



Two new genera of fossil palaeontinids from the Middle Jurassic in Daohugou, Inner Mongolia, China (Hemiptera, Palaeontinidae)

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Abstract

In this paper two new genera and three new species of Palaeontinidae are described: *Quadraticossus* gen.nov., containing two new species, *Q. fangi* and *Q. longicaulis*; *Hamicossus laevis* gen. et sp. nov. These two new genera are established based on both complete forewings and hind wings. All of them were collected from the Middle Jurassic Jiulongshan Formation at Daohugou Village, Inner Mongolia. The type specimens are deposited in the College of Life Science, Capital Normal University.

Key words Morphology, taxonomy, palaeontology, Cicadomorpha, Mesozoic

Introduction

Palaeontinidae Handlirsch, 1906 is an extinct family of hemipteran insects with 34 known genera and 71 species recorded from Eurasia, America, Africa and Australia, which occurred throughout the Mesozoic, from the Triassic to the Cretaceous (Carpenter 1992; Ren *et al.* 1998; Menon *et al.* 2005; Wang & Ren 2006; Wang *et al.* 2006a, b).

Palaeontinids have large setose bodies, small heads, and broad wings, so they were originally thought to be moths. The bodies are even rarer than fossils with both wings present, and nothing is really known about the heads, so their placement in Cicadomorpha is problematic, and this lack of information and the confusion of these insects with moths, led Evans (1956) to list the cicada-like forms under “Cicadomorphidae” while retaining the moth-like fossils under Palaeontinidae.

Up to now, 16 known genera and 29 species fossil palaeontinids have been found from northern China. Well-preserved specimens described in this paper were collected from a small section of the Jiulongshan Formation at Daohugou (N41°18'38", E119°13'20") of the town of Ningcheng in southeastern Inner Mongolia, China. So far, the genera erected based on both forewings and hind wings are rare: only 5 genera described so far include both forewings and incomplete hind wings (Evans 1956; Martins-Neto 1998; Ren *et al.* 1998; Menon *et al.* 2005). Our findings represent one of the first records of well-preserved forewings and complete hind wings in Daohugou area. The age of the Daohugou fossil-bearing beds is still being debated and three opinions have been presented: Middle Jurassic (Shen *et al.* 2003; Chen *et al.* 2004; Liu *et al.* 2004; Ren *et al.* 1995; Ren *et al.* 2002; Ren & Krzemiski 2002; Ji *et al.* 2006; Gao & Ren 2006; Huang *et al.* 2006), Late Jurassic (Zhang 2002) or Early Cretaceous (Wang *et al.* 2005). We believe it to be Middle Jurassic (Jiulongshan Formation).

Material and methods

The specimens were examined by a LEICA MZ12.5 dissecting microscope and illustrated with the aid of a camera lucida attached to the microscope. All fossils studied here are deposited in the Key Lab of Insect Evolution & Environmental Changes, the College of Life Sciences, Capital Normal University, Beijing, China (CNU; Ren Dong, Curator).

The wing venation nomenclature used in this paper is based on the interpretation of Becker-Migdisova (1949): Sc, subcosta; R₁, the first branch of anterior radial vein; R₂, the second branch of anterior radial vein; Rs, posterior radial vein; M₁, anterior branch of the media; M₂, the second branch of the media; M₃, the third branch of the media; M₄, the fourth branch of the media; CuA₁, the anterior branch of the cubitus; CuA₂, the second branch of the cubitus; CuP, postcubital vein; A₁, the anterior branch of anal vein; A₂, the second branch of anal vein; r-m, crossvein connects the posterior radial vein and the anterior branch of the media; m₄-cua, crossvein connects the fourth branch of the media and the anterior branch of the cubitus.

Systematic Description

Order Hemiptera Linnaeus, 1758

Suborder Cicadomorpha Evans, 1946

Family Palaeontinidae Handlirsch, 1906 =Cicadomorphidae Evans, 1956

Genus *Quadraticossus* gen. nov.

Type species: *Quadraticossus fangi* sp. nov.

Diagnosis. Forewing triangular. Sc separated from R at base, and then fused with R, extending to near the indentation and terminating on R₁. Rs simple. M four-branched, M₄ sharply flexed after it arising from M₃₊₄. CuA connected with M₄ by a horizontal crossvein. Vein A two branched, and A₂ with branches. Nodal line divided discal cells into two parts, and the shape of 2nd discal cell nearly rectangular. Hind wing small, with distinct indentation. The stem of M₁₊₂ long, and M₄ not divided from M₃₊₄. Anal vein single.

Etymology: The generic name is a combination of Latin prefix *quadrat-* (Latin quadratus-rectangular) and *-cossus* (a common suffix for fossil palaeontinids), referring to the shape of 2nd discal cell nearly rectangular. Gender: masculine.

Species included: Two species- *Q. fangi* sp. nov. ; *Q. longicaulis* sp. nov.

Remarks: The new genus is referred to the family Palaeontinidae because the forewing has the membranous, distal part broader and longer than the basal, tegminous part; vein Sc is usually weakly developed, commonly with branches or vestiges of branches; R and M separate before or close to mid-wing; and R and Rs are nearly straight. Also, the hind wing has a prominent indentation on the costal margin; M₁ is commonly coalesced for a short interval with Rs; the head is small and narrow; the pronotum is wide; and the body is generally clothed with numerous hairs.

This new genus can be distinguished from all known genera in the following features on the forewing: Sc separated from R at base, and then fused with R after the point of R separating into R₁ and Rs, extending beyond the nodal line and terminating on R₁; M₄ is sharply flexed after arising from M₃₊₄; CuA connected with M₄ by a horizontal crossvein; shape of 2nd discal cell nearly rectangular.

Based on forewing venation (indented and CP present, nodal line developed in forewing), this new genus

is quite similar to *Phragmatoecites* Oppenheim, 1887 and *Liaocossus* Ren, Yin and Dou, 1998, but it differs from them mainly by the following combination of features: M_4 sharply flexed after arising from M_{3+4} , CuA connected with M_4 by horizontal crossvein; 2nd discal cell nearly rectangular.

On the basis of venation of the hind wing, the new genus shows close similarity with *Shurabocossus* Becker-Migdisova, 1949 from Shurab in Tadzhikistan, *Yumenia* Hong, 1982 from the Gansu Province in China and *Plachutella* Becker-Migdisova, 1949 from Shurab in Tadzhikistan, Izkutsk and Iya in Russia and Xinjiang in China, but differs in having the stem of M_{1+2} long and M_4 not divided from M_{3+4} .

***Quadraticossus fangi* sp. nov.**

(Fig. 1A–F)

Diagnosis: Sc without branches and terminating on R_1 near the distal part. M bifurcated into M_{1+2} and M_{3+4} at level of Rs arising from R. Horizontal crossvein m_4 -cua long.

Description: Head with pair of large eyes. Rostrum long but not reaching posterior margin of mesoscutum. In ventral view, legs partly preserved, femora stout, tibiae somewhat slender. Abdomen with at least 6 visible segments.

Forewing triangular with distinct CP and nodal line. Sc without branches, separated from R at base, then fused with R after point of R separating into R_1 and Rs, extending beyond nodal line and terminating on R_1 . M bifurcated into M_{1+2} and M_{3+4} at same level of Rs arising from R. M_{1+2} and M_{3+4} separated at same level. Crossvein r-m present between Rs and M_1 . Cu divided into CuA and CuP at base. CuA curved, irregular, joined with M by crossvein m-cua and also connected with M_4 by long horizontal crossvein. CuA branched into CuA_1 and CuA_2 after point of M bifurcating into M_{1+2} and M_{3+4} . CuP single. Vein A two branched, A_2 with branches. Nodal line traceable as indentation across Sc, and along with Sc for a short distance, then across Rs to M_{1+2} , along with the latter to branching point of M, separating discal cells into two unequal parts, following stem CuA and CuA_2 , terminating at distal end of clavus.

Hind wing smaller than forewing, costal margin curved posteriorly, forming prominent indentation. Rs coalesced with M_1 for long interval before separating. Stem of M_{1+2} long, M_2 arising from M_1 at same level of Rs separating from R. M_4 not divided from M_{3+4} . Short crossvein m_{3+4} -cua present. CuA_1 fused with CuA_2 for long interval. Anal vein single. Both forewings and hind wings with prominent color pattern consisting of hyaline patches on a dark ground. (Fig. 1. A, B, C, D, F).

Body 25 mm long, 15 mm wide; forewing 41 mm long, 18 mm wide; hind wing 24 mm long, 16 mm wide.

Etymology: This species is named after Mr. Fang Liang for his contribution in collecting Daohugou fossils, including this specimen.

Material: The new species is established based on body with a pair of forewings and a pair of hind wings. Holotype: Body with wings compression, part and counterpart, No.: CNU-H-NN2006093-1, CNU-H-NN2006093-2.

Horizon and locality: Jiulongshan Formation, Middle Jurassic, Daohugou Village, Shantou Township, Ningcheng County, Inner Mongolia, China.

***Quadraticossus longicaulis* sp. nov.**

(Fig. 2A–B)

Diagnosis: Sc with weak branches, terminating on R_1 near the middle of forewing. The stem of M is long and M bifurcated into M_{1+2} and M_{3+4} at the same level of Sc fusing with R_1 . Crossvein m-cua near point of Sc arising from Sc+ R_1 .

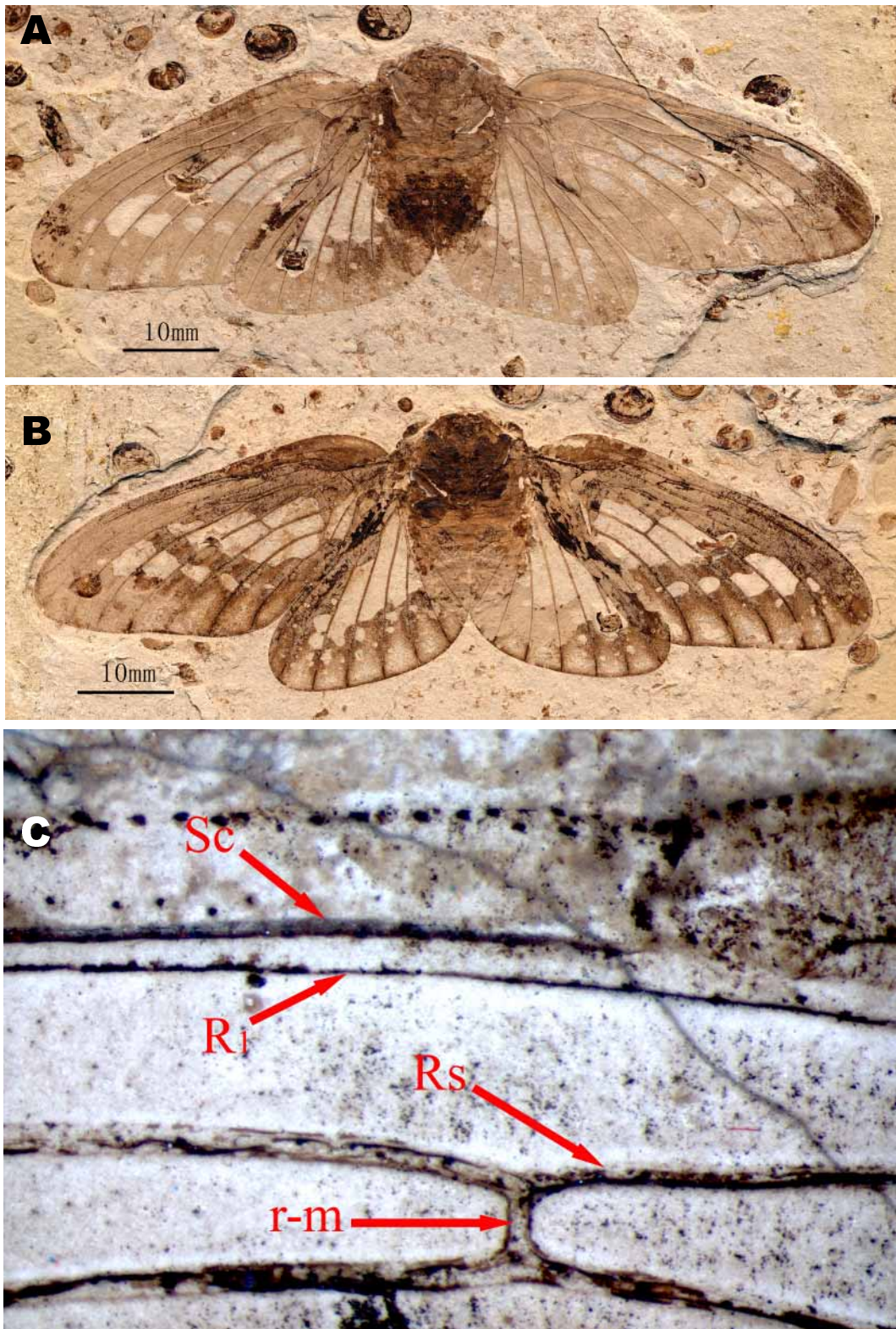


FIGURE 1 A-C. *Quadraticossus fangi* gen. & sp. nov., holotype: A, photograph of part CNU-H-NN2006093-1; B, photograph of counterpart CNU-H-NN2006093-2; C, photograph of subcosta (Sc) on forewing.

Description: Forewing triangular with distinct CP and nodal line. Sc with weak branches, separated from R at base, fused with R at the level of M bifurcation into M_{1+2} and M_{3+4} , extending at indentation and terminating on R_1 . M branched into M_{1+2} and M_{3+4} little after point of R bifurcation into R_1 and Rs. M_{1+2} and M_{3+4} separated at same level. Crossvein r-m near point of M_{1+2} branching into M_1 and M_2 . CuA curved joined with M by

a crossvein m-cua and also connected with M_4 by long horizontal crossvein. Nodal line traceable as indentation across point of Sc arising from Sc+ R_1 , along with R_1 for a short distance, then across R_s to M_{1+2} , along with latter to separating point of M, separating discal cells. Forewing with prominent color pattern consisting of hyaline patches on a dark ground. (Fig.2. A, B).

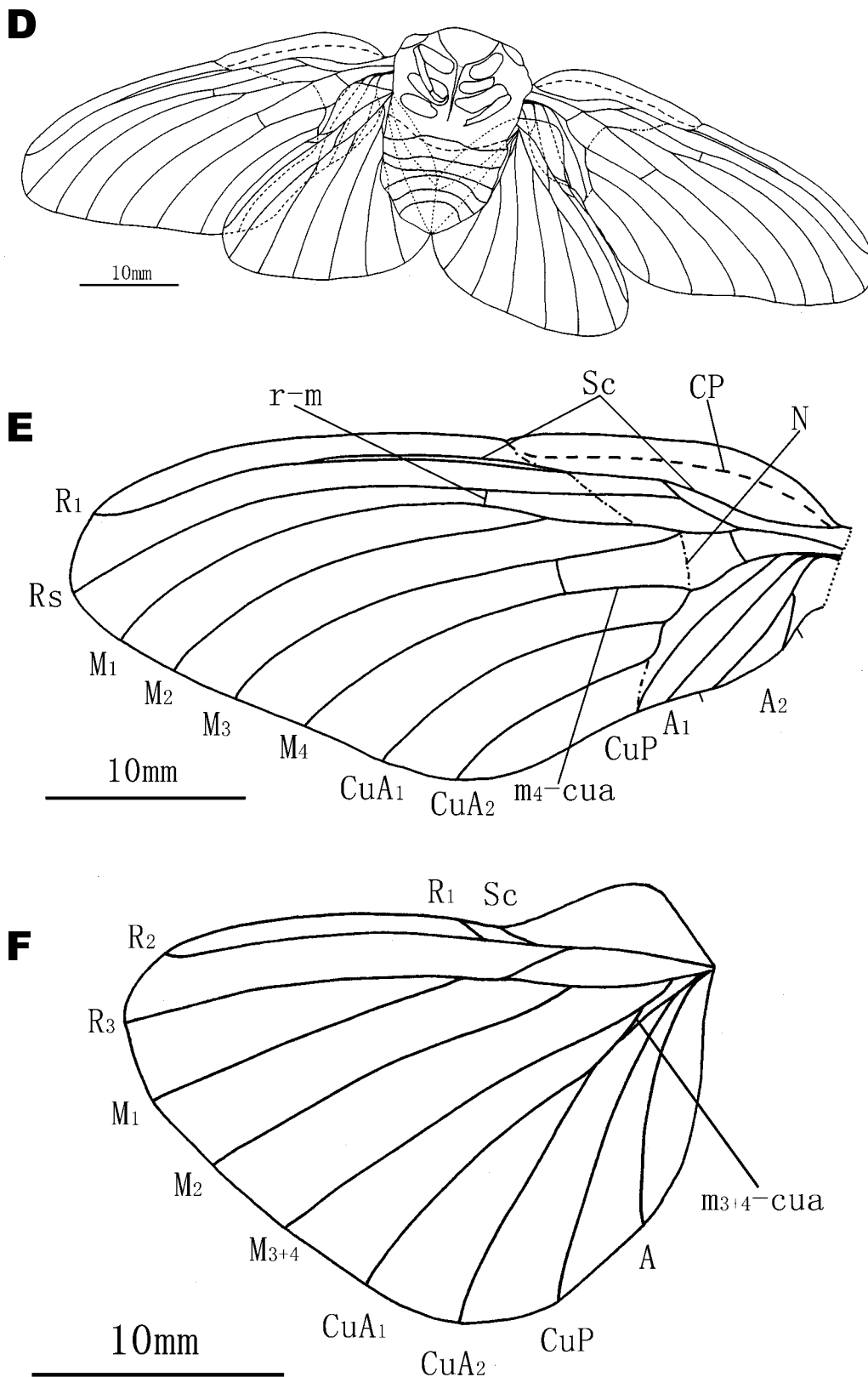


FIGURE 1 D-F. *Quadraticossus fangi* gen. & sp. nov., holotype: D, body with wings; E, forewing; F, hind wing.

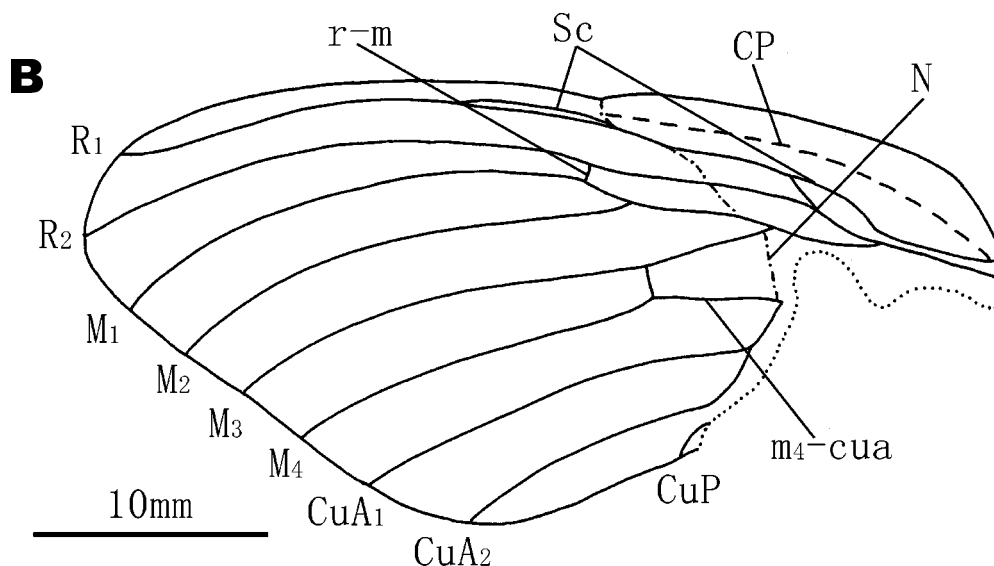
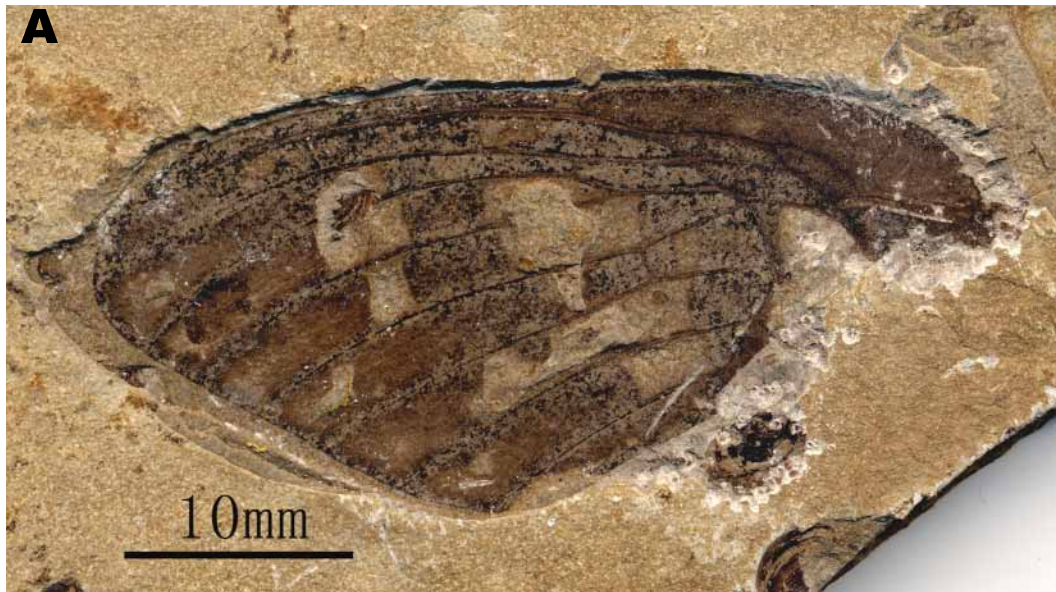


FIGURE 2. A, B, *Quadraticossus longicaulis* gen. & sp. nov., holotype: A, photograph of part CNU-H-NN2006094; B, line drawing.

Forewing (preserved part) 40 mm long, 19 mm wide.

Etymology: Specific epithet is a combination of Latin prefix longi- (long) and -caulis (stem), referring to the long stem of forewing vein M.

Material: The new species is known from a single forewing. Holotype: A single forewing, with anal area missing, No.: CNU-H-NN2006094.

Horizon and locality: Jiulongshan Formation, Middle Jurassic, Daohugou Village, Shantou Township, Ningcheng County, Inner Mongolia, China.

Remarks: This species is similar to *Q. fangi* sp. nov, but can be differentiated from the latter in the following features on the forewing: Sc with weak branches, terminating on R_1 near the middle of wing; M bifurcated into M_{1+2} and M_{3+4} at the same level of Sc fusing with R_1 ; crossvein r-m near the point of M_{1+2} branching into M_1 and M_2 ; m_4-cua is shorter than the latter.

This new species is erected based on a single incomplete forewing, but we anticipate discovery of more well-preserved specimens that will allow us to restudy this species in detail.

Genus *Hamicossus* gen. nov.

Type species: *Hamicossus laevis* sp. nov.

Diagnosis. Forewing triangular. Sc with several oblique veinlets, fused with stem of R+M at base, separating from R+M for short distance, and fusing with R again. M_4 sharply flexed. CuA connected with M_4 by horizontal crossvein.

Hind wing small, with distinct costal indentation.

Etymology: The generic name is combination of Latin prefix *ham-* (Latin *hamatus*- hooked) and *-cossus* (a common suffix for fossil palaeontinids), referring to the shape M_4 . Gender: masculine.

Species included: only the type species: *Hamicossus laevis* sp. nov.

Remarks: This new genus can be distinguished from all known genera in the following features on the forewing: Sc with several oblique veinlets and the shape of Sc (fused with stem of R+M at basal, and arising from R+M before R+M separating into R and M, and fusing with R again little after R_1 arising from R); M_4 is sharply flexed after arising from M_{3+4} ; CuA connected with M_4 by a horizontal crossvein and the shape of 2nd discal cell nearly rectangle.

This new genus is associated with a similar genus, *Liaocossus*, described by Ren, Yin and Dou, 1998 from the Late Jurassic of Liaoning. But it can be distinguished from *Liaocossus* Ren, Yin and Dou by the following characters: on the forewing, Sc with several oblique veinlets and the shape of Sc; M_4 is sharply flexed after it arising from M_{3+4} ; CuA connected with M_4 by a horizontal crossvein and the shape of 2nd discal cell nearly rectangular.

On the basis of venation, the new genus is also closely related to *Pseudocossus* Martynov, 1931, but differs from the latter in Sc fusing with R at base; crossvein m_4 -cua straight and horizontal and the shape of 2nd discal cell nearly rectangular.

Based on some venation characters (shape of nodal line; M_4 sharply flexed after arising from M_{3+4} ; CuA connected with M_4 by a horizontal crossvein and the shape of 2ed discal cell nearly rectangle), this new genus resembles *Quadraticossus* but it differs from the latter mainly by the following combination of features: Shape of Sc (fused with stem of R+M at basal, and arising from R+M before R+M separating into R and M, and fusing with R again little after R_1 arising from R), and crossvein r-m short.

***Hamicossus laevis* sp. nov.**

(Fig. 3A–B)

Diagnosis: As for genus.

Description: Head oval with a rostrum. Abdomen with at least 8 visible segments.

Forewing triangular with distinct CP and nodal line. Sc with several oblique veinlets, fused with stem of R+M at basal, and arising from R+M before R+M separating into R and M, and fusing with R again little after R_1 arising from R. Rs simple. M four-branched and bifurcating into M_{1+2} and M_{3+4} little after point of R_1 arising from R. M_4 sharply flexed after arising from M_{3+4} . Short crossvein r-m present between Rs and M_1 . Cu divided into CuA and CuP at base. CuA curved, joined with M by crossvein m-cua and also connected with M_4 by long horizontal crossvein. CuA branched into CuA_1 and CuA_2 . CuP single. Anal area with 1 visible vein. Nodal line traceable as indentation cross Sc+R and Rs to M_{1+2} , along with latter to branching point of M, dividing discal cells into two parts, following stem CuA and CuA_2 , terminating at distal end of clavus. 2nd discal cell nearly rectangle.

Hind wing smaller than forewing, costal margin curved posteriorly, forming prominent indentation.

Body 21 mm long, 13 mm wide; forewing 36 mm long, 16 mm wide; hind wing 20 mm long, 14 mm wide.

Etymology: From the Latin 'laevis' = vein smooth, indicating the shape of crossvein m_4 -cua.

Material: The new species is established based on body with a pair of forewings and a pair of hind wings. Holotype: Body with wings compression, No.: CNU-H-NN2006095.

Horizon and locality: Jiulongshan Formation, Middle Jurassic, Daohugou Village, Shantou Township, Ningcheng County, Inner Mongolia, China.

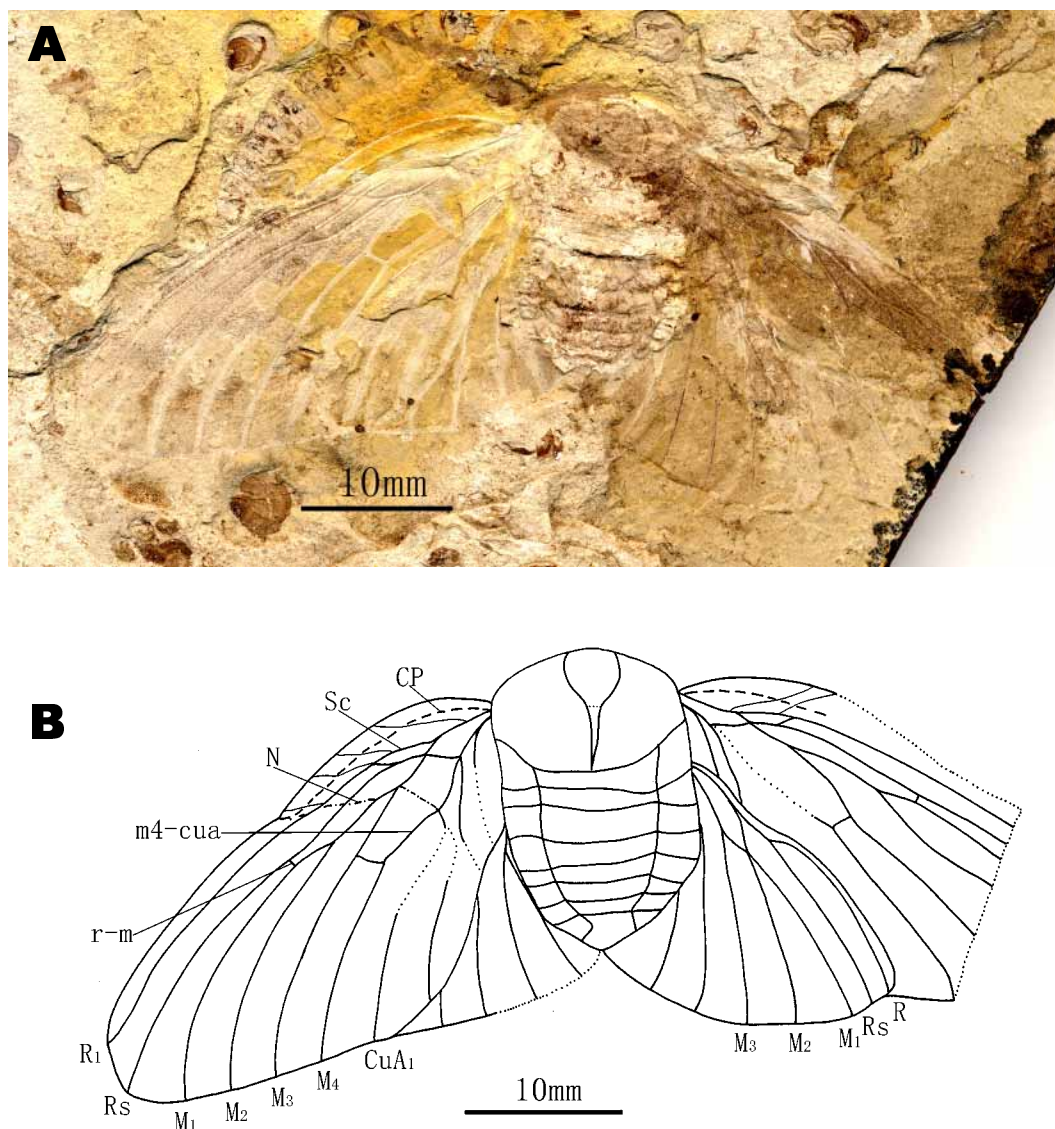


FIGURE 3. A, B, *Hamicossus laevis* gen. & sp. nov., holotype: A, photograph of part CNU-H-NN2006095; B, line drawing.

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