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New Early Cretaceous hylicellids (Insecta: Hemiptera: Cicadomorpha) from Southwest Beijing, China

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The clade Clypeata, Qadri, 1967 unites all living Cicadomorpha (Cercopoidea, Cicadoidea, Myerslopioidea and Membracoidea) and their common stem group (Wang *et al*., 2012; Chen *et al*., 2019). The Clypeata first appeared in the Late Permian; and during the early Mesozoic modern cicadomorphan lineages gradually rose and flourished (Shcherbakov & Popov, 2002; Szwedo, 2018).

The extinct and poorly-studied family Hylicellidae Evans, 1956 (which is considered the common ancestor to all extant superfamilies of Cicadomorpha) evolved from the Prosboloidea by the Middle Triassic (Shcherbakov, 1996; Wang *et al*., 2012). Their taxonomic diversity is still weakly recognized (Li *et al*., 2010). Fossil Hylicellidae include 17 valid genera with 28 species that are classified into three subfamilies (Hylicellinae Evans, 1956, Vietocyclinae Shcherbakov, 1988 and Conjucellinae Shcherbakov, 2012) occurring from the Upper Triassic to the Early Cretaceous. Vietocyclinae is known from the Early Jurassic to the Early Cretaceous of Eurasia, comprising two valid genera: *Cycloscytina* Martynov, 1926 and *Vietocycla* Shcherbakov, 1988. Up to now, the Cretaceous Vietocyclinae is very rare, with only single species reported: *Vietocycla peregrina* Shcherbakov, 1988, from the Lower Cretaceous Zaza Formation of Baissa in Buryatia, Russia.

The Lushangfen entomofauna contains abundant fossil insects and is one of the important Early Cretaceous entomofaunas in studying fossil insects (Hong, 1981; Ren, 1995; Huang & Zhang, 1997; Huang & Yang, 1999; Huang & Lin, 2001; Zhang *et al*., 2001; Zhang, 2002; Huang *et al*., 2009). To date, seven genera and 10 species of cicadomorphan insects have been described from the Lushangfen Formation of Southwest Beijing, including procercopids, palaeontinids as well as Fulgoroidea planthoppers (Ren, 1995; Zhang, 2002). Herein we report a new species of hylicellid, *Vietocycla katyae* **sp. nov.**, from the Lower Cretaceous Lushangfen Formation at Southwest Beijing, China.

Geological setting

In 1981, Hong studied the Lushangfen entomofauna on the basis of new finding of various fossil insects and assigned *Xishania fusiformis* Hong, 1981 as the representative species. Ren *et al.* (1995) described a large number of fossil insects from the area near the Chongqing Reservoir but no *Xishania fusiformis* were found; instead *Hemeroscopus baissicus* Pritykina, 1977 was considered as the representative species. Xiao (1994) also reported some fossil insects from the overlying Xiazhuang Formation, represented by *H. baissicus*. The fossil insects of the Lushangfen and Xiazhuang formations are collectively called the Lushangfen entomofauna represented by *H. baissicus*, with the lower assemblage rich in *X. fusiformis* (Huang *et al*., 2012).

The current stratigraphic division tends to divide the so-called 'Lushangfen Formation' into different formations, viz., Member 1 and Member 2 of the 'Lushangfen Formation' are assigned to the Tuoli Formation, while Member 3 and Member 4 are assigned to the Xiazhuang Formation (Bureau of Geology and Mineral Resources of Beijing Municipality, 1996). The fossil insects of the original 'Lushangfen Formation' were found in Member 4, belonging to the lower assemblages of the Lushangfen entomofauna; fossil insects persevered in the Xiazhuang Formation belonging to the upper assemblage of the Lushangfen entomofauna. The palynological assemblages of the Lushangfen Formation reveal middle and late stages of the Early Cretaceous. The lower palynological assemblage can be compared with that of the Fuxin Formation, and the upper assemblage correlate the period of the Aptian–Albian stages (Zhang & Chang, 1994). Con-

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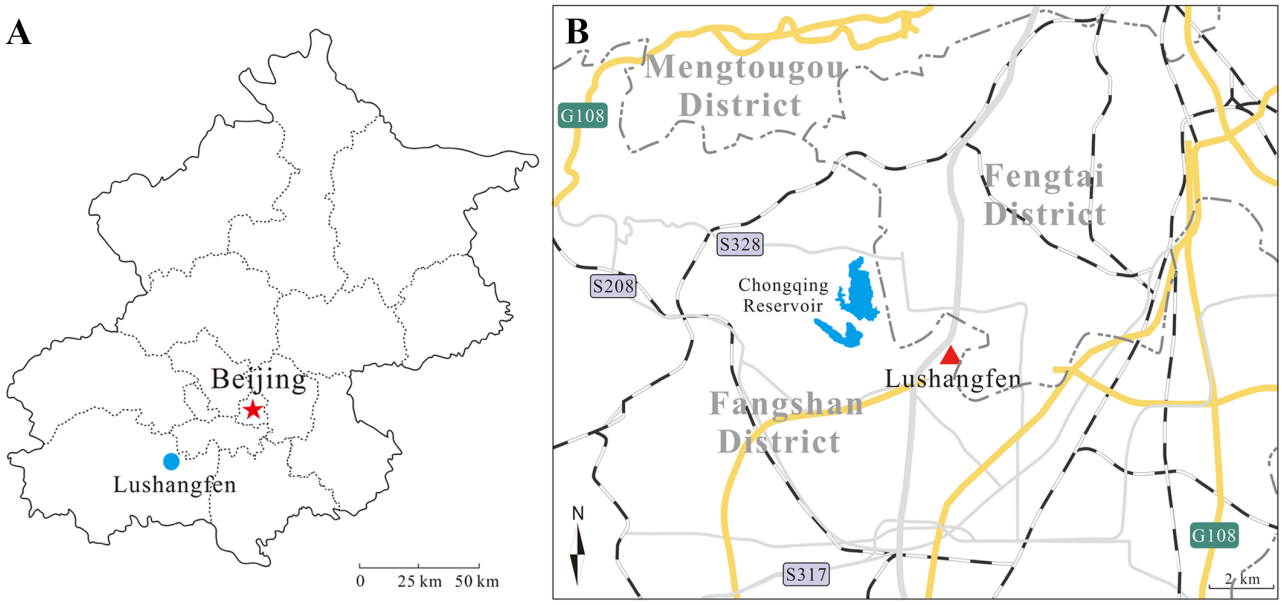

FIGURE 1. Maps of the fossil locality of *Vietocycla katyae* **sp. nov. A**, Showing the location in Beijing, with blue circle indicating the Lushangfen village, where the holotype was discovered. **B**, Detailed map of the fossil locality, with red triangle indicating the Lushangfen village.

chostracans from Member 4 of the Lushangfen Formation is closely linked with that form the Fuxin Formation of Western Liaoning Province, perhaps assigned to the Late Aptian (Liao *et al*., 2014).

Material and methods

A complete forewing (NIGP169636) preserved in yellowish paper-like shale collected by one of us (DH) in 1995 from Member 4 of the Lushangfen Formation, at the Lushangfen Village, Fangshan District, Beijing (Fig. 1).

Observations were made using an Olympus SZX7 microscope. Photographs were taken using a digital camera attached to a Zeiss Discovery V16 microscope; confocal images were made using Helicon Focus 6 software. Maps and line drawing were drafted with CorelDRAW X7 graphic software. The invert function in Photoshop CS6 software was used to invert colors of specimen images to show certain details more clearly. The holotype studied here is deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China.

Wing venation terminology follows Bourgoin *et al.* (2015) and Nel *et al.* (2012). All measurements are presented in millimeters.

Systematic palaeontology

Family Hylicellidae Evans, 1956
Subfamily Vietocyclinae Shcherbakov, 1988
Genus *Vietocycla* Shcherbakov, 1988

Type species. *Vietocycla peregrina* Shcherbakov, 1988; by original designation and monotypy.

***Vietocycla katyae* sp. nov.**

Holotype. NIGP169636, a complete forewing.

Etymology. The specific name commemorates the late Dr. Ekaterina (Katya) Sidorchuk. She untimely deceased in January, 2019.

Type locality, formation and age. The Lushangfen Village, Fangshan District, Southwest Beijing, China; Early Cretaceous; Lushangfen Formation.

Diagnosis. The new species is distinguished from the type species of the genus by the following characters: tegmen relatively wide, with length/width ratio about 2.6; stem ScP + R branching into ScP and RA nearly midpoint of wing; RA with six branches and seven terminals; RP with two branches and eight terminals; MP with at least twelve terminals; CuA with four terminals; crossveins including four im and a single m-cu.

Description. Tegmen length 15.9 mm long and 6.1

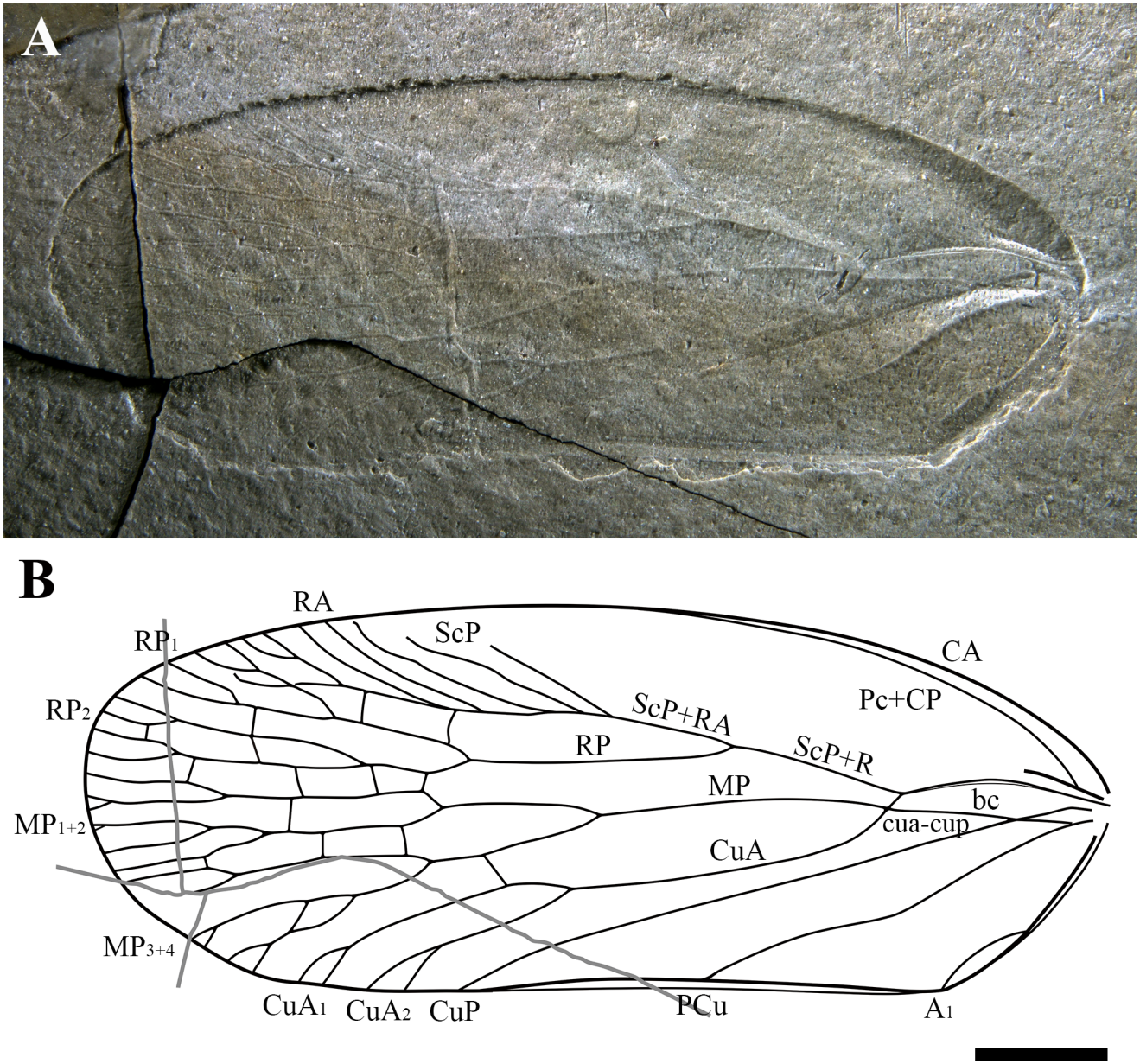

FIGURE 2. Holotype (NIGP169636) of *Vietocycla katyae* **sp. nov. A**, Photograph of forewing. **B**, Line drawing of forewing. (Scale bar = 2 mm).

mm wide, about 2.6 times as long as wide (Fig. 2); basal cell and claval portion of tegmen punctate; costal margin thickened, mildly curved at base; posterior margin nearly straight; angulately rounded in apical portion of tegmen, with no projecting apex; basal cell nearly 0.22 times as long as tegmen, with a short common portion of MP + CuA closing it apically; basal portion of ScP slightly shifted from stem R + MP + CuA, not reaching half of basal cell length; Pc + CP relatively long, extended beyond apex of basal cell, reaching 0.47 of tegmen length; stem ScP + R leaving basal cell slightly basal of MP + CuA fork, branching into ScP + RA and RP at level of PCu fusion with margin, reaching 0.37 of tegmen length; ScP + RA branching into ScP and RA basal of MP branching, nearly at midpoint of wing; a few prenodal branches of ScP weak, posteriad of ScP + RA and RP fork; RA with six branches and seven terminals, the posteriormost branch of RA connecting base of RP_{1a}; RP connecting RA by two crossveins ir, branching into RP_1 and RP_2 reaching 0.63 of tegmen length; RP_1 with four terminals, RP_2 with four terminals; MP with at least twelve terminals visible, connecting RP by four crossveins r-m, branching into MP_{1+2} and MP_{3+4} basal of CuA branching; MP_{3+4} with six terminals visible, the posteriormost two branches of MP_{3+4} fused at middle and then separated; CuA curved anteriorly, branching into CuA_1 and CuA_2 reaching 0.63

of tegmen length; CuP almost straight, ending distinctly after midpoint of wing; PCu slightly curved, proximally well separated from A_1; A_1 simple, arcuate; crossveins including two ir, four r-m, four im and a single m-cu visible.

Discussion

The systematic position, early evolution, palaeobiogeography, and palaeoecology of Hylicellidae are poorly-known (Li *et al*., 2010). Most hylicellids are described only on the basis of wing fragments such as *Hylicella* and *Cinemala* (Evans, 1956; Shcherbakov, 2012). The new species, *Vietocycla katyae* **sp. nov.** described here exhibits forewing venation only, it can definitely be assigned to the subfamily Vietocyclinae (Hylicellidae) based on the apical part of forewing with rich venation, including longitudinal veins and crossveins.

The new species is placed in *Vietocycla* because it shares several critical characters of forewing venation with *Vietocycla peregrina* Shcherbakov, 1988, from the Lower Cretaceous Zaza Formation of Baissa, Yeravnenskiy District, Buryatia, Russia. However, it differs from the latter in the following characters: 1) stem ScP + RA branching into ScP and RA nearly at midpoint of wing in contrast to ScP + RA absent in *V. peregrina*; 2) RP with two branches and eight terminals in contrast to RP simple in *V. peregrina*; 3) MP with at least twelve terminals, the posteriormost two branches of MP_{3+4} fused and then separated in contrast to MP with nine terminals in *V. peregrina*; 4) CuA with four terminals in contrast to CuA with two terminals in *V. peregrina*; 5) crossveins including four im and a single m-cu in contrast to crossveins including eleven im and two m-cu in *V. peregrina*.

Our discovery represents the second species of *Vietocycla* and the first record of Hylicellidae from China. Thus, it broadens the biogeographic distribution and increases the documented palaeodiversity of the Cretaceous hylicellids. Additionally, the present material provides evidence indicating the stratigraphic correlation between the Lushangfen Formation at Southwest Beijing, China and the Zaza Formation at Buryatia, Russia.

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