



Five new species of *Ishiharella* Dworakowska (Hemiptera: Cicadellidae: Typhlocybinae) with a key to worldwide species of the genus

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Abstract

Detailed morphological descriptions and illustrations of five new species of the empoascine leafhopper genus *Ishiharella* Dworakowska (Typhlocybinae: Emposascini): *I. dentidensa* Yu & Yang, **sp. nov.**, *I. falcata* Yu, Yang & Dietrich, **sp. nov.**, *I. hirsuta* Yu, Yang & Dietrich, **sp. nov.**, *I. inflata* Yu & Yang, **sp. nov.** and *I. multiprotrusa* Yu, Yang & Dietrich, **sp. nov.** are provided and a key to species of the genus is given.

Key words: Auchenorrhyncha, Emposascini, *Ishiharella*, taxonomy

Introduction

The genus *Ishiharella* established by Dworakowska (1970) and included in the typhlocybine leafhopper tribe Emposascini, includes 6 previously described species distributed from Russia (the Caucasus) to Japan and China, including *Ishiharella polyphemus* Matsumura, 1931 (type species of the genus), *Ishiharella iochoui* Dworakowska, 1982, *Ishiharella hastata* Qin & Zhang, 2004, *Ishiharella dentata* Qin & Zhang, 2004, *Ishiharella donanensis* Ohara, 2010 and *Ishiharella paradentata* Lu & Qin, 2015.

During our work on the genus, five new species from China and Thailand were found, and detailed morphological descriptions are given here.

Material and methods

The methods and terminology follow Zhang (1990) except for the nomenclature of the wing, for which we follow Dworakowska (1993). Male specimens were dissected under a MOTIC B1 SMS-168 SERIES microscope. Figures were made using OLYMPUS CX41 and enhanced using Adobe Illustrator CS4. Photos were taken with a VHX-1000C digital camera and edited with Adobe Illustrator CS4. The body length is measured from the apex of the head to the apex of the folded forewing. The specimens examined are stored in The Institute of Entomology of Guizhou University, P. R. China (IEGU) and Queen Sirikit Botanical Garden, Chiang Mai, Thailand (QSBG).

Results

Genus *Ishiharella* Dworakowska, 1970

Ishiharella Dworakowska, 1970, Bulletin de l'Académie Polonaise des Sciences. Série des Sciences Biologiques, 18 (11): 716.

Type species. *Ishiharella polyphemus* (Matsumura, 1931)

Description. Body robust (Figs 44, 46, 48, 50, 52). Crown broad, coronal suture absent, anterior margin rounded, with median black spot, posterior margin concave, midline shorter than interocular width (Figs 44, 46, 48, 50, 52). Face broad, width across eyes nearly equal to length, frontoclypeus swollen (Figs 45, 47, 49, 51, 53). Pronotum large, much longer and slightly wider than crown, with pair of sublateral curved markings; scutoscuteellar sulcus distinct, not reaching lateral margin (Figs 44, 46, 48, 50, 52). Forewing with RP and MP' stalked, RP, MP' and MP''+CuA' arise from m cell; hindwing with CuA unbranched.

Abdominal apodemes not greatly enlarged (Figs 1, 10, 19, 28, 36). Pygofer lobe with outer margin infolded and forming slight process distally (Figs 3, 4, 12, 13, 21, 22, 30, 38, 39). Subgenital plate partly to completely fused, with row of sublateral macrosetae (Figs 2, 11, 20, 29, 37). Paramere elongate, apex highly modified and variable interspecifically (Figs 5, 6, 14, 23, 31, 40). Aedeagus shaft broad, structure complex, basally with long paired processes (Figs 7, 8, 15, 16, 24, 25, 32, 33, 41, 42). Anal tube process well developed (Figs 9, 18, 27, 35, 43).

Discussion. The genus *Ishiharella* Dworakowska resembles *Dialecticopteryx* Kirkaldy and *Velu* Ghauri in having the latero-posterior margin of the crown with a shallow concavity, the posterior margin of the pronotum with a black triangular-shaped mark, RP and MP' of the forewing stalked, RP, MP' and MP''+CuA' arising from m cell, and CuA of the hind wing unbranched (Figs 44, 46, 48, 50, 52) and in the male genitalia by the aedeagal shaft with a very long process (Figs 7, 8, 15, 16, 24, 25, 32, 33, 41, 42). It differs from both genera by the presence of a lateral black spot on the vertex and from *Dialecticopteryx* by the absence of a coronal suture (Figs 44, 46, 48, 50, 52), the elongate, apically specialized paramere (Figs 5, 6, 14, 23, 31, 40), and the aedeagus separated from the connective (Figs 7, 8, 15, 16, 24, 25, 32, 33, 41, 42).

Distribution. China (Anhui, Hunan, Hubei, Guangdong, Guizhou, Shaanxi, Zhejiang, Yunnan); Japan; Russia; Thailand.

***Ishiharella dentidensa* Yu & Yang, sp. nov.**

(Figs 1–9, 44–45)

Type material. Holotype: 1♂, P. R. China, Mengyang, Yunnan Province, 28 July 2013, coll. Zhihua Fan; 1♂, P. R. China, Mt. Leigong, Guizhou Province, 10 July 2011, Zhimin Chang trap (all IEGU).

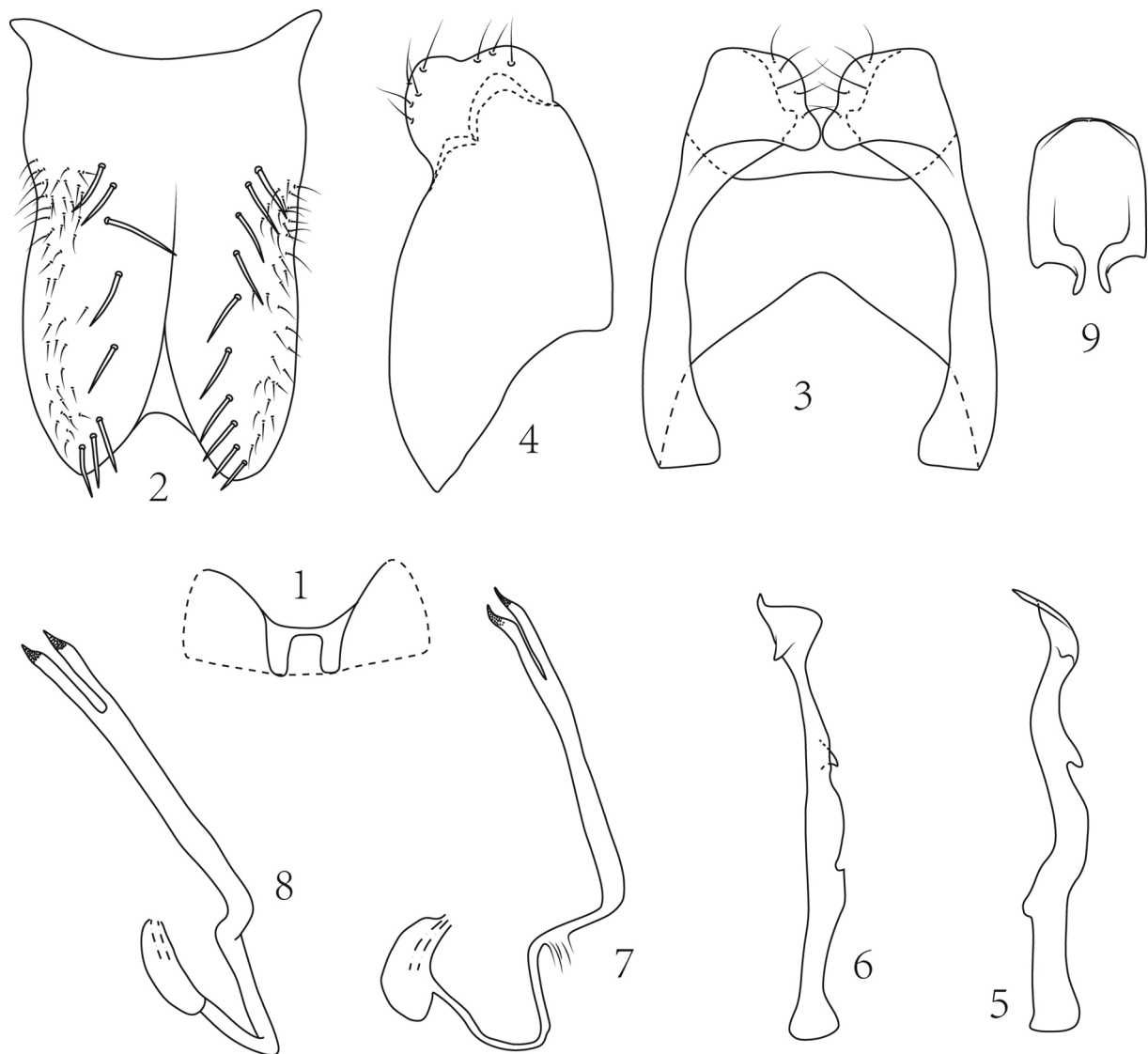
Length: ♂4.14–4.32mm.

Crown orange, with pair of longitudinal pigmented depressions and a yellowish patch. Eyes black; ocelli gray (Fig. 44). Face yellowish, anteclypeus apically black (Fig. 45). Pronotum posteriorly with median triangular black patch (Fig. 44). Scutellum pale orange, scutoscuteellar sulcus brownish (Fig. 44). Forewing light brown; hind wing hyaline (Fig. 44). Legs yellowish (Fig. 45).

Male ventral abdominal apodemes reaching posterior margin of segment 3 (Fig. 1). Male pygofer with anterior margin involuted, bearing few setae, ventral margin sinuate, dorsal margin straight; dorsal bridge short (Figs 3, 4). Subgenital plates surpassing pygofer in lateral view, fused in basal 1/3, bearing 10 macrosetae in one row and ca. 42 microsetae in 3–4 rows, width of base nearly equal to width subapically (Fig. 2). Paramere sinuate, subapically broad then narrowing to acute apex, with dorsal process on the swollen subapical part and ventral process near midlength of apophysis (Figs 5, 6). Aedeagus with shaft short, broad, ovoid, strongly laterally compressed, with slender basal apophysis, slightly asymmetrical, branched near apex with branches slightly divergent and with numerous denticuli near apex (Figs 7, 8). Anal tube process sinuate in ventral view, weakly developed (Fig. 9).

Etymology. The new species name is derived from the combination of “denti-” and “densus”, referring to densely denticulate apex of the aedeagal processes.

Remarks. The new species is similar to *I. iochoui* Dworakowska, 1982 in having a branched aedeagal process (Figs 7, 8) but differs in having many denticuli on the apex of each branch (Figs 7, 8), the paramere with two processes and the apex unbranched and subapically swollen (Figs 5, 6), and the anal tube process sinuate in ventral view (Fig. 9).



FIGURES 1–9. *Ishiharella dentidensa* Yu & Yang, sp. nov., 1 male abdominal apodemes, 2 subgenital plate, ventral view, 3 male pygofer, ventral view, 4 male pygofer, lateral view, 5 paramere, dorsal view, 6 paramere, lateral view, 7 aedeagus, lateral view, 8 aedeagus, dorsal view, 9 anal tube process, ventral view.

***Ishiharella falcata* Yu, Yang & Dietrich, sp. nov.**

(Figs 10–18, 46–47)

Type material. Holotype: 1♂, Sakon Nakhon, Phuphan NP, forest, ca. Huay Nam Pung Dam, Thailand, 16°54.713'N, 103°54.294'E, 289m, Malaise trap, 19–25 November 2006, Sailom Tongboonchai leg (QSBG); 1♂, Phetchabun Nam Nao NP Hell evergreen, Thailand, 16°44.371'N, 101°34.549'E, height: 834m, Malaise trap, 20–27 November 2006, Leng Jantiep leg (IEGU).

Length: ♂ 3.90–3.91mm.

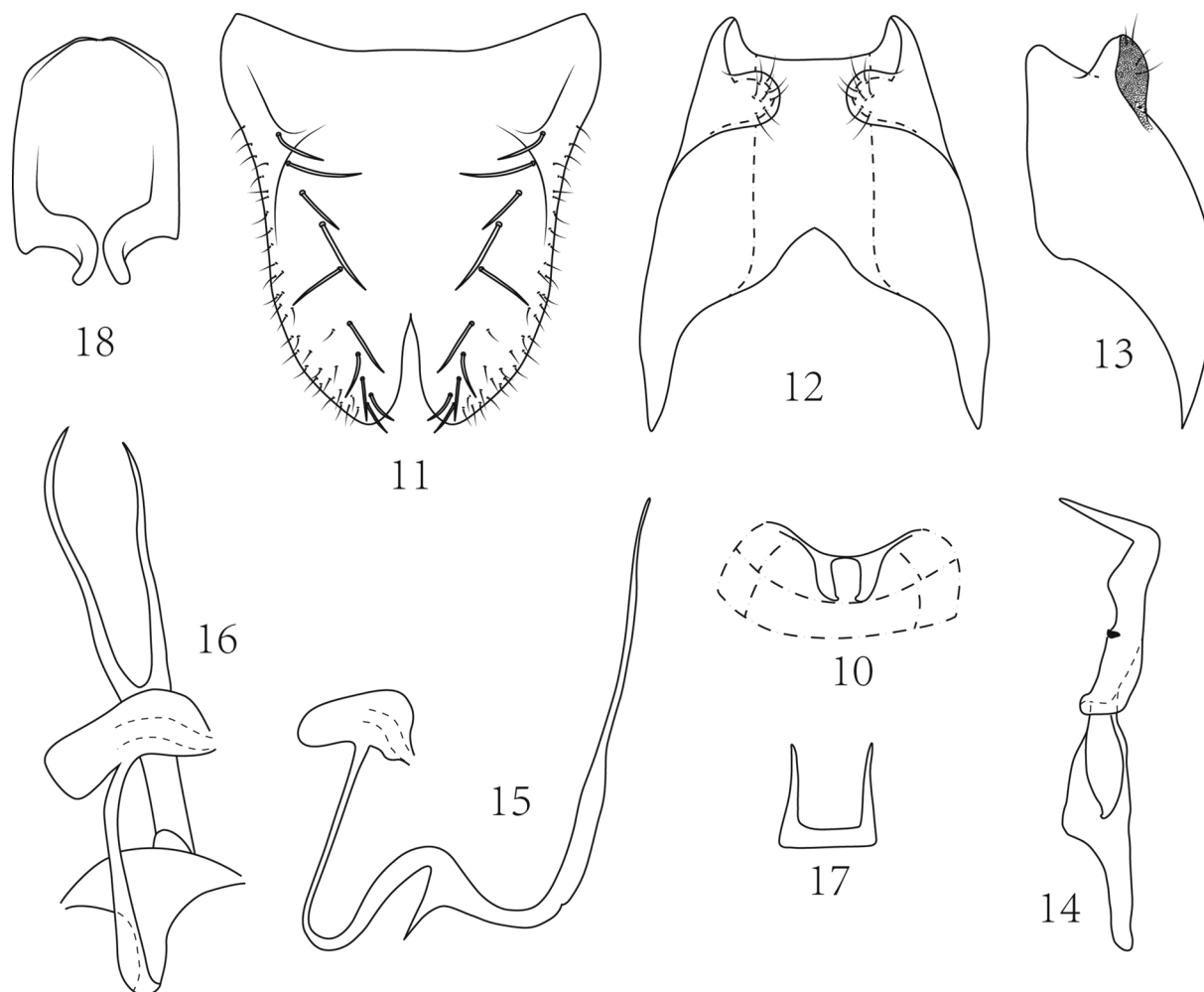
Crown orange with brown longitudinal depression beside gray eyes, two yellowish patches inside depression (Fig. 46). Face yellow, anteclypeus black apically (Fig. 47). Pronotum posteriorly with black median triangular patch (Fig. 46). Scutellum yellowish, apex black, scutoscutellar sulcus brownish (Fig. 46). Forewing brown; hind wing hyaline (Fig. 46). Legs yellowish except claws black (Fig. 47).

Male ventral abdominal apodemes reaching posterior margin of segment 3 (Fig. 10). Male pygofer with 1/2 anterior margin involuted with few setae (Figs 12, 13). Subgenital plates extended beyond pygofer in lateral view, fused in basal 2/3, with 10 macrosetae in one row and ca. 35 microsetae in 3 rows, base slightly wider than width

subapically (Fig. 11). Paramere robust, bent at nearly right angle preapically with apex slender and evenly tapered, apophysis with lamellar process in basal 1/3 and dorsal tooth more distad (Fig. 14). Aedeagal shaft short, broad, ovoid, strongly compressed, basal process distinctly asymmetrical, branched near midlength with right branch longer and curved more strongly mesad than left branch (Figs 15, 16). Anal tube process sinuate in ventral view (Fig. 18). Connective U-shaped (Fig. 17).

Etymology. The name of the new species is based on the falcate shape of the paramere apex.

Remarks. The new species is similar to *I. iochoui* Dworakowska and *I. hastata* Qin & Zhang in having the aedeagal process branched, but differs in the position of the branching and in the structure of the branches (Figs 15, 16). It can be distinguished from *I. iochoui* by the paramere with a lamellar process and apex unbranched (Fig. 14) and the more extensively fused subgenital plates (Fig. 11). It also differs from *I. hastata* in having the anal tube process apically extend in lateral view (Fig. 18) and the paramere not bifurcated (Fig. 14).



FIGURES 10–18. *Ishiharella falcata* Yu, Yang & Dietrich, sp. nov., 10 male abdominal apodemes, 11 subgenital plate, ventral view, 12 male pygofer, ventral view, 13 male pygofer, lateral view, 14 paramere, 15 aedeagus, lateral view, 16 aedeagus, dorsal view, 17 connective, 18 anal tube process, ventral view.

***Ishiharella hirsuta* Yu, Yang & Dietrich, sp. nov.**

(Figs 19–27, 48–49)

Type material. Holotype: 1♂, Thailand, Phetchabun Khao Kho NP, mixed deciduous forest, 16°32.539'N, 101°2.483'E, 524m, pan trap, 11–12 December 2006, Somchai Chachumnan & Saink Singtong leg (QSBG).

Length: ♂3.73mm.

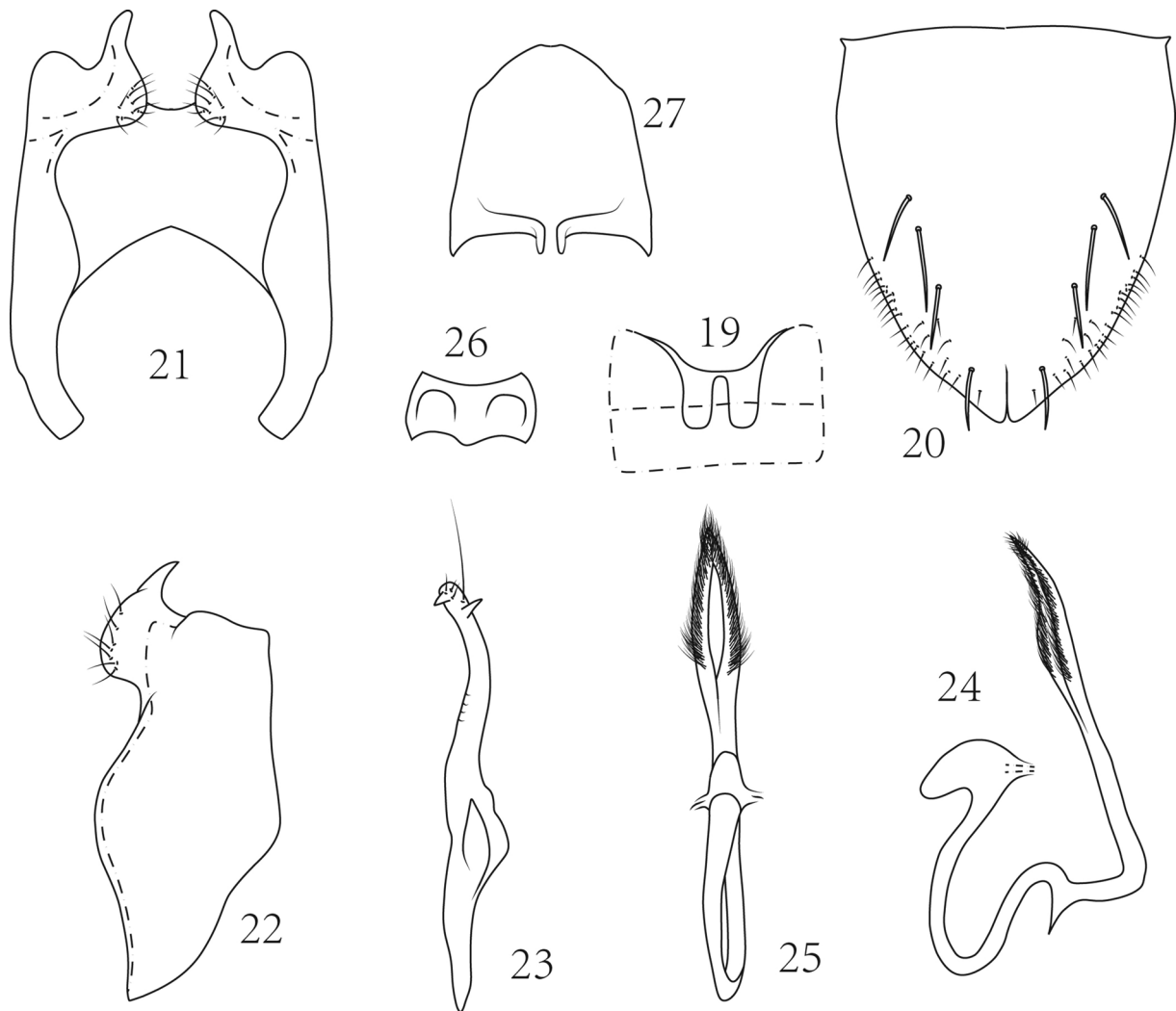
Crown yellowish orange, with pigmented depression adjacent to eyes, two yellowish patches between eyes, posterior margin with median brownish patch (Fig. 48). Eyes greyish (Fig. 48). Face yellow, anteclypeus with apex

black (Fig. 49). Pronotum orange. Scutellum yellow, apex black, scutoscutellar sulcus brownish (Fig. 48). Forewing brown, hind wing hyaline (Fig. 48). Legs yellowish (Fig. 49).

Male ventral abdominal apodemes reaching middle of segment 4 (Fig. 19). Male pygofer strongly narrowed anteriorly, apex pointed (Figs 21, 22). Subgenital plates extended beyond pygofer in lateral view, fused almost to apex, bearing ca. 4 macrosetae in one row and ca. 23 microsetae in 3 rows (Fig. 20). Paramere elongate, subapically to apex with two spinelike processes and with few short setae and a long slender seta (Fig. 23). Aedeagal shaft short, broad, ovoid, strongly compressed, basal process slender, nearly symmetrical, with two slender laterally bowed distal branches each densely clothed dorsally with fine pubescence (Figs 24, 25). Anal tube process sinuate to lateral view (Fig. 27). Connective nearly rectangular (Fig. 26).

Etymology. The species name refers to the distinctly hirsute aedeagal processes.

Remarks. The new species differs distinctly from others of the genus in having the aedeagal process branches distinctly hirsute (Figs 24, 25).



FIGURES 19–27 *Ishiharella hirsuta* Yu & Yang, **sp. nov.**, 19 male abdominal apodemes, 20 subgenital plate, ventral view, 21 male pygofer, ventral view, 22 male pygofer, lateral view, 23 paramere, 24 aedeagus, lateral view, 25 aedeagus, dorsal view, 26 connective, 27 anal tube process, ventral view.

***Ishiharella inflata* Yu & Yang, sp. nov.**

(Figs 28–35, 50–51)

Type material. Holotype: 1♂, P. R. China, Mt. Gaoligong, Yunnan Province, 6 August 2013, coll. Zhihua Fan; paratypes: 3♀, same data as holotype (all IEGU).

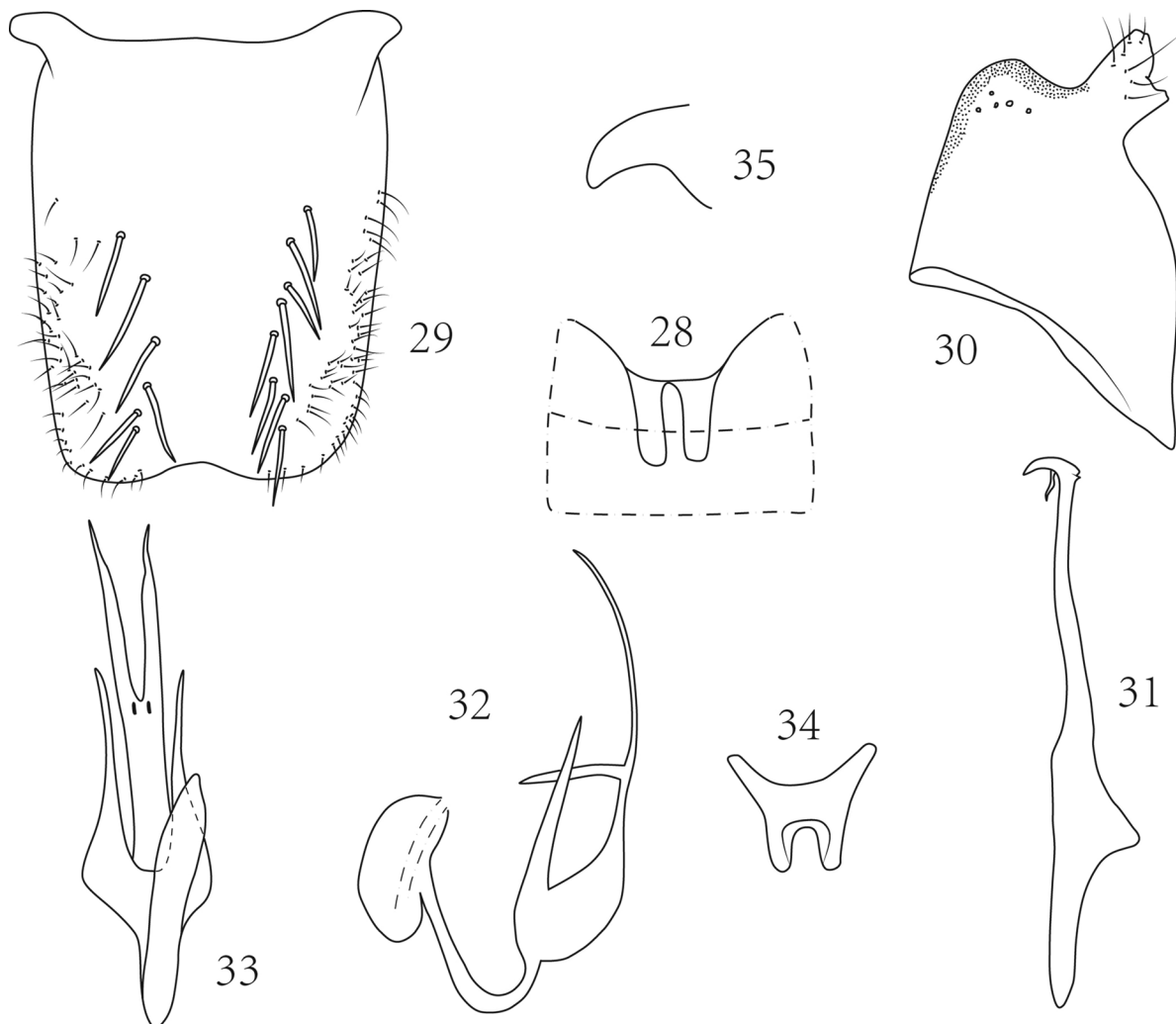
Length: ♂4.68mm, ♀3.94–4.70mm

Crown yellowish orange, female with black patch posteriorly between eyes (Fig. 50). Eyes black (Fig. 50). Face yellowish, anteclypeus black apically (Fig. 51). Pronotum orange, with blackish posteromedial patch (Fig. 50). Scutellum yellowish, apex slightly black, scutoscutellar sulcus brownish (Fig. 50). Forewing brown, hind wing hyaline (Fig. 50). Legs yellowish (Fig. 51).

Male ventral abdominal apodemes reaching middle of segment 4 (Fig. 28). Male pygofer strongly narrowed anteriorly, anterior margin unsmooth, dorsal margin pigmented (Fig. 30). Subgenital plates extended beyond pygofer in lateral view, completely fused with only slight median emargination distally, bearing 8 macrosetae in one row and ca. 50 microsetae in 3 or 4 rows (Fig. 29). Paramere elongate, apex strongly bent, with thin preapical process extended basad, apophysis attenuated preapically (Fig. 31). Aedeagal shaft short, broad, ovoid, strongly compressed, basal process nearly symmetrical with three pairs of branches, middle branches extended dorsad and crossing basal branches in lateral view, middle length expanded in lateral view (Figs 32, 33). Anal tube process curved in lateral view (Fig. 35). Connective with paired apical and basal lobes, apex broader than base, apical margin concave (Fig. 34).

Etymology. The name of the new species refers to the medially inflated basal aedeagal process.

Remarks. The new species differs distinctly from others in the genus in the shape of the paramere apex (Fig. 31) and aedeagal process with three pairs of branches (Figs 32, 33).



FIGURES 28–35 *Ishiharella inflata* Yu & Yang, sp. nov., 28 male abdominal apodemes, 29 subgenital plate, ventral view, 30 male pygofer, lateral view, 31 paramere, 32 aedeagus, lateral view, 33 aedeagus, dorsal view, 34 connective, 35 male tube process, lateral process.

***Ishiharella multiprotrusa* Yu, Yang & Dietrich, sp. nov.**

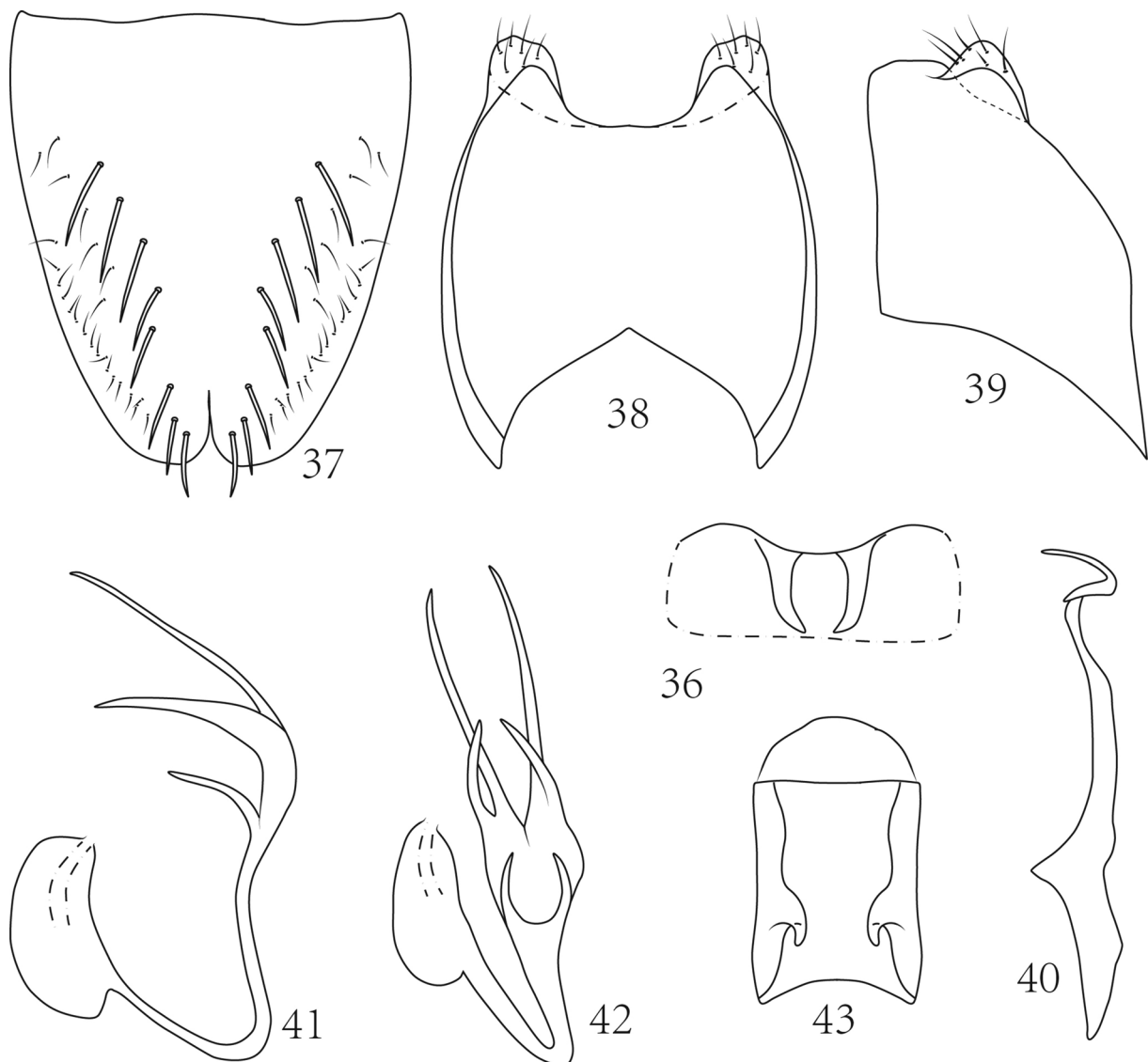
(Figs 36–43, 52–53)

Type material. Holotype: 1♂, Thailand, Loei Phu Ruea NP office, 17°28.805'N, 101°21.242'E, 870m., malaise trap, 12–19 July 2006, Patikhom Tamtio leg (QSBG).

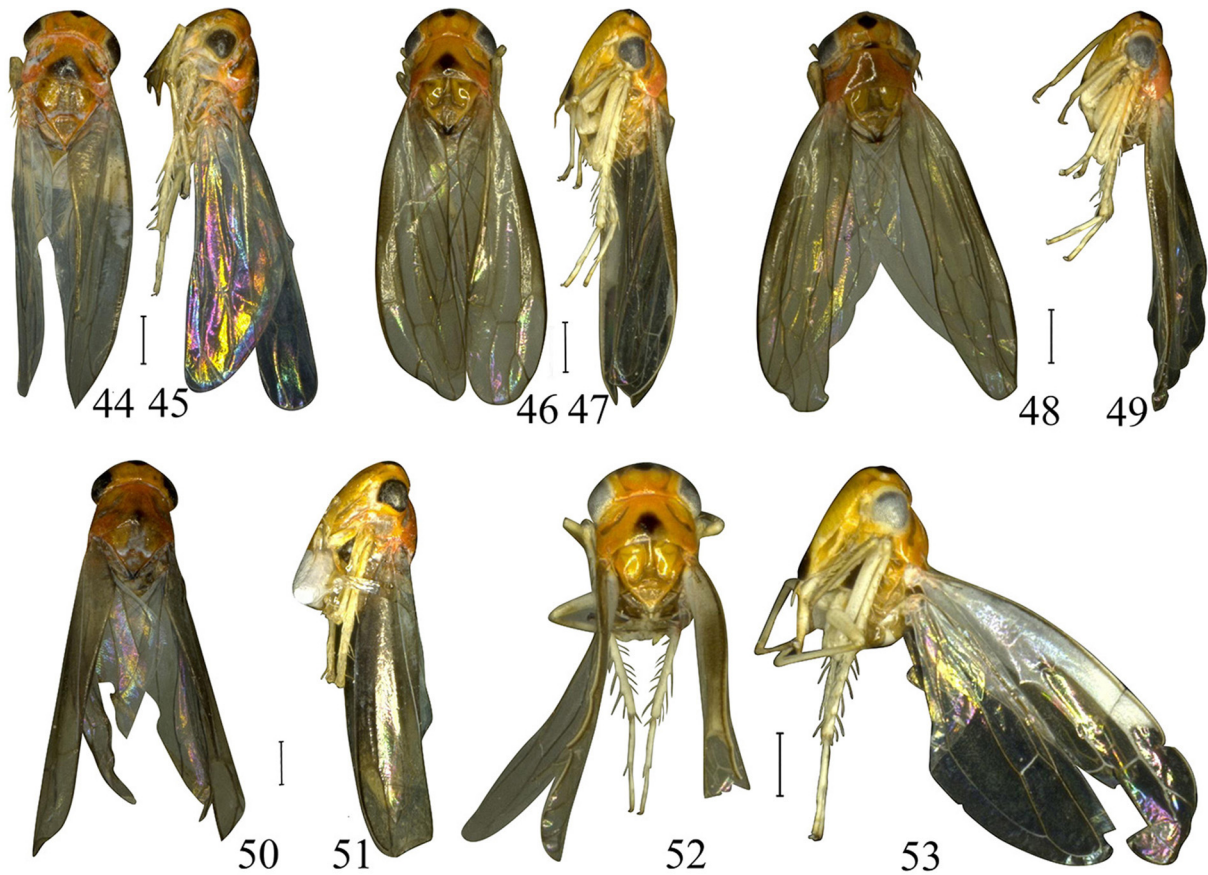
Length: ♂3.54mm.

Crown orange, area between eyes with two pigmented depressions and yellowish patches (Fig. 52). Eyes grey (Fig. 52). Ocelli white (Fig. 52). Face yellowish, anteclypeus black apically (Fig. 53). Pronotum orange with brown depression in lateral margin and blackish posteromedial patch (Fig. 52). Scutellum yellowish, scutoscutellar sulcus brownish (Fig. 52). Forewing brown, hind wing hyaline (Fig. 52). Legs yellowish except claws black (Fig. 53).

Male ventral abdominal apodemes reaching posterior margin of segment 3 (Fig. 36). Male pygofer narrowed anteriorly, anterior margin bearing few setae (Figs 38, 39). Subgenital plates longer than pygofer in lateral view, fused almost to apex, bearing 8 macrosetae in one row and ca. 23 microsetae in 3 rows (Fig. 37). Paramere elongate, apex slender, cheliform (Fig. 40). Aedeagal shaft short, broad, ovoid, strongly compressed, ventral process nearly symmetrical, bearing three pairs of branches, branches slender and bowed laterad, becoming progressively longer distally (Figs 41, 42). Anal tube process falcate in ventral view (Fig. 43).



FIGURES 36–43 *Ishiharella multiprotrusa* Yu, Yang & Dietrich, sp. nov., 36 male abdominal apodemes, 37 subgenital plate, ventral view, 38 male pygofer, ventral view, 39 male pygofer, lateral view, 40 paramere, 41 aedeagus, lateral view, 42 aedeagus, dorsolateral view, 43 male tube process, ventral process.



FIGURES 44–53 whole body. **44–45** *Ishiharella dentidensa* sp. nov.; **46–47** *Ishiharella falcata* sp. nov.; **48–49** *Ishiharella hirsuta* sp. nov.; **50–51** *Ishiharella inflata* sp. nov.; **52–53** *Ishiharella multiprotrusa* sp. nov. Scale bars = 1.0 mm

Etymology. The name of the new species is derived from the combination of “multi-” and “protrusus”, referring to the aedeagal process with three pairs of branches that look like protrusions.

Remarks. The new species is similar to *I. inflata* Yu & Yang, sp. nov. in having three pairs of branches on the aedeagal process (Figs 41, 42), but differs from the latter in having the middle pair of branches longer than the basal pair and not crossing the basal pair in lateral view (Figs 41, 42), and by shape of the paramere apex (Fig. 40).

Key of *Ishiharella* Dworakowska (males)

1. Aedeagal process with three paired branches 2
- Aedeagal process with one paired branches 3
2. Aedeagal process with penultimate pair of branches perpendicular to the long axis of the process in lateral view (Figs 32, 33).
..... *I. inflata* sp. nov.
- Aedeagal process with penultimate pair of branches not perpendicular to the long axis of the process in lateral view (Figs 41, 42).
..... *I. multiprotrusa* sp. nov.
3. Aedeagal process with branches dentate or hirsute 4
- Aedeagal process with branches glabrous 5
4. Aedeagal process with branches distinctly hirsute distally (Figs 24, 25) *I. hirsuta* sp. nov.
- Aedeagal process with branches dentate apically (Figs 7, 8) *I. dentidensa* sp. nov.
5. Paramere with lamellar process (Fig. 14) *I. falcata* sp. nov.
- Paramere without lamellar process 6
6. Paramere bifurcated apically 7
- Paramere not bifurcated apically 9
7. Subgenital plates fused only in basal half *I. iochouii*
- Subgenital plates fused for more than half total length 8
8. Pygofer with dorsal and ventral pointed process *I. donanensis*

- Pygofer only with straight ventral process *I. hastata*
- 9. Aedeagus without dorsoatrium *I. dentata*
- Aedeagus with dorsoatrium 10
- 10. Aedeagal process extended distinctly beyond shaft *I. polyphemus*
- Aedeagal process nearly equal in length with shaft *I. paradentata*

Checklist of species of the genus *Ishiharella* Dworakowska

Ishiharella polyphemus (Matsumura, 1931) (type species)

Empoascapolyphemus Matsumura, 1931, 6(2): 82, *Insecta Matsumurana*.

Ishiharellapolyphemus Dworakowska, 1970h, 18(11): 716, *Bulletin de l'Academie Polonaise des Sciences*.

Distribution. China, Caucasus, Japan.

Ishiharella iochoui Dworakowska, 1982

Ishiharella iochoui Dworakowska, 1982, 20(4): 55, *Reichenbachia*.

Ishiharellascitula Qin & Zhang, 2004, 26(2): 116, *Entomotaxonomia*.

Distribution. China

Ishiharella dentata Qin & Zhang, 2004

Ishiharella dentata Qin & Zhang, 2004, 26(2): 118, *Entomotaxonomia*.

Distribution. China

Ishiharella hastata Qin & Zhang, 2004

Ishiharella hastata Qin & Zhang, 2004, 26(2): 115, *Entomotaxonomia*.

Distribution. China

Ishiharella donanensis Ohara, 2010

Ishiharella donanensis Ohara, 2010, 16(2): 258, *Japanese Journal of Systematic Entomology*.

Distribution. Japan

Ishiharella paradentata Liu & Qin, 2015

Ishiharella paradentata Liu & Qin, 2015, 98(1): 289, *Florida Entomologist*.

Distribution. China

Ishiharella dentidensa Yu & Yang **sp. nov.**

Distribution. China

Ishiharella falcata Yu, Yang & Dietrich, **sp. nov.**

Distribution. Thailand

Ishiharella hirsuta Yu, Yang & Dietrich, **sp. nov.**

Distribution. Thailand

Ishiharella inflata Yu & Yang, **sp. nov.**

Distribution. China

Ishiharella multiprotrusa Yu, Yang & Dietrich, **sp. nov.**

Distribution. Thailand

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References

- Dworakowska, I. (1970) On some genera of Typhlocybini and Empoascini (Auchenorrhyncha: Cicadellidae: Typhlocybinae). *Bulletin de l' Academie Polonaise des Sciences. Serie des Sciences Biologique*, 18 (11), 707–716.
- Dworakowska, I. (1993) Remarks on *Alebra* Fab. and Eastern Hemisphere Alebrini (Auchenorrhyncha: Cicadellidae: Typhlocybinae). *Entomotaxonomia*, 15 (2), 91–121.
- Lu, S.H., Suo, H.F. & Qin, D.Z. (2015) Revision of the leafhopper genus *Ishiharella* (Hemiptera: Cicadellidae: Typhlocybinae), with description of one new species in China. *Florida Entomological Society*, 98 (1), 280–289.
- Matsumura, S.A. (1931) A revision of the Palaearctic and Oriental Typhlocybid-genera with descriptions of new species and new genera. *Insecta Matsumurana*, 6 (2), 55–92.
- Ohara, N. (2010) Two new typhlocybine leafhoppers (Auchenorrhyncha, Cicadellidae) from the Ryukyu Islands, Japan. *Japanese Journal of Systematic Entomology*, 16 (2), 255–260.
- Qin, D.Z. & Zhang, Y.L. (2004) Taxonomic study on *Ishiharella* (Homoptera: Cicadellidae: Typhlocybinae) with description of three new species from China. *Entomotaxonomia*, 26 (2), 114–120.
- Qin, D.Z. & Zhang, Y.L. (2008) Two new empoascine leafhopper genera and species (Hemiptera: Cicadellidae: Typhlocybinae) from southern China, with a key to Chinese genera of Empoascini. *Zootaxa*, 1966, 62–68.
- Zhang, Y.L. (1990) *A taxonomic study of Chinese Cicadellidae (Homoptera)*. Tianze Eldonejo. Yangling, 218 pp.