Two new species of the genus *Tsauria* Koçak & Kemal (Hemiptera, Fulgoromorpha, Cixiidae) from China, with descriptions of female genitalia of three species

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Abstract

Two new species of cixiid planthoppers genus *Tsauria* Koçak & Kemal, *Tsauria brevispina* Zhi & Chen, sp. nov. and *T. longispina* Zhi & Chen, sp. nov., are described and illustrated from China and *T. transspinus* (Zhang & Chen, 2011) was removed to give the genus four species in total. The female genitalia of three species are described and illustrated for the first time. A key to all known species of *Tsauria* based on male genitalia, and a key to three species (except for *T. major*) based on female genitalia, are provided.

Keywords

Female genitalia, Fulgoroidea, morphology, Oriental region, taxonomy

Introduction

Tsaur et al. (1991) established the cixiid planthopper genus *Discophorellus* with the type species *Discophorellus major* Tsaur & Hsu, 1991 from China (Taiwan), and placed this genus in the tribe Cixiini of the subfamily Cixiinae (Hemiptera: Fulgoromorpha: Cixiidae). Later, Koçak and Kemal (2009) proposed a new replacement name *Tsauria* for *Discophorellus* Tsaur & Hsu, 1991 because the latter is a junior homonym of...
Discophorellus Wibmer & O’Brien, 1986 (Coleoptera). But, Zhang and Chen (2011) did not recognize the homonym of Discophorellus and described two new species from China: D. cehengensis and D. transspinus. Subsequently, Xing and Chen (2014) transferred the two species described by Zhang and Chen (2011) to Tsauria. However, the taxonomic status of T. transpinus (Zhang & Chen, 2011) is reviewed in this study and, based on a few diagnostic characters, removed from Tsauria (see Discussion). So far, Tsauria includes two species: T. cehengensis (Zhang & Chen, 2011) and T. major (Tsaur & Hsu, 1991).

Herein, two new species: Tsauria brevispina Zhi & Chen, sp. nov. and T. longispina Zhi & Chen, sp. nov. are described and illustrated from China. Female genitalia of three Chinese species are described and illustrated for the first time. The genus now includes four species, and all from China. A key to all known species of Tsauria based on male genitalia, and a key to three species (except for T. major) based on female genitalia, are provided.

Materials and methods

The morphological terminology and measurements follow Bourgoin (1987) and Bourgoin et al. (2015). The morphological terminology of female genitalia follows Bourgoin (1993). Body length was measured from apex of vertex to tip of forewing; vertex length was measured the median length of vertex (from apical transverse carina to tip of basal emargination). Fuchsin staining was used to highlight the female genitalia structures studied. Ten to fifteen female specimens per species were dissected. External morphology and drawings were done with the aid of a Leica MZ 12.5 stereomicroscope. Photographs were taken with KEYENCE VHX-1000 system. Illustrations were scanned with CanoScan LiDE 200 and imported into Adobe Photoshop CS7 for labeling and plate composition. The dissected male and female genitalia are preserved in glycerin in small plastic tubes pinned together with the specimens.

The type specimens examined are deposited in the Institute of Entomology, Guizhou University, Guiyang, Guizhou Province, China (GUGC).

Taxonomy

Tsauria Koçak & Kemal, 2009

Discophorellus Tsaur & Hsu, 1991: 21; Zhang and Chen 2011: 60.
Tsauria Koçak & Kemal, 2009: 6 for Discophorellus Tsaur & Hsu, 1991, nec Wibmer & O’Brien, 1986; Xing and Chen 2014: 149.

Type species. Discophorellus major Tsaur & Hsu, 1991, by original designation. For the relationship and diagnosis of Tsauria see Tsaur et al. (1991: 21) and Zhang and Chen (2011: 60).

Distribution. Oriental region (China).
Key to species (males) of *Tsauria* (revised from Zhang and Chen 2011)

1 Ventral margin of aedeagal periandrium with an extremely long spinose process, which is the longest of all spinose processes of periandrium (Figs 46–49) ................................................................. *T. longispina* sp. nov.
   – Spinose process on ventral margin of aedeagal periandrium not the longest of periandrium ................................................................. 2

2 Ventral margin of aedeagal periandrium with an extremely short spinose process, which is the shortest of all spinose processes of periandrium (Figs 13–16) ................................................................. *T. brevispina* sp. nov.
   – Spinose process on ventral margin of aedeagal periandrium not the shortest of periandrium ................................................................. 3

3 Forewings with r-m cross-vein and apical cells yellowish brown (Zhang and Chen 2011: Fig. 36); medioventral process of pygofer papillary in ventral view, with bristles at apex (Zhang and Chen 2011: Fig. 5) .... *T. cehengensis*
   – Forewings with r-m cross-vein and apical cells black; medioventral process of pygofer sub-triangular in ventral view, rounded and smooth at apex (Tsaur et al. 1991: Fig. 10E) ................................................................. *T. major*

Key to species (females) of *Tsauria* (except for *T. major*)

1 Wax plate divided by median keel (Fig. 53) .................. *T. longispina* sp. nov.
   – Wax plate widened laterally and without median keel .......................... 2

2 The length of posterior vagina (Figs 34–35) equal to the width. Sclerites in ventral view mainly concentrated in the middle area and the ones in dorsal view mainly concentrated on left side. Gonapophysis IX (Fig. 32) with two middle teeth, denticulate portion with one small rounded odontoid .......... ................................................................. *T. cehengensis*
   – Posterior vagina (Figs 24–25) elongate, with sclerites dispersed both in ventral and dorsal view. Gonapophysis IX (Fig. 22) with one middle tooth, denticulate portion degenerated ................................................................. *T. brevispina* sp. nov.

*Tsauria brevispina* Zhi & Chen, sp. nov.
http://zoobank.org/30979941-88CE-413C-9E3F-E4C2C1B1BDD1
Figs 1–2; 5–26

**Type material.** Holotype: ♂, China: Hubei, Luotian County, Dabieshan, 15 July 2010, Jun-qiang Ni; paratypes: 3 ♀, Hubei, Luotian County, Dabieshan, 15–17 July 2010, Jun-qiang Ni; 2♂5♀♀, Hubei, Luotian County, Dabieshan, Qingtaiguan, 2–3 July 2014, Mei-na Guo, Jian-kun Long, Zheng-xiang Zhou; 1♂2♀♀, Hubei, Luotian County, Dabieshan, Taohuachong, 23–28 June 2014, Mei-na Guo, Hai-yan
Description. Body length: male 6.9–7.5 mm ($n = 11$), female 7.0–8.8 mm ($n = 16$). Coloration. General color yellowish brown (Figs 1, 2, 5, 6). Eyes yellowish brown, ocelli yellow. Vertex, face, rostrum and pronotum yellowish brown, mesonotum brown. Forewing semi-translucent, yellowish brown, stigma yellowish brown, termination of forewing blackish brown. Hind tibiae and abdominal sternites yellowish brown.

Head and thorax. Vertex (Figs 1, 5, 7) broad, 1.5 times wider than long; subapical carina with middle prominent into obtuse angle, median carina interrupted by subapical carina, with anterior portion complete, posterior portion only discernible at basal half. Frons (Fig. 6) 1.2 times as long as wide. Clypeus with median carina distinct and elevated throughout. Pronotum (Figs 1, 5) 1.9 times longer than vertex. Mesonotum 1.6 times longer than pronotum and vertex combined. Forewing (Fig. 8) 2.7 times longer than wide, with 13 apical and 7 subapical cells; RP 4 branches, MP with 5 terminals: MP$_{11}$, MP$_{12}$, MP$_{2}$, MP$_{3}$, and MP$_{4}$; fork MP$_{1}$+MP$_{2}$ basad of fork MP$_{3}$+MP$_{4}$. Hind tibia with 3–5 lateral spines; chaetotaxy of hind tarsi: 8–9/10–11, second segment of hind tarsus with 7 platellae.

Male genitalia. Pygofer (Figs 9, 10) symmetrical, dorsal margin concave and U-shaped ventrally, widened towards apex; in lateral view, lateral lobes triangularly extended caudally. Medioventral process mastoid ventrally. Anal segment (Figs 9, 11) long tubular, symmetrical, 2.5 times longer than wide in dorsal view; anal style
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Figures 5–16. *Tsauria brevispina* sp. nov., male. 5 head and thorax, dorsal view; 6 face, ventral view; 7 head, top view; 8 forewing; 9 genitalia, lateral view; 10 pygofer and gonostyli, ventral view; 11 anal segment, dorsal view; 12 gonostyli, inner lateral view; 13 aedeagus, right side; 14 aedeagus, left side; 15 aedeagus, dorsal view; 16 aedeagus, ventral view. Scale bars: 0.5 mm (5–7, 9–16); 1.0 mm (8).
Figures 17–26. *Tsauria brevispina* sp. nov., female 17 genitalia, lateral view 18 genitalia, ventral view 19 anal segment, dorsal view 20 tergite IX, caudal view 21 gonapophysis VIII and gonocoxa VIII, dorsal view 22 gonapophysis IX, lateral view 23 gonoplac, inner lateral view 24 posterior vagina, ventral view 25 posterior vagina, dorsal view 26 internal genitalia. Scale bars: 0.5 mm.
Two new species of the genus *Tsauria* from China

finger-like, not beyond anal segment. Gonostyli (Figs 9, 10, 12) in ventral view, symmetrical, widening towards apex, apical part extended, apical margin rounded; in lateral view, “L-shaped”. Aedeagus (Figs 13–16) in total with four processes. Spinose process on left side near apex of periantrium being the longest, straight, directed ventrocephalically; right side of periantrium with a medium-sized spinose process, strongly curved, directed dorsocaudally at apex; periantrium with a medium-sized spinose process positioning slightly to left side of its dorsal margin, directed right-ventrocephalically; ventral margin of aedeagal periantrium with an extremely short spinose process, which is the shortest of all spinose processes of periantrium, hooked, curved towards right side. Endosoma moderately sclerotized, simple, generally curving left.

Female genitalia. Tergite IX (Figs 17, 18, 20) moderately sclerotized, with a large nearly elliptical wax plate. Anal segment (Figs 17, 19) rectangle, 2.2 times longer than wide in dorsal view. Gonapophysis VIII (Fig. 21) elongate, and slightly curved upwards. Gonapophysis IX (Fig. 22) with one middle tooth, denticulate portion degenerated. Gonoplac (Fig. 23) rod-like, 3.7 times longer than wide in lateral view. Posterior vagina (Figs 24, 25) elongate, with many small round, oval and oblong sclerites both in ventral and dorsal view, dispersed. Base with several relatively large sclerites, and the middle area with a longitudinally oblong sclerite in ventral view; at basal each lateral side with several relatively large sclerites respectively in dorsal view. Internal genitalia as shown in Fig. 26.

**Distributions.** China (Guizhou, Hubei).

**Etymology.** The specific name is derived from the Latin prefixes “*brevi*” and noun “*spina*”, referring to the ventral margin of aedeagal periantrium with an extremely short spinose process, which is the shortest of all spinose processes of the periantrium.

**Remarks.** Male genitalia of *T. brevispina* sp. nov. is similar to *T. cehengensis* (Zhang & Chen), but differs in: (1) spinose process on ventral margin of periantrium being the shortest of all spinose processes of periantrium (in *T. cehengensis*, not the shortest one); (2) spinose process on left side near apex of periantrium being the longest, straight (in *T. cehengensis*, spinose process in the same position being the shortest, basal two-thirds stout and apical third arc-shaped curved); (3) medioventral process without bristles at apex (the latter with bristles); (4) forewing with 13 apical cells (the latter with 12 apical cells).

Female genitalia of *T. brevispina* sp. nov. is similar to *T. cehengensis* (Zhang & Chen), but differs in: (1) posterior vagina elongate (in *T. cehengensis*, the length of posterior vagina equal to the width); (2) sclerites dispersed both in ventral and dorsal view (in *T. cehengensis*, sclerites in ventral view mainly concentrated in the middle area and the ones in dorsal view mainly concentrated in left side); (3) Gonapophysis IX with one middle tooth, denticulate portion degenerated (in *T. cehengensis*, Gonapophysis IX with two middle teeth, denticulate portion with one small rounded odontoid).
Figures 27–37. *Tsauria cehengensis* (Zhang & Chen, 2011) 27–36, female 27 genitalia, lateral view 28 genitalia, ventral view 29 anal segment, dorsal view 30 tergite IX, caudal view 31 gonapophysis VIII and gonocoxa VIII, dorsal view 32 gonapophysis IX, lateral view 33 gonoplac, inner lateral view 34 posterior vagina, ventral view 35 posterior vagina, dorsal view 36 internal genitalia 37 head, top view, male. Scale bars: 0.5 mm.
Tsauria cehengensis (Zhang & Chen, 2011)
Figs 27–37

Discophorellus cehengensis Zhang & Chen, 2011: 61, figs 1–11, 36–37.
Tsauria cehengensis (Zhang & Chen, 2011): Xing and Chen 2014: 149.

Material examined. China: 1♂, Guizhou, Ceheng County (900 m), 29 June–1 July 2006, Qiong-zhang Song (holotype); 9♂3♀, same data as holotype, Qiong-zhang Song, Pei Zhang (paratypes); 4♀, Guizhou, Ziyun County, Getuhe, Dahemiaozhai (930 m), 24–27 June 2006, Pei Zhang (paratypes); 2♂, Guizhou, Libo County, Maolan, Banzhai, 4–6 July 2010, Pei Zhang, Xiao-hui Hou; 1♂1♀, Guizhou, Libo County, Maolan, Wengang, 4 July 2010, Pei Zhang; 1♂, Guizhou, Huishui County, Duanshan, Guangrong, 9 May 2013, Jian-kun Long; 1♂♀, Guizhou, Guiyang, Forest Park, 25 June 2010, Yan-li Zheng; 1♂1♀, Jiangsu, Longnan County, Jiulianshan, Daqutian, 24 July 2009, Ze-hong Meng; 3♂3♀, Anhui, Huangshan City, Tangkou (500 m), 20 May 2008, Zheng-guang Zhang; 17♂19♀, Guangxi, Shangsi County, Shiwandashan National Forest Park, 2 May 2011, Rong Huang, Xiao-fei Yu; 1♀, Guangxi, Shangsi County, Shiwandashan National Forest Park, 9 June 2012, Jian-kun Long; 1♂♀, Guangxi, Shangsi County, Shiwandashan National Forest Park, 30 May 2012, Nan-nan Yang; 1♀1♂, Guizhou, Leishan County, Leigongshan, Xiaodanjian, 6–8 July 2011, Jian-kun Long, Wei-bin Zheng; 1♂2♀, Guizhou, Wangmo County, Xintun, 28 June 2013, Jian-kun Long, Yang-yang Liu; 1♂, Guizhou, Congjiang County, Guanghu, 20 July 2016, Zheng-xue Zhao.

Supplementary description. Female genitalia. Tergite IX (Figs 27, 28, 30) moderately sclerotized, with a large nearly trapezoidal wax plate. Anal segment (Figs 27, 29) rectangle, 2.1 times longer than wide in dorsal view. Gonapophysis VIII (Fig. 31) elongate, and slightly curved upwards. Gonapophysis IX (Fig. 32) with two middle teeth, denticulate portion with only one small rounded odontoid. Gonoplac (Fig. 33) rod-like, 3.9 times longer than wide in lateral view. The length of posterior vagina (Figs 34, 35) equal to the width. Posterior vagina with many small round, oval and oblong sclerites both in ventral and dorsal view. Sclerites in ventral view mainly concentrated in the middle area and the ones in dorsal view mainly concentrated in left side. Internal genitalia as shown in Fig. 36.

Distributions. China (Anhui, Jiangsu, Guangxi, Guizhou).

Note. The female genitalia of this species are described and illustrated for the first time.

Tsauria longispina Zhi & Chen, sp. nov.
http://zoobank.org/A394C767-D2ED-4689-89DB-5B16D0CF4232
Figs 3, 4; 38–59

Type material. Holotype: ♂, China: Zhejiang, Hangzhou City, Tianmushan, 22 July 2009, Ting-ting He; paratypes: 24♂33♀, Zhejiang, Hangzhou City, Tianmushan,
Figures 38–49. *Tsauria longispina* sp. nov., male 38 head and thorax, dorsal view 39 face, ventral view 40 head, top view 41 forewing 42 genitalia, lateral view 43 pygofer and gonostyli, ventral view 44 anal segment, dorsal view 45 gonostyli, inner lateral view 46 aedeagus, right side 47 aedeagus, left side 48 aedeagus, dorsal view 49 aedeagus, ventral view. Scale bars: 0.5 mm (38–40, 42–49); 1.0 mm (41).
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Figures 50–59. *Tsauria longispina* sp. nov., female 50 genitalia, lateral view 51 genitalia, ventral view 52 anal segment, dorsal view 53 tergite IX, caudal view 54 gonapophysis VIII and gonocoxa VIII, dorsal view 55 gonapophysis IX, lateral view 56 gonoplac, inner lateral view 57 posterior vagina, ventral view 58 posterior vagina, dorsal view 59 internal genitalia. Scale bars: 0.5 mm.
20–22 July 2009, Yong Chen, Ting-ting He; 1♂, Zhejiang, Longquan City, Fengyangshan, 28–29 July 2009, Ting-ting He; 2♂♂, Guizhou, Liping County, Taipingshan (520–859 m), 15–23 July 2006, Zheng-Guang Zhang; 1♂♀♀, Guizhou, Liping County, Deshun, 14 July 2016, Yan-li Zheng, Nian Gong, Zheng-xue Zhao, Ying-jian Wang; 1♂, Hainan, Wuzhishan (650 m), 14 July 2007, Ji-chun Xing; 3♂♂, Fujian, Jianou City, Wanmulin, 8–10 August 2009, Pei Zhang, Jun-qiang Ni; 2♂♀♀, Fujian, Jianou City, Wanmulin, 20 May 2012, Jian-kun Long, Wei-cheng Yang; 1♂♀♀, Fujian, Dehua county, Guobao, Yunlonggu, 11 May 2012, Jian-kun Long, Wei-cheng Yang; 1♂, Fujian, Datiang County, Forest Park, 14 May 2012, Wei-cheng Yang.

Description. Body length: male 6.8–7.6 mm ($n = 37$), female 7.0–8.3 mm ($n = 42$).

Coloration. General color yellowish brown (Figs 3, 4, 38–39). Eyes yellowish brown, ocelli pale yellow. Vertex, face, rostrum, pronotum and mesonotum brown. Forewing semi-translucent, yellowish brown, apical 1/5 with a wide blackish brown stripe, stigma yellowish brown. Hind tibiae yellowish brown and abdominal sternites dark brown.

Head and thorax. Vertex (Figs 3, 38, 40) broad, 1.3 times wider than long; subapical carina with middle prominent into obtuse angle, median carina interrupted by subapical carina, with anterior portion complete, posterior portion only discernible at basal half. Frons (Fig. 39) 1.2 times as long as wide. Clypeus with median carina distinct and elevated throughout. Pronotum (Figs 3, 38) 1.8 times longer than vertex; mesonotum 1.5 times longer than pronotum and vertex combined. Forewing (Fig. 41) 2.7 times longer than wide, with 12 apical and 7 subapical cells; RP 3 branches, MP with 5 terminals: MP$^{11}$, MP$^{12}$, MP$^{2}$, MP$^{3}$, and MP$^{4}$, fork MP$^{1}$+MP$^{2}$, basad of fork MP$^{3}$+MP$^{4}$. Hind tibia with 3–4 lateral spines; chaetotaxy of hind tarsus: 9/10–12, second segment of hind tarsus with 6–9 platellae.

Male genitalia. Pygofer (Figs 42, 43) symmetrical, dorsal margin concave and U-shaped ventrally; in lateral view, lateral lobes triangularly extended caudally, apex round. Medioventral process mastoid ventrally. Anal segment (Figs 42, 44) long tubular, symmetrical, 2.9 times longer than wide in dorsal view; anal style finger-like, slightly beyond anal segment. Gonostyli (Figs 42, 43, 45) in ventral view, symmetrical, widening towards apex, apical part extended, apical margin rounded; in lateral view, “L-shaped”. Aedeagus (Figs 46–49) in total with four processes. Left side of periandrium with a medium-sized spinose process, slightly curved, directed left-ventrocephalically at apex; right side near apex of periandrium with a short spinose process, directed left-dorsocephalically; periandrium with a medium-sized spinose process positioning slightly to left side of its dorsal margin, slightly curved upward and directed right-dorsally at apex; ventral margin of aedeagal periandrium with an extremely long spinose process, which is the longest of all spinose processes of periandrium, straight, generally directed towards left side, apex directed cephalically. Endosoma moderately sclerotized, structure simple, generally curving left.

Female genitalia. Tergite IX (Figs 50, 51, 53) subtriangular, moderately sclerotized, divided by median keel. Anal segment (Figs 50, 53) rectangle, 2.3 times longer than wide in dorsal view. Gonapophysis VIII (Fig. 54) elongate, and slightly curved upwards. Gonapophysis IX (Fig. 55) with two middle teeth, denticulate portion with
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Figures 60–63. Tsauria transspinus (Zhang & Chen, 2011) incertae sedis, female 60 genitalia, lateral view 61 tergite IX, caudal view 62 anal segment, dorsal view 63 head, top view, male. Scale bars: 0.5 mm.

only one small rounded odontoid. Gonoplac (Fig. 56) rod-like, 3.7 times longer than wide in lateral view. Posterior vagina (Figs 57, 58) elongate. Posterior vagina with many small round, oval and oblong sclerites both in ventral and dorsal view. Sclerites in ventral view dispersed and the ones in dorsal view mainly concentrated in left side. Internal genitalia as shown in Fig. 59.

**Distributions.** China (Fujian, Guizhou, Hainan, Zhejiang).

**Etymology.** The specific name is derived from the Latin prefixes “longi” and noun “spina”, referring to the ventral margin of aedeagal periantrium with an extremely long spinose process, which is the longest of all spinose processes of the periantrium.

**Remarks.** Male genitalia of *T. longispina* sp. nov. is similar to *T. brevispina* sp. nov., but differs in: (1) spinose process on ventral margin of periantrium being the longest of all spinose processes of periantrium, straight (in *T. brevispina*, spinose process on ventral margin of periantrium being the shortest of all spinose processes of periantrium, hooked at apex); (2) spinose process on right side near apex of periantrium slightly curved, directed left-dorsocephally at apex (the latter strongly curved, directed dorsocaudally at apex).

Female genitalia of *T. longispina* sp. nov. is similar to *T. cehengensis* (Zhang & Chen), but differs in: (1) wax plate divided by median keel (the latter widened laterally and without median keel; (2) posterior vagina elongate (in *T. cehengensis*, the length of posterior vagina equal to the width).

**Discussion**

Holzinger (2002) emphasized the importance of the morphological characters of the female abdomen wax plate and its conformation in Cixiiini. The conformation of the wax-plate area below the anal tube in females has great taxonomic value in Cixiidae. Therefore, following Holzinger’s taxonomic practice, we confirmed that the species *Tsauria transspinus* (Zhang & Chen, 2011) had been incorrectly placed in this genus, for its females lacked the wax plate (Fig. 61), whereas the existence of this structure was critical in *Tsauria*. Some other characters, such as “vertex with median carina before subapical carina vanished (Fig. 63) and abdomen with shorter anal tube in females
(Figs 61–62)” were also distinctly inconsistent with the other members of Tsauria. For the above reasons, in this study we removed Tsauria transspinus from Tsauria and left it as incertae sedis provisionally, as determining its taxonomic position was out of the main purpose of this paper, and it probably should be dealt with elsewhere.

Tsauria cehengensis (Zhang & Chen, 2011) and T. major (Tsaur & Hsu, 1991) were distinguished mainly on the characters of the male genitalia; only the anal segment of T. major was illustrated for the female (Tsaur et al. 1991; Zhang and Chen 2011). Zhi et al. (2017, 2018) found the characters of the sclerites on the posterior vagina could be considered as key diagnostic characters for female identification in the genera Neocarpia (Eucarpiini) and Oecleopsis (Pentastirini). The authors also discussed the external and the internal structures of the female genitalia in cixiid planthoppers. In this study, the sclerites of the vagina are studied in detail in Tsauria brevispina (Figs 24, 25), T. cehengensis (Figs 34, 35) and T. longispina (Figs 57, 58). As a result, the characters of the posterior vagina have been shown to be fairly effective when used to distinguish among species of Tsauria.

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References

Bourgoin T (1987) A new interpretation of the homologies of the Hemiptera male genitalia, illustrated by the Tettigometridae (Hemiptera, Fulgoromorpha). Proceedings 6th Auchenorrhyncha Meeting, Turin, Italy, 7–11 September 1987, 113–120.

Bourgoin T (1993) Female genitalia in Hemiptera Fulgoromorpha, morphological and phylogenetic data. Annales de la Société Entomologique France 29(3): 225–244.

Bourgoin T, Wang RR, Asche M, Hoch H, Soulier-Perkins A, Stroiński A, Yap S, Szwe do J (2015) From micropterism to hyperpterism: recognition strategy and standardized homology-driven terminology of the forewing venation patterns in planthoppers (Hemiptera: Fulgoromorpha). Zoomorphology 134: 63–77. https://doi.org/10.1007/s00435-014-0243-6

Holzinger WE (2002) A review of the European planthopper genus Trirhacus and related taxa, with a key to the genera of European Cixiidae (Hemiptera: Fulgoromorpha). European Journal of Entomology 99: 373–398. https://doi.org/10.14411/eje.2002.048
Koçak AÖ, Kemal M (2009) Two replacement names for the genera in the family Cixiidae (Hemoptera). Centre for Entomological Studies Ankara, Miscellaneous Papers 147–148: 5–6.
Tsaur SC, Hsu TC, Stalle JV (1991) Cixiidae of Taiwan, Part V. Cixiini except Cixius. Journal of Taiwan Museum 44: 1–78.
Xing JC, Chen XS (2014) Nomenclatural changes for the genus Discophorellus Tsaur & Hsu, 1991 and new replacement name for Numata Matsumura, 1935 (Hemiptera: Fulgoromorpha). Zootaxa 3856(1): 149–150. https://doi.org/10.11646/zootaxa.3856.1.8
Zhang P, Chen XS (2011) Two new species of the genus Discophorellus Tsaur & Hsu (Hemiptera: Fulgoromorpha: Cixiidae: Cixiini) from Guizhou Province, China. Zootaxa 3105: 60–68. https://doi.org/10.11646/zootaxa.3105.1.3
Zhi Y, Yang L, Zhang P, Chen XS (2017) Taxonomic study of the genus Neocarpia Tsaur & Hsu, with descriptions of two new species from China (Hemiptera, Fulgoromorpha, Cixiidae). ZooKeys 695: 19–35. https://doi.org/10.3897/zookeys.695.12809
Zhi Y, Yang L, Zhang P, Chen XS (2018) Two new species of genus Oecleopsis Emeljanov from China, with descriptions of female genitalia of five species (Hemiptera, Fulgoromorpha, Cixiidae). ZooKeys 768: 1–17. https://doi.org/10.3897/zookeys.768.24796