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A new species of the genus *Kodaianellissus* Wang, Bourgoin & Zhang (Hemiptera: Issidae) with morphological and molecular data

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Abstract

Kodaianellissus gibbusis **sp. nov.** is described from Rawlakot, Azad Jammu & Kashmir (Pakistan), which is first record of the genus *Kodaianellissus* Wang, Bourgoin & Zhang, 2017 from the country. Morphological characters including male genitalia structure are described and illustrated. A checklist and key to all species of *Kodaianellissus* are provided. A molecular analysis with morphological characters indicates its placement into the *Kodaianellissus*.

Key words: Fulgoromorpha, taxonomy, morphology, checklist, molecular analysis

Introduction

Issidae Spinola, 1839 are widely distributed and is one of the species-rich planthopper families (Gnezdilov 2013a). Currently this family encompasses 1030 species in 197 genera (Bourgoin 2018). The Fulgoromorpha fauna of Pakistan is very diverse but unfortunately remained terra incognita concerning the family Issidae. Until now, only three species of Issidae have been recorded from the country: *Quadriva artemisiae* Ghauri, 1965, *Ziartissus artemisiae* Qadri et Mirza, 1966, and *Eusarima albifrons* Gnezdilov, 2016.

The genus *Kodaianellissus* Wang, Bourgoin & Zhang, 2017 was established by Wang, Bourgoin & Zhang (2017) for the type species *Kodaianellissus intorqueus* from Yunnan (China). Currently, the genus *Kodaianellissus* comprised of only one species, *K. intorqueus*. The new species described herein is the second representative of *Kodaianellissus* and this genus is a new record for the Fulgoroidea fauna of Pakistan.

Materials and methods

Fresh specimens collected from Pakistan (preserved in 70% Ethanol) were used in this study. Specimens mounted on card point were used for the description. Morphological terminology follows Gnezdilov (2003) and Bourgoin *et al.* (2015). Taxonomy of Issidae follows Wang *et al.* (2016). Morphological characters were observed using the stereomicroscope Olympus SZX10. Measurements of characters are given in millimeters (mm). The genital segment was removed from the examined specimen and macerated in 10% NaOH for 10–12h at room temperature. The genitalia were then placed in water for a few minutes and then transferred to a depression slide filled with glycerin for further study. Photographs of the adults were taken using a Zeiss AxioCam ICc 5. Adobe Photoshop was used for labeling and plate composition of the obtained images.

The total genomic DNA was extracted from abdominal muscles by using TransGen EasyPure Genomic DNA Kit. COI and Cytb genes were gained using the same primers and amplification procedure as Wang *et al.* (2016). Seqman (www.dnastar.com) was used for assembling contigs. MEGA v7.0 (Kumar *et al.* 2016) was used for alignments. Phylogenetic relationships reconstruction was based on the concatenated data of the 2 genes by using ML (maximum likelihood) and BI (Bayesian inference) analyses. IQtree online (Nguyen *et al.* 2015) was used for maximum likelihood phylogenetic analysis using 10000 ultrafast bootstrap with substitution model automatically select-

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ed. Bayesian inference phylogenies were inferred using MrBayes 3.2.6 (Ronquist *et al.*, 2012) under partition model (2 parallel runs, 5,000,000 generations), in which the initial 25% of sampled data were discarded as burin-in.

Materials examined in this study are deposited at the Entomological Museum of Northwest A&F University (NWAFU) Yangling, Shaanxi China. The COI and Cytb sequences of *Kodaianellissus gibbusis* **sp. nov.** were registered in GenBank with accession numbers MN560154 (COI) and MN560155 (Cytb), the other sequences used in this study were obtained from the National Center for Biotechnology Information (https://www.ncbi.nlm.nih.gov).

Checklist of species of the genus *Kodaianellissus*

Kodaianellissus intorqueus Wang, Bourgoin & Zhang, 2017: 357–359, figs 1–11.
Distribution: China (Yunnan)

Taxonomy

Issidae Spinola, 1839

Hemisphaeriinae Melichar, 1906

Kodaianellini Wang, Zhang & Bourgoin, 2016

Kodaianellissus Wang, Bourgoin & Zhang, 2017

Key to species of *Kodaianellissus*

1. Male anal segment in dorsal view with straight apical and dorsolateral margins; aedeagus with pair of hooks directed downwards in ventral view . . . . . *Kodaianellissus gibbusis* **sp. nov.**
- Male anal segment in dorsal view slightly convex in apical margin, laterally with two convex angles; aedeagus with pair of hooks directed outwards in ventral view (Wang *et al.*, 2017, figs 4, 8, 11) . . . . . *Kodaianellissus intorqueus*

Kodaianellissus gibbusis Kamran, Huang et Zhang, sp. nov.

Description: Length of male (from apex of head to tip of forewing, N=3) 5.5–6.0 mm.

Vertex and frons yellowish brown, anterior margin of frons black with small yellow spots, lateral margins yellowish with brown markings. Clypeus yellowish. Eyes greyish with tanned bands. Gena and antennae brown. Pronotum yellowish, mesonotum light brown. Abdomen dark brown dorsally. Tegmina, legs and longitudinal veins brown, cross veins yellowish.

Disc of vertex rectangular, 1.9 times wider than long, centrally and laterally carinate, two rounded markings near lateral margins. Posterior margins concave, anterior margins slightly curved in mid line at apex, lateral margins slightly transverse (Fig. 1D). Frons slightly globose, broader behind the eyes (Fig. 1C), median carina obvious, lateral margins slightly straight, concavely truncated behind eyes, obliquely narrow near clypeus (Fig. 1C). Clypeus with distinct brown transverse strips (Fig. 1C). Large compound eyes (Figs. 1C, D). Gena smooth, oblique in lateral view (Fig. 1B). Pronotum longer than vertex centrally, anterior margin convex, strongly carinate; posterior margin truncate, central carina yellowish, two black incisions near median carina on the disk (Fig. 1D). Mesonotum as long as pronotum, two brown spots near lateral margins and near base on each side of the disc, posterior one obviously smaller than apical one. Tegmina, distinctly longer than wide, ScP+R vein forked near base, ScP+RA vein long reaching ⅓ costal margin, RP vein very long, exceeding 1/3 of costa distad at outer margin of tegmina. MP vein bifurcate near basal ¼ long surpassing, MP_{1+2} and MP_{3+4} sinuate at apical margin. Cu forked at apical ⅓, Pcu and A_1 combine at basal half of clavus (Fig. 1E). Hind wing fully developed tri-lobed. Lobe Pcu-A_1 distinctly longer than wide; A_2 lobe narrower distad at ⅓ of Pcu-A_1, A_2 lobe simple, longer not forked (Fig. 1F). Hind tibiae with two lateral spines, spinal formula 8-7-2.

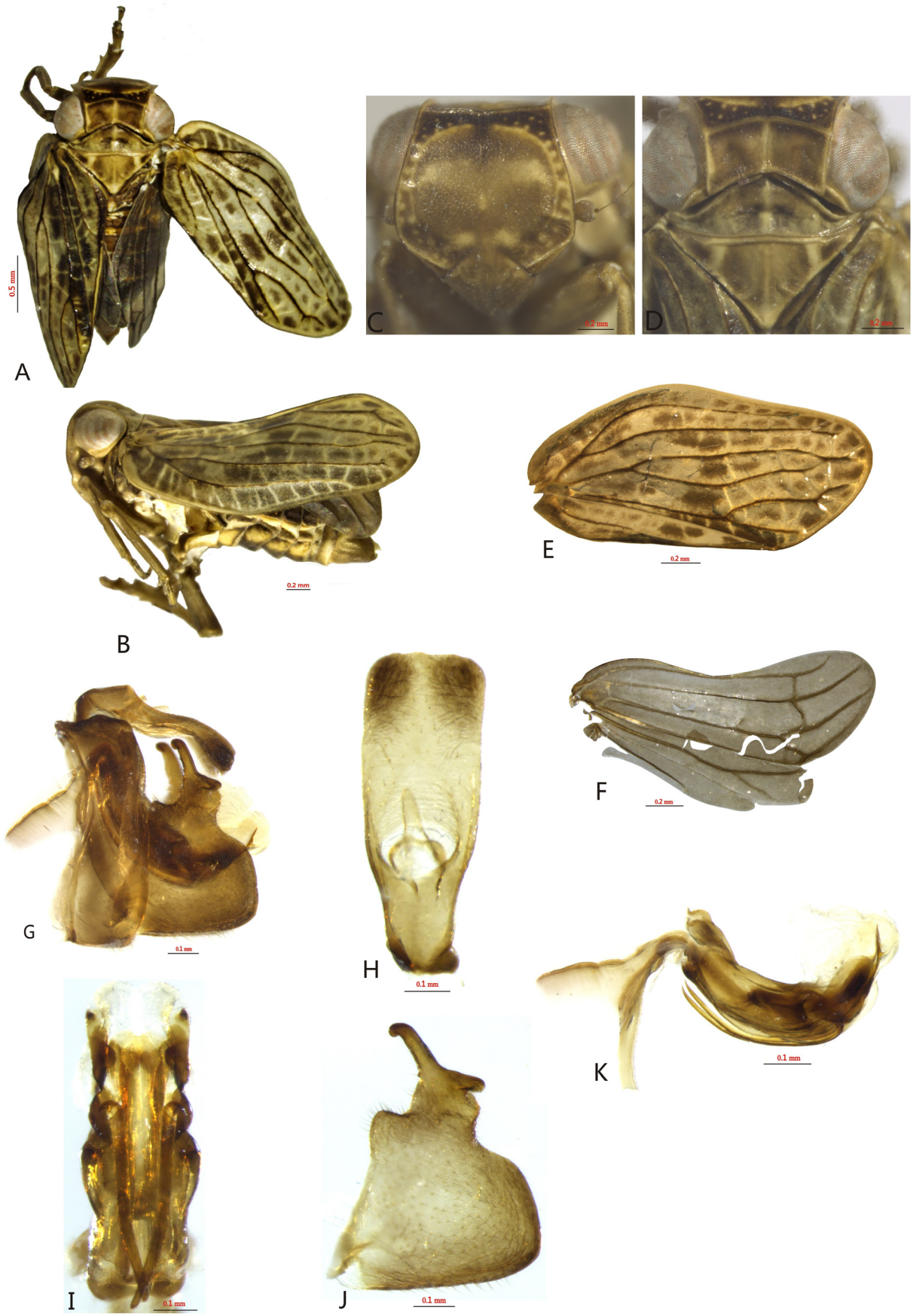

FIGURE 1. A–K. *Kodaianellissus gibbusis* **sp. nov.** A. adult, dorsal view; B. adult, right lateral view; C. frons, ventral view; D. vertex, pronotum & mesonotum dorsal view; E, F. fore and hind wings left lateral view; G. pygofer, lateral view; H. anal segment, dorsal view; I. aedeagus, ventral view; J. genital style, lateral view; K. phallic complex, lateral view.

Male genitalia. Anal segment in dorsal view (Fig. 1H) rectangular, longer than wide, laterally straight, slightly convex at basal half, anal foramen short, located in basal half (Fig. 1H). Anal tube in lateral view long, convex at posterior ⅓, ventral margins slightly prominent (Fig. 1G). Pygofer in lateral view, long and slender with parallel anterior and posterior margins (Fig. 1G). Genital styles rectangular, widest at basal ⅓, caudoventrally rectangular slightly curved near base of capitilum at posterior margin, dorsolaterally provided with hump-like processes near base of capitulum (Fig. 1J). Capitilum very long, tubular, apically sclerotized slightly bent directed anteriorly, posterior margin with lobe-like process (Fig. 1J). Aedeagus in lateral view elevated at both sides, divided into two lobes, dorsolateral lobe slightly membranous in apical portion, centrally convex. Sharp sclerotized spines directed dorsad on each side of ventral apical part (Fig. 1K). In ventral view, periandrium is long U-shaped, somewhat symmetrical, dorsolateral margins twisted in distal half, pair of long hooks arising in distal half directed downwards (Fig. 1I).

Type materials: Holotype: ♂ Rawlakot, Azad Jammu & Kashmir, Pakistan, 33°51'32.18"N, 73° 45'34.93"E, 1628 m, 14-vii-2018, coll. Kamran Sohail. Paratypes 2♂♂, same data as holotype.

Female: Unknown.

Etymology: Latin word "*gibbus*" means hump, referring to hump-like processes near base of capitilum on dorsolateral side.

Host plants: Unknown.

Diagnosis: *Kodaianellissus gibbusis* **sp. nov.** can be differentiated from *K. intorqueus* by characters mentioned in the key.

Remarks: Phylogenetic analyses of 5 species of Hemisphaeriinae, including two out-groups (*Gelastyrella litaoensis* and *Darwallia barbata*), based on ML and BI analyses of nucleotide sequence data of two genes, yielded almost same topologies with strong support (Fig. 2). The molecular analyses (Fig. 2) with morphological characters indicates its placement into the *Kodaianellissus*.

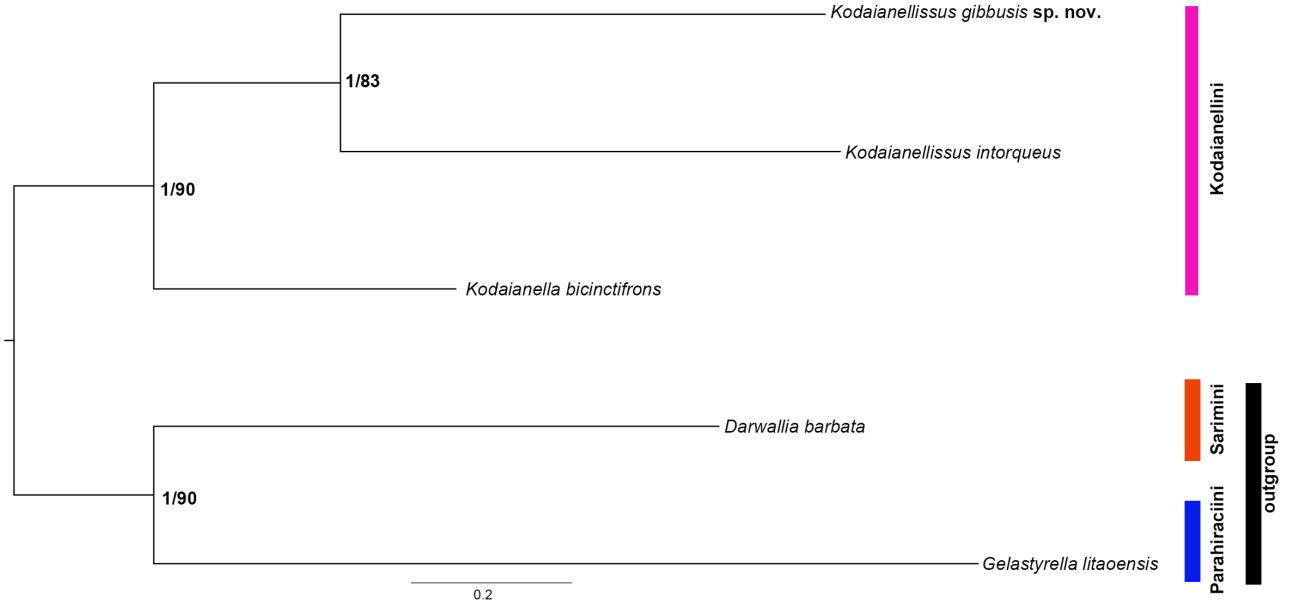

FIGURE 2. Phylogenetic tree based on COI and cytb sequences with *Gelastyrella litaoensis* (Hemisphaeriinae, Parahiraciini) and *Darwallia barbata* (Hemisphaeriinae, Sarimini) as outgroup to test the position of *Kodaianellissus gibbusis* **sp. nov.** in the classification with the genus *Kodaianella*. At each node, values indicate Bayesian PP and ML support: Bayesian posterior probability (PP) / ultrafast bootstrap (UFB) values.

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