Compound eyes large, median ocellus small, near frontoclypeal suture. Antennae poorly preserved, pedicel subcylindrical.

Thorax. Length of pronotum longer than half of mesonotum, pronotum anterior margin arcuately convex, extending forward beyond compound eyes posterior, posterior margin shallowly incised, lateral margins reinforced, median carina on pronotum present nearly throughout, lateral carinae only present in anterior area.

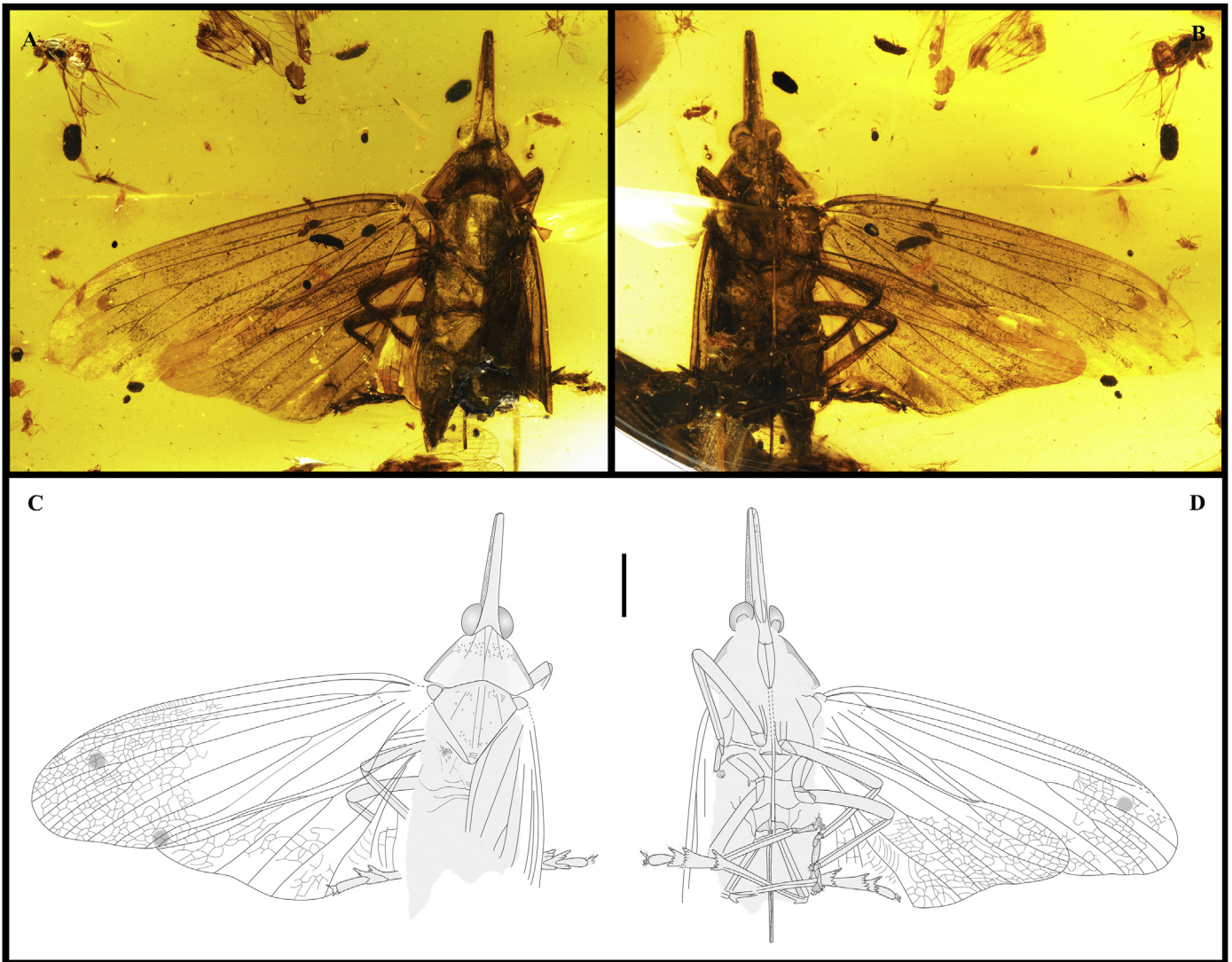


Fig. 2. Holotype of *Jaculistilus oligotrichus* gen. et sp. nov. A, Photograph habitus in dorsal view. B, Photograph habitus in ventral view. C, Line drawing habitus in dorsal view. D, Line drawing habitus in ventral view. Scale bar = 2.5 mm.

Mesonotum approximately as long as wide in mid line, with many small sensory pits, median carinae paired completely independent, lateral carinae convergent anteriorly, scutellum transversely wrinkled. Serried small sensory pits present on metanotum, tegula large.

Wings. Wings open, membranous, tegmen 16 mm long, 5 mm wide, about 3 times as long as wide, with two black spots in wing apical area, costal margin slightly thickened, convex at base, apical margin round, posterior margin straight, clavus open, claval apex reaching apical half of tegmen, coupling lobe at wing midlength. Costal area long, narrowing toward wing apex, with transverse veinlets in apical part. Common stalk of ScP + R short, ScP + RA not forked before apex, curved upward to apical margin, RP single, almost straight, parallel to branch ScP + RA and costal margin, M straight, forked in wing apical half, with four terminals, arculus (basal portion of stem CuA) very weak and indistinct, the bifurcation of CuA near wing basal one-third, with two terminals, branch CuA₂ simple, CuP present throughout tegmen, more distinct in apical portion, claval suture extending to near apical apex of coupling lobe, Pcu and A1 fused slightly proximad of wing midlength, free stem of Pcu longer than common part of Pcu + A1, irregular meshwork veinlets present in apical half of tegmen.

Hind wing membranous, 12 mm long, 5 mm wide, slightly shorter than tegmen, apical margin almost rounded, coupling lobe slightly distad of wing midlength, common stem of ScP + R nearly straight, forked at the same level of coupling lobe, with two terminals, RP curved in apical portion, M simple, arculus distinct, the bifurcation of CuA at basal half of hind wing, with two terminals, CuP nearly straight, Pcu arcuately curved to wing margin, irregular meshwork veinlets present in apical and anal areas of hind wing.

Legs. Fore leg 10 mm long, covered with short setae, coxa elongate and carinate, fore femur flattened and dilated, slightly longer than fore tibia, fore tibia carinate, subquadrate in cross section, basitarsomere and midtarsomere short, common length much shorter than apical tarsomere, length of fore tarsomeres: I 0.26 mm, II 0.40 mm, III 1.05 mm, arolium large, tarsal claws developed. Mid leg 10.2 mm long, covered with short setae, coxa carinate, with a large coxal spine, mid femur flattened and dilated, nearly as long as mid tibia, mid tibia carinate, subquadrate in cross section, basitarsomere and midtarsomere as in fore leg, very short, length of mid tarsomeres: I 0.20 mm, II 0.40 mm, III 0.83 mm, arolium distinct, tarsal claws developed. Hind leg slender, 10.6 mm long, covered with short setae, hind coxae carinate, stick together,

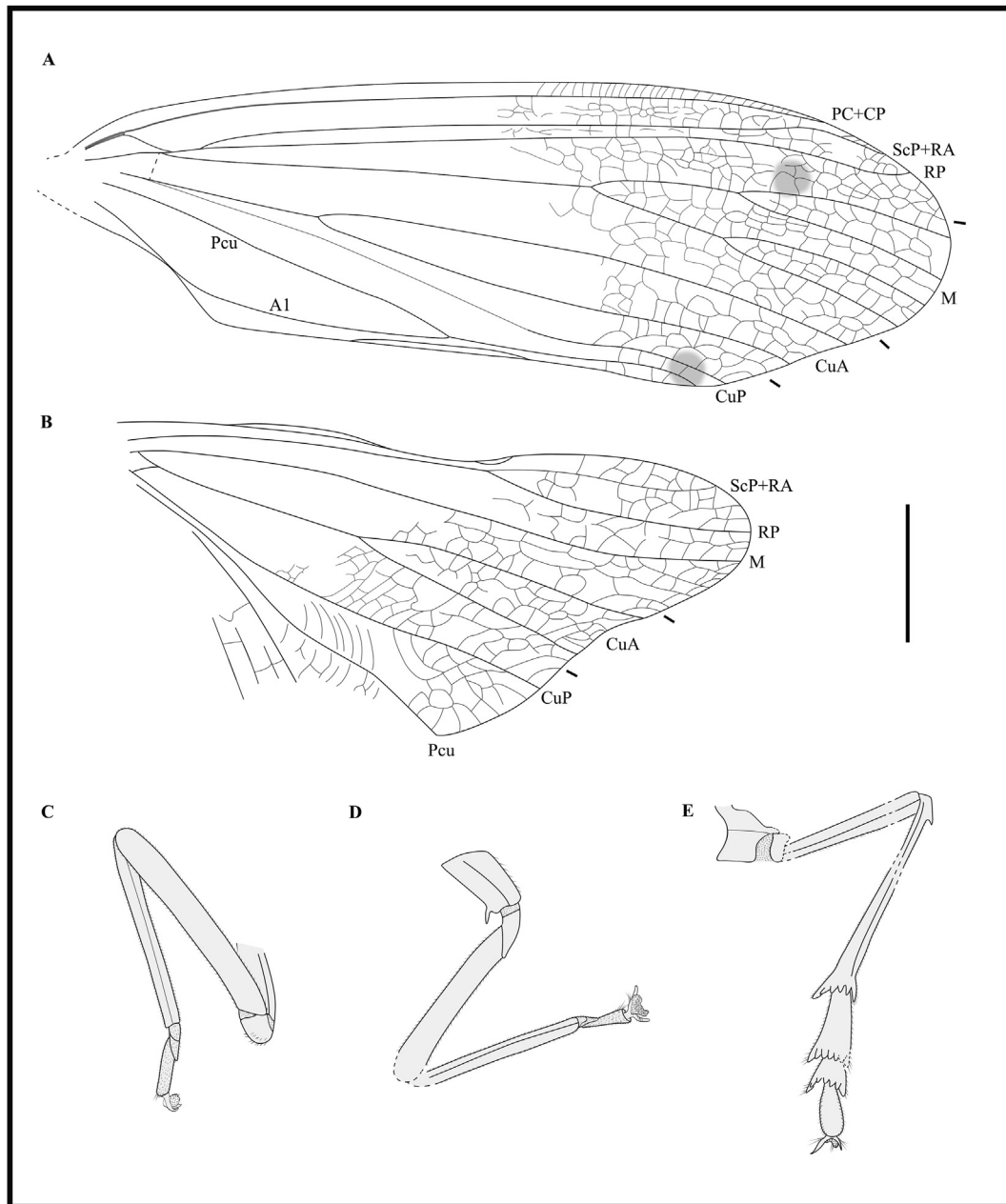


Fig. 3. Line drawings of *Jaculistilus oligotrichus* gen. et sp. nov. A, Forewing. B, Hind wing. C, Fore leg. D, Mid leg. E, Hind leg. Scale bar = 2.5 mm.

hind femur about 2.95 mm long, apparently shorter than hind tibia, carinate, subquadrate in cross section, hind tibia about 3.85 mm long, carinate, shape of cross section similar to hind femur, with a row of six apical teeth, basitarsomere the longest, 1.16 mm long, with seven apical teeth, shorter than combined length of mid and apical tarsomeres, midtarsomere 0.51 mm long, with seven apical teeth, apical margin similar to swallowtail, subapical setae on all pectens of hind leg absent, apical tarsomere 0.87 mm long, tarsal claws large, arolium wide.

4. Discussion

Jaculistilus oligotrichus gen. et sp. nov. is the first discovery of Mimarachnidae with an elongate head process, which indicates strongly produced head has existed in Mesozoic planthoppers. Within extant Fulgoroidea, head process is very common, at least eleven planthopper families with this character (O'Brien, 2002;

Urban and Cryan, 2009), sometimes even strangely shaped, especially in Dictyopharidae and Fulgoridae. The function of head process has been postulated, including sexual selection, mimicry and bioluminescence (Hogue, 1984; Zolnerowich, 1992; O'Brien, 2002; Goemans, 2006). But measurements of female and male head process showed no sex-based difference, and evolution examination of fulgorid head process suggested its shape across distantly related lineages seemed to be convergent, head morphology may be adaptive (Urban and Cryan, 2009). Fossil records of head process have been reported in many planthopper families, during the Mesozoic, different sized and shaped head processes were recorded from mid-Cretaceous adults of Lalacidae (Hamilton, 1990), Mimarachnidae and nymphs of Dorytocidae; during the Cenozoic, a great diversity of head processes were reported from Dictyopharidae (Becker-Migdisova, 1964; Szwedo, 2008b), Fulgoridae (Scudder, 1890; Zhang, 1989; Zhang et al., 1994) and Caliscelidae (Bourgoin et al., 2016), as in extant planthoppers, this feature is also most common

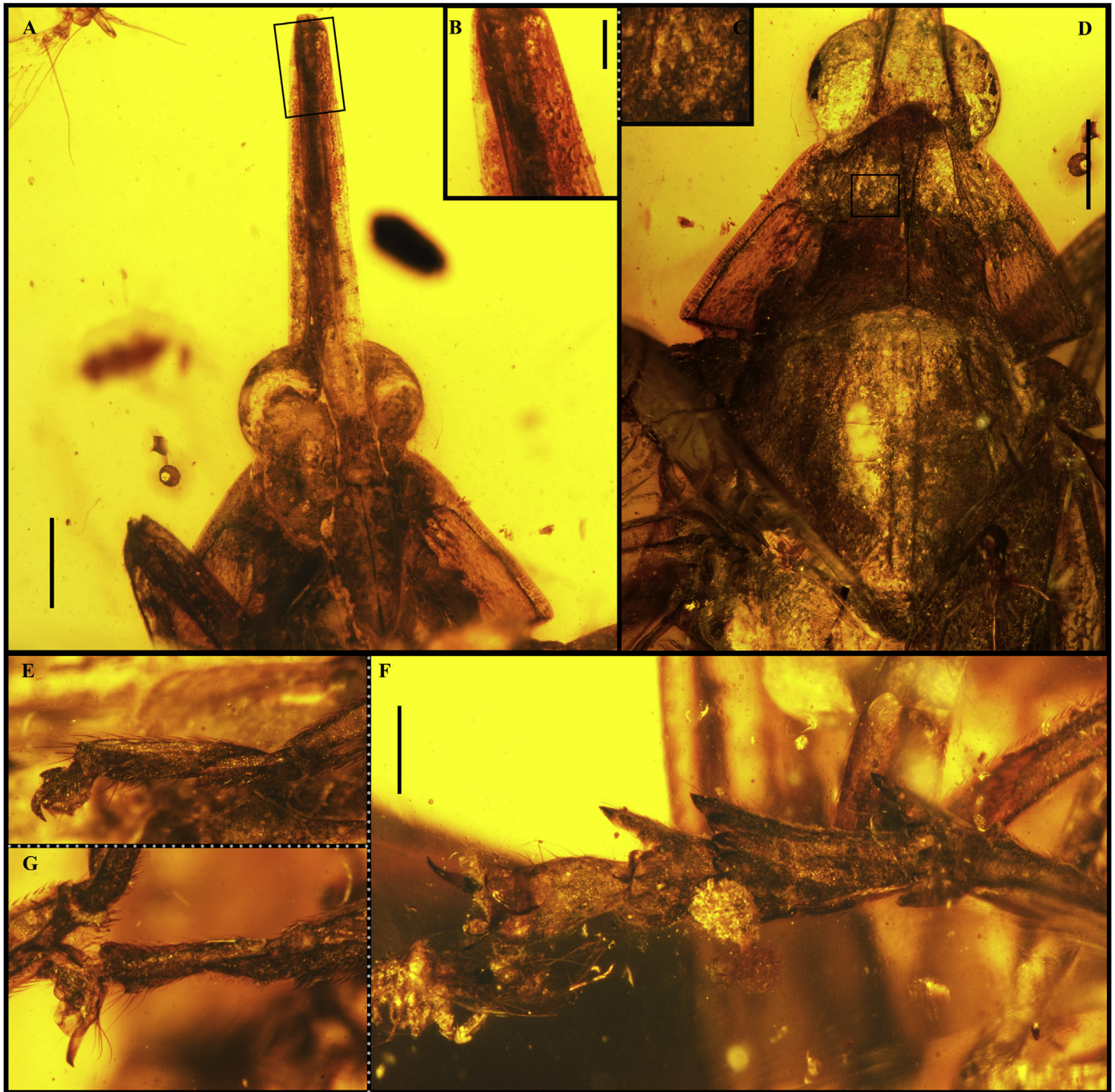


Fig. 4. Detailed photographs of *Jaculistilus oligotrichus* gen. et sp. nov. A, Face. B, Sensory pits on head process. C, Sensory pits on pronotum. D, Pronotum and mesonotum. E, Fore tarsus. F, Hind tarsus. G, Mid tarsus. Scale bar for A, D = 1 mm; B-C = 0.25 mm; E-G = 0.5 mm.

in Dictyopharidae and Fulgoridae. Head process of Fulgoroidea may originate from no later than mid-Cretaceous, with considerable variation in its length, curvature and shape in fossil planthoppers.

Sensory pits are specific organs of planthopper nymphs and very rare in adults (Emeljanov, 2001), they usually disappear at the late instars or adults (Zhang et al., 2017b), but are sometimes retained in extant adults of extreme xerophiles or hygrophiles (Szwedo, 2008a). Šulc (1928) postulated the role of sensory pits may be hygrosensors, but still required more experimental evidence. Sensory pits persist at the adult stage in Perforissidae and Mimarachnidae, this feature seems to be a neotenic character, retained in adults of Cretaceous Mimarachnidae and Perforissidae (Szwedo and Ansoerge, 2015).

Hind tibial or tarsal pectens setigerous occurs in many fossil planthoppers, this feature is believed to be a plesiomorphic condition by Emeljanov (1987). Shcherbakov (2004) also proposed the morphoserries evolutionary going up with reduction of subapical setae, firstly on tibia, then on tarsal segments. In Mimarachnidae, hind tibial pecten setigerous in some undescribed specimens (Shcherbakov, 2007); in *Chalidoridulum* and *Burmissus*, only basitarsomere and midtarsomere with subapical setae; in new genus and *Mimamontsecia*, all pectens of hind leg asetigerous. This indicates hind leg pectens provided with subapical setae is various in Mimarachnidae, and as mentioned above, it has gradually reduced on hind leg apical pectens.

Shcherbakov (2007) suggested Mimarachnidae shared some features with Surijokocixiidae, Fulgoridiidae and Perforissidae, e.g. sensory pits retained in imagines and metatibial teeth provided with subapical setae, they may be the 'pre-cixioid' section of planthoppers. On the other hand, according to Bourgoin and Szwedo (2008) and Szwedo (2009), Mimarachnidae could be included in 'cixiidae-like' planthoppers, this group also comprises extinct Fulgoridiidae, Neazoniidae, Lalacidae and some extant families whose body structures are similar to Cixiidae. Based on many shared characters of Mimarachnidae and Fulgoridae: hind midtarsomere with a row of apical spines, numerous cross veins in hind wing anal area, strongly produced head and larger size, we hypothesize Mimarachnidae may be closely related to Fulgoridae, this family together with Jurassic Fulgoridiidae and Cretaceous Lalacidae, Neazoniidae, Dorytociidae, Perforissidae, possess some ancient characters (sensory pits retained in adults or setigerous pectens of hind leg), possibly ancestral to extant Fulgoroidea.

5. Conclusions

Jaculistilus oligotrichus gen. et sp. nov. from the mid-Cretaceous Burmese amber is documented. Various head processes reported from fossil groups indicate a higher diversity of this character in fossil planthoppers, sensory pits which retained in adults of Mimarachnidae and Perforissidae seems to be a neotenic feature, and subapical setae of hind leg pectens are various in Mimarachnidae. This family could be closely related to Fulgoridae on the basis of the shared characters.

Acknowledgments

We sincerely thank Jacek Szwedo and Zhishun Song for their constructive suggestion of this new specimen. We are also grateful to the editors and anonymous reviewers for valuable comments and constructive criticism to improve this paper. This project is supported by grants from the National Natural Science Foundation of China (41688103), Program for Changjiang Scholars and Innovative Research Team in University (IRT-17R75), Support Project of High-level Teachers in Beijing Municipal Universities in the Period of 13th Five-year Plan (IDHT20180518) and the Youth Innovative Research Team Project of Capital Normal University.

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