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A giant tettigarctid cicada from the Mesozoic of northeastern China

(Hemiptera, Tettigarctidae)

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A new genus, *Macrotettigarcta* gen. nov. in the insect family Tettigarctidae with a new species *Macrotettigarcta obesa* spec. nov., is described from the latest Middle–earliest Late Jurassic of northeastern China. The new tettigarctid cicada is giant and morphologically unique, and so adds to our knowledge of the biodiversity of the Mesozoic Tettigarctidae. In addition, the evolutionary history of Jurassic–Cretaceous Tettigarctidae in northeastern China is discussed.

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Introduction

The Tettigarctidae (hairy cicadas) is the most ancient group of the superfamily Cicadoidea and is now relict, with only two species attributed to the sole genus *Tettigarcta* White, 1845 (Moulds 1990, Shcherbakov 2009). The Mesozoic records of this family are relatively rich, but most known fossils are just incomplete forewing impressions (Li et al. 2012). The fragmentary fossil records of Tettigarctidae lead to a controversial taxonomic history (e. g. Becker-Migdisova 1949, Evans 1956, Boulard & Nel 1990, Hamilton 1990, 1996, Nel et al. 1998, Menon 2005). On basis of the morphological characters of forewing, Shcherbakov (2009) reviewed Tettigarctidae in detail, and divided the family into two subfamilies with three tribes respectively.

We here reported a new giant whole-bodied fossil tettigarctid specimen (both body and forewing length nearly 50 mm) yielded from the Middle–Upper Jurassic of northeastern China, which is discriminated from all known extinct and living tettigarctids in possessing some distinctive characters of forewing as well as other body structures. The new taxon further ascertains the fact that Mesozoic tettigarctids were highly structurally diversified, and so adds to our knowledge of the biodiversity and evolutionary history of Tettigarctidae.

Material and methods

The new specimen (NIGP151861) was collected from the Daohugou volcanic deposits of Inner Mongolia, northeastern China, and is housed in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. Up to now, approximately 20 different insect orders have been recognized (Huang et al. 2006, Ren et al. 2010), making Daohugou one of the most important insect Lagerstätte (Rasnitsyn et al. 2006). The age of Daohugou fossil-bearing strata is controversial (see Chen et al. 2014b), we tentatively consider it as Callovian–Oxfordian (latest Middle–earliest Late Jurassic) as following Wang et al. (2015).

The specimen was examined and microphotographed using stereomicroscopes (Nikon SMZ1000

and Zeiss SteREO Discovery V8). The photograph was prepared using a Nikon D800 digital camera. Line drawings were prepared with two image-editing pieces of software (CorelDraw 12.0 and Adobe Photoshop CS3). The venational terminologies used herein are followed new interpretations of wing venation pattern for all Paraneoptera as proposed by Nel et al. (2012).

Systematics

Family Tettigarctidae Distant, 1905
Subfamily Cicadoprosbolinae Evans, 1956
Tribe Cicadoprosbolini Evans, 1956

Revised diagnosis. Medium to large size. Forewing with costal area and clavus long and broad; marginal membrane narrow; basal cell broad; apical cells oblique (vs. most apical cells of consubfamilial tribes Turutanoviini Shcherbakov, 2009 and Architettigini Shcherbakov, 2009 nearly longitudinal); branches of RA at least three in number, commonly forked (except for *Macrotettigarcta* gen. nov.); crossvein *cua-cup* long; vein M+CuA branching into M and CuA just beyond its connection with crossvein *cua-cup*; vein CuA_2 relatively long. Hindwing unknown.

Macrotettigarcta gen. nov.

Type species. *Macrotettigarcta obesa* spec. nov., by present designation.

Etymology. The generic name is after the Greek "macro" (meaning large) and the generic name *Tettigarcta*.

Diagnosis. Body thick. Ovipositor relatively short. Mesonotum with longitudinal carinae. Forewing large, length about 50 mm; basal cell short and broad; nodal incision at about basal 0.6 wing length; stem ScP+R+M+CuA branching at about basal 0.18 wing length: stem ScP+R very short; vein RA three-branched; vein M+CuA branching into M and CuA at basal 0.2 wing length, just beyond its connection with crossvein *cua-cup*; stem M_{1+2} connected with M_3 by crossvein *im*; vein CuA_2 long, S-shaped; vein CuP ending at about midpoint of wing.

Type horizon and locality. Middle-Upper Jurassic, Daohugou Formation; Daohugou Village, Ningcheng County, Chifeng City, Inner Mongolia, China.

Macrotettigarcta obesa spec. nov.
Figs 1–2

Holotype. NIGP151861a, b, part and counterpart; adult female in lateral aspect with one forewing at top of body and the other outspread.

Diagnosis. As for the genus.

Description

Measurements. Body length: 48.1 mm. Pronotum length: 10.8 mm. Forewing length: 48.9 mm; width: 19.3 mm.

Body. Thick. Compound eyes large, almost circular. Postclypeus strongly convex, with distinct transverse grooves. Pronotum with posterior area transversely rugose, anterior margin nearly straight, posterior margin distinctly concave medially, median length of pronotum 3 times that of vertex. Rostrum long, extending to abdomen. Legs obscured. Abdomen obese, with eight segments visible. Ovipositor relatively short.

Forewing. Elongate. Costal margin moderately arched, convex at basal 0.25 wing length, and costal area long. Clavus strongly arched, large and broad. Nodal incision distinct at about basal 0.6 wing length. Stem ScP+R+M+CuA branching at basal 0.18 wing length. Stem ScP+R very short, branching into veins ScP+RA and RP at basal 0.23 wing length. ScP separating from ScP+RA just before nodal incision and then terminating at nodal incision. Stem RA straight, with three terminations. Branches RA_1 and RA_2 subparallel; branch RA_3 connected with vein RP by a short crossvein *ir*. Vein RP slightly curved, geniculate just before bifurcation of ScP+RA, and then nearly straight, and connected with branch M_1 by a long crossvein *r-m*. Vein M+CuA branching into M and CuA at basal 0.2 wing length, just beyond its connection with long crossvein *cua-cup*. Stem M branching into veins M_{1+2} and M_{3+4} at basal 0.4 wing length. Vein M_{1+2} connected with M_3 by crossvein *im*. Vein M_{3+4} branching into veins M_3 and M_4 basal of bifurcation of vein M_{1+2}. Branch M_3 sinuous, slightly longer than M_4. Stem CuA strongly curved at base, then nearly straight, and branching into veins CuA_1 and CuA_2 at basal 0.52 wing length. Vein CuA_1 nearly straight, connected with M_4 by crossvein *m-cua*, and then slightly curved. Vein CuA_2 nearly S-shaped and extremely long. Vein CuP long, nearly straight, ending at about midpoint of wing. Vein A_1 slightly sinuous. Vein A_2 short and terminating basal of bifurcation of stem ScP+R+M+CuA at inner margin. Hindwing unknown.

Etymology. The specific epithet refers to the obese body.

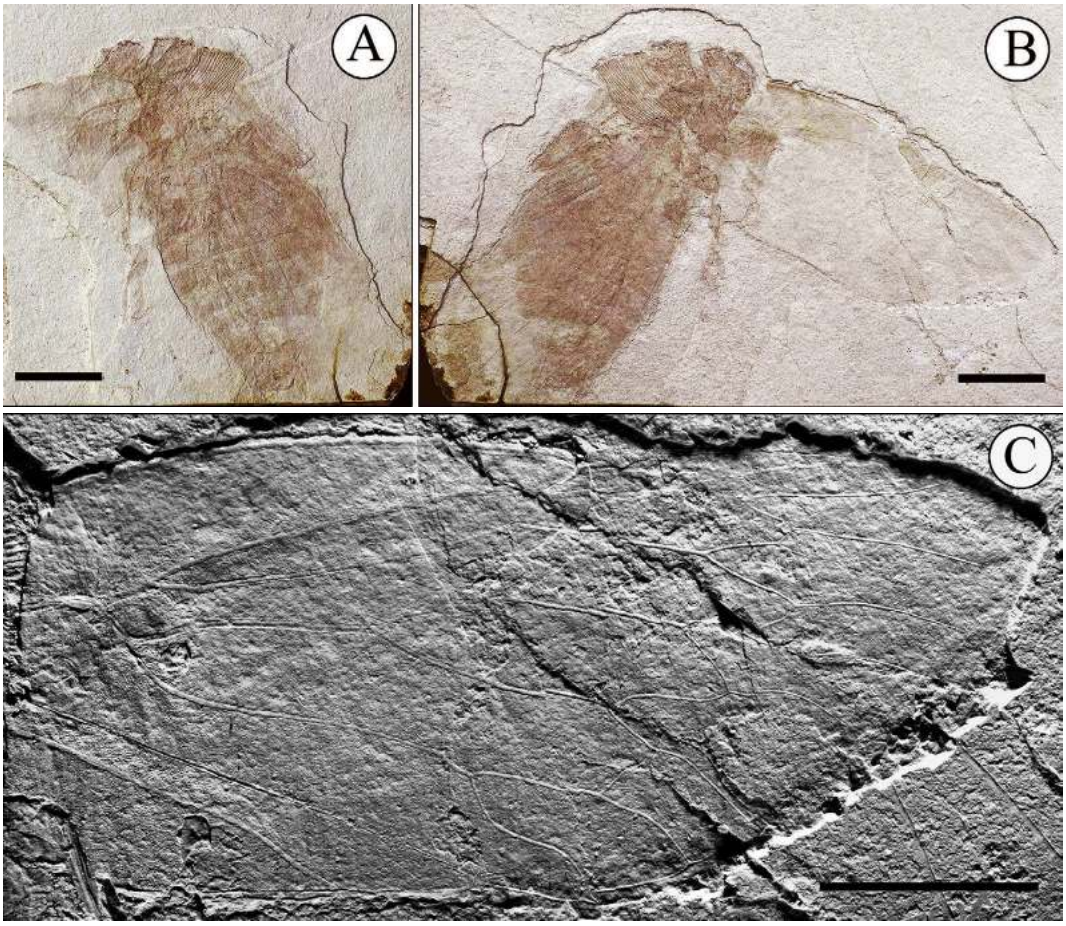

Fig. 1. Photographs of the holotype of *Macrotettigarcta obesa* spec. nov. **A.** Part. **B.** Counterpart. **C.** Enlargement of forewing in black-and-white. Scale bars = 10 mm.

Occurrence. Middle–Late Jurassic; Daohugou Village, Ningcheng County, Chifeng City, Inner Mongolia, China.

Discussion

The new taxon undoubtedly belongs to the family Tettigarctidae based on the following characteristics: postclypeus greatly inflated; pronotum expanded, with posterior area transversely rugose; forewing with vein RA forked and RP single; vein M four-branched; vein CuA two-branched, vein A_1 and A_2 simple. However, it distinctly differs from all known extinct and living tettigarctids in having ovipositor relatively short, mesonotum with longitudinal carinae, and forewing with basal cell short and broad, crossvein *im* connecting vein M_{1+2} instead of M_2, and CuA_2 extremely long and nearly S-shape. Due to its broad costal area and clavus, the new genus can be attributed to the subfamily Cicadoprosbolinae. In addition, we attribute the new genus to Cicadoprosbolini Evans, 1956 based on forewing characters: vein M+CuA branching into M and CuA just beyond its connection with crossvein *cua-cup*, most apical cells oblique (not longitudinal), and CuA_2 extremely long, which is discriminated from the consubfamilial tribes Turutanoviini Shcherbakov, 2009 and Architettigini Shcherbakov, 2009.

The known diversity of Mesozoic tettigarctids is rich, with approximate 25 species attributed to about 15 genera, widespread in Eurasia, Australia, Africa and South America (Shcherbakov 2009, Wang & Zhang 2009, Li et al. 2012, Chen et al. 2014a). The earliest Tettigarctidae appeared in the terminal Triassic of England, and then flourished in the Jurassic

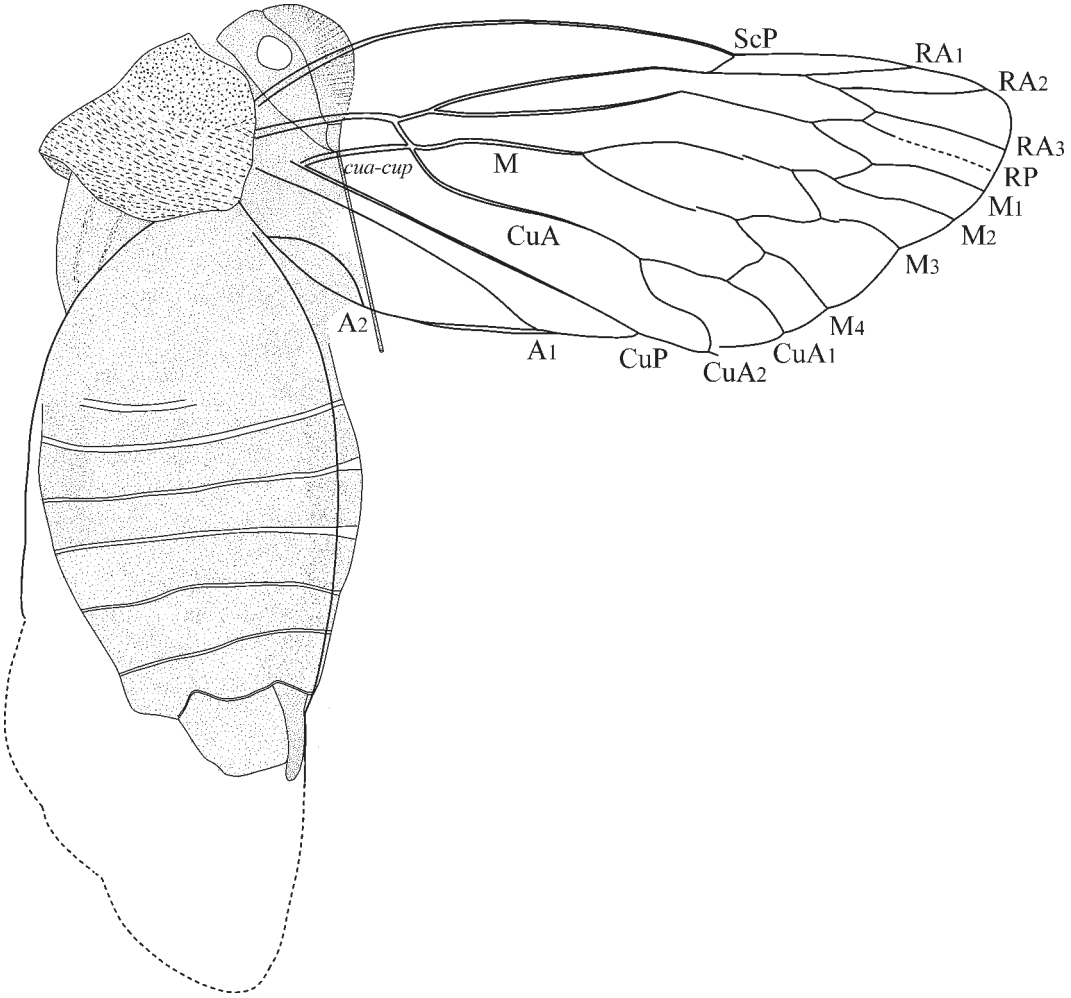

Fig. 2. Illustration of the holotype of *Macrotettigarcta obesa* spec. nov.

and Early Cretaceous (Whalley 1983, Shcherbakov & Popov 2002, Wang & Zhang 2009, Chen et al. 2014a). However, the fossil records of the Late Cretaceous and Cenozoic tettigarctids are relatively rare, and the relict extant genus *Tettigarcta* White, 1845 is just restricted to the mountains of Tasmania and South-East Australia (Moulds 1990, Piton 1936, Zeuner 1944, Wappler 2003, Kaulfuss & Moulds 2015). The scarcity of tettigarctids in the Late Cretaceous and Cenozoic is probably due to angiosperm floristic revolution and competitive displacement with singing cicadas (Cicadidae) (Wang & Zhang 2009).

The Tettigarctidae is abounded and morphologically diversified in the Jurassic strata of northeastern China. The Jurassic tettigarctids make up about 9 % of the Mesozoic cicadomorph fossil materials of this area (Wang et al. 2013). Up to now, eight species within five genera have been reported from the Jurassic deposits of northeastern China, and meanwhile some taxa new to science are still undescribed (Hong 1982, 1983, Wang & Zhang 2009, Li et al. 2010, 2012, Chen et al. 2014a; this study). Interestingly, no fossil tettigarctids have been described from the Lower Cretaceous of northeastern China (i. e., the famous Jehol Group) up to now and the known unreported tettigarctids of the Jehol Group are also very few. Considering that the Procercopidae and Palaeontinidae, common in the Jurassic of northeastern China, are also well represented by many specimens in the Jehol Group, the scarcity of the Tettigarctidae is unlikely a result of taphonomical bias. In the Late Jurassic–Early Cretaceous, numerous feathered

theropods, early birds, and primitive mammals appeared, and the intense predation pressures might result in the decline of the diversity of Palaeontinidae (Wang et al. 2008, Wang et al. 2010). The similar scenario likely also appeared for tettigarctids, which are large-sized arboreal cicadomorphs with a similar body and wing shape like Palaeontinidae (Wang et al. 2013), in the Late Jurassic–Early Cretaceous in northeastern China.

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