A Review of the Genus *Alulatettix* Liang (Orthoptera: Tetrigoidea: Tetrigidae)

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Abstract

The taxonomy of the tetrigid genus *Alulatettix* Liang is reviewed. A new species, *Alulatettix orthomarginalis* n. sp. is described. The annotated list and key to all known species of *Alulatettix* are given.

Introduction

The genus *Alulatettix* (Orthoptera: Tetrigidae) was erected by Liang (1993) with the type species *Alulatettix yunnanensis* Liang from China. Since Liang (1993), several new species of the genus *Alulatettix* have been described (Niu 1994, Zheng & Zhou 1996, Wang & Zheng 1997, Fu et al 1998, Zheng & Zhong 2001, Zheng 2006, 2012, Zhong & Zheng 2003, Tsai & Yang 2005, Liang & Jiang 2005, Deng et al 2006, 2009). Additionally, *Tetrix fornicatus* Ichikawa was transferred to *Alulatettix* by Zheng & Zhong (2001). Deng et al (2006) revised the genus *Alulatettix* from China, and included 11 species. To date, the genus includes 17 known species distributed in China and Japan (Ichikawa 1993, Liang & Zheng 1998, Zheng 2005, Tsai & Yang 2005, Deng et al 2007).

In this paper, the genus of *Alulatettix* Liang is systematically revised and we include the clarification of the taxonomic status of the genus *Alulatettix* and determine the characters for species diagnosis. Information on biology and geographical distribution are also added, we describe *Alulatettix orthomarginalis* n. sp. and provide an updated key to the species.

Material and Methods

All specimens used in this study are deposited in the Institute of Zoology, Shaanxi Normal University, Xi'an, China, Department of Chemistry and Life Science, Hechi University, Yizhou, Guangxi, China, and the Research Institute of Entomology, Zhongshan University, Guangzhou, China.

Specimens were examined and illustrated by using a stereomicroscope (Guangzhou LISS Optical Instrument Ltd. XTL-1, China) at ×20 magnification. Photographs were taken with a digital stereomicroscope (Sunny/DMSZM45) with a series of images montage using the program CombineZ5.3 (Hadley 2006). Morphological terminology and measurement landmarks followed those of Vickery & Kevan (1983). Measurements are given in millimeters.

Taxonomy

Alulatettix Liang

Alulatettix Liang (1993, p. 73), Jiang & Zheng (1998, p. 342), Liang & Zheng (1998, p. 276), Zheng (2005, p. 342), Deng et al (2007, p. 306). Type species: *A. yunnanensis* Liang, 1993, China (Yunnan), by original designation.

Description. Body size small, with small granules. Vertex protruding beyond anterior margin of eyes, with median carina. Vertex about 1.5–2.0 times as wide as an eye. Frons oblique, frontal costa slightly concave between lateral ocelli and protruding between the base of antennae in profile, longitudinal groove on frontal costa as wide as 1st antennal segment. Lateral ocelli situated middle of anterior margin of eyes. Eyes spherical. Pronotum distinctly tectiform, median carina, lateral carinae, and humeral angles of pronotum well defined; apex of hind process rounded or with triangular concavity; posterior margins of lateral lobes of pronotum with two concavities. Elytra and wings brachypterous. Fore and mid femora with nearly straight or wave-like ventral margin. First segment of hind tarsi longer than the third.

Key to the species of *Alulatettix* Liang

1. Anterior margin of pronotum straight.....2
 - Anterior margin of pronotum protruding acute angular or obtuse angular..... 8
2. Disk of pronotum with a pair of abbreviated carinae between shoulders 3
 - Disk of pronotum without abbreviated carinae between shoulders 4
3. With numerous large and fine tubercles on dorsum of pronotum, median carina of pronotum interrupted; in profile, upper margin of pronotum wave-like *Alulatettix interrupta* Deng et al
 - Dorsum of pronotum smooth, median carina of pronotum complete, in profile, upper margin of pronotum arched..... *Alulatettix angustivertex* Tsai & Yang
4. In profile, anterior part of upper margin of pronotum arched, middle part concave, posterior part arched; lower margins of fore and middle femora distinctly wave-like *Alulatettix wudangshanensis* Wang & Zheng
 - In profile, anterior half of upper margin of pronotum arched, posterior half flat 5
5. Width of vertex about two times that of one eye; hind wing reaching posterior margin of first segment of abdomen..... *Alulatettix bamianshanensis* Fu & Zheng
 - Width of vertex about 1.3–1.6 times that of one eye; hind wing reaching the posterior margin of second or third segment of abdomen 6
6. Width of vertex about 1.3 times that of one eye; hind wing reaching middle of second segment of abdomen; lower margins of middle femora straight; posterior margin of subgenital plate straight..... *Alulatettix rectimargina* Zheng
 - Width of vertex about 1.5–1.6 times that of one eye; hind wing reaching posterior margin of third segment of abdomen; lower margins of middle femora undulated 7
7. In profile, frontal costa concave between lateral ocelli; width of longitudinal furrow equal to that of first segment of antennae; prozona with lateral keels parallel; first segment of hind tarsi about 1.5 times longer than the third segment *A. qinlingensis* Deng et al
 - In profile, frontal costa straight between lateral ocelli; width of longitudinal furrow wider than that of first segment of antennae; prozona with lateral keels constricted backwards; first segment of hind tarsi about 2.0 times longer than third segment..... *Alulatettix ochrotibis* Deng & Zheng
8. Anterior margin of pronotum acute-angularly protruding 9
 - Anterior margin of pronotum obtuse angularly protruding 10
9. Width of vertex about 1.5 times that of one eye, anterior margin of vertex straight; middle femur 1.6 times width of tegmina; first segment of hind tarsi about 1.3×longer than the third segments..... *A. guangxiensis* Zheng & Zhou
 - Width of vertex about 2.0 times that of one eye, anterior margin of vertex curved; middle femur three times width of tegmina; first segment of hind tarsi about 2.0 times longer than the third segments..... *A. anhuiensis* Zheng
10. Apex of hind pronotal process rounded 11
 - Apex of hind pronotal process triangularly excised 14
11. Anterior margin of vertex rounded; in profile, upper margin of pronotum slightly arched 12
 - Anterior margin of vertex straight; in profile, upper margin of pronotum distinctly spherical 13
12. Disk of pronotum with a pair of abbreviated carinae between shoulders; ovipositor short, valves of ovipositor broad, upper valve 2.5 times as long as wide *Alulatettix fornicata* (Ichikawa)
 - Disk of pronotum without abbreviated carinae between shoulders; ovipositor narrow and long, upper valvulae four times as long as width *A. yunnanensis* Liang
13. Apex of hind pronotal process reaching posterior end of abdomen; hind wings reaching posterior margin of third segment of abdomen *Alulatettix bulbosus* Zheng & Zhong
 - Apex of hind pronotal process reaching apex of supra-anal plate; hind wings reaching posterior margin of first segment of abdomen *Alulatettix leyensis* Liang & Jiang
14. Ventral margins of mid femora straight 15
 - Ventral margins of mid femora undulated 16
15. In profile, upper margin of pronotum arcuate above fore leg, more straight in middle and posterior part; hind wings reaching posterior margin of second segment of abdomen; middle of posterior margin of subgenital plate of female triangularly projecting *Alulatettix zhengi* Niu
 - In profile, upper margin of pronotum arcuate; hind wings reaching the posterior margin of 1st segment of abdomen; posterior margin of subgenital plate of female with three teeth *Alulatettix kunmingensis* Zheng

16. Width of longitudinal furrow of frontal ridge equal to width of first segment of antennae; lower margin of hind process of pronotum straight; mid-femur two times width visible part of tegmina *A. orthomarginalis* n. sp.
 – Width of longitudinal furrow of frontal ridge wider than width of first segment of antennae; lower margin of hind process of pronotum curved; mid-femur three times width visible part of tegmina 17
17. In profile, frontal costa together with vertex forming an acute angle; posterior margin of subgenital plate of female straight *Alulatettix wufengensis* Zhong & Zheng
 – In profile, frontal costa together with vertex forming a right angle; in female, with a slender triangular projection in middle of posterior margin of subgenital plate *Alulatettix chuxiongensis* Zheng

Checklist of species of the genus *Alulatettix*

Alulatettix angustivertex Tsai & Yang

Alulatettix angustivertex (Tsai & Yang 2005, p. 53; holotype—male, China: Taiwan, Taitung; in the Department of Entomology, National Chung Hsing University, Taichung, Taiwan).

Specimens examined. No specimens were examined.

Data is recovered only from the literature.

Distribution. People's Republic of China: Taiwan.

Alulatettix anhuiensis Zheng

Alulatettix anhuiensis Zheng and Zhong 2001, p. 195 (holotype—female, China: Anhui, Guniujiang; in the Institute of Zoology, Shaanxi Normal University).

Specimens examined. One ♀, Anhui, Guniujiang, 15.viii.1984.

Distribution. People's Republic of China: Anhui.

Alulatettix bamianshanensis Fu & Zheng

Alulatettix bamianshanensis (Fu et al 1998; p. 41; holotype—female, China: Hunan, Guidong; in the Institute of Zoology, Shaanxi Normal University).

Specimens examined. Six ♂, four ♀, Hunan, Linxiang, 4 Aug. 2010; one ♀, Hunan, Guidong, 10.viii.1996.

Distribution. People's Republic of China: Hunan.

Alulatettix bulbosus Zheng & Zhong

Alulatettix bulbosus Zheng & Zhong 2001, p. 197 (holotype—male, China: Hubei, Luotian; in the Institute of Zoology, Shaanxi Normal University).

Specimens examined. One ♂, Hubei, Luotian, 14.Jue.1999; three ♂, Hubei, Luotian, 10.Jue.1999; two ♂, four ♀, Zhejiang, Linan, 28.vi.2012.

Distribution. People's Republic of China: Hubei and Zhejiang.

Alulatettix chuxiongensis Zheng

Alulatettix chuxiongensis Zheng and Zhong 2001, p. 201 (holotype—female, China: Yunnan, Chuxiong; in the

Research Institute of Entomology, Zhongshan University; Zheng 2005, p. 345; Deng et al 2007, p. 310).

Specimens examined. Five ♂, four ♀, Yunnan, Zhenxiong, 15 Aug. 2008; one ♀, Yunnan, Chuxiong, 21 July 1997; one ♀, Yunnan, Chuxiong, 1.viii.1975.

Distribution. People's Republic of China: Yunnan.

Alulatettix fornicata (Ichikawa)

Tetrix fornicatus (Ichikawa 1993, p. 2; holotype—female, Japan: Hatsutani Mts; in OMNH Osaka); *A. fornicata* (Ichikawa, 1993; Zheng and Zhong 2001, p.197).

Specimens examined. No specimens were examined.

Data is recovered only from the literature.

Distribution. Japan: Osaka prefecture, Mie prefecture, Kyoto prefecture, Hyogo prefecture, Okayama prefecture.

Alulatettix guangxiensis Zheng & Zhou

Alulatettix guangxiensis Zheng & Zhou 1996, p. 87 (holotype—male, China: Guangxi, xingan; in the Institute of Zoology, Shaanxi Normal University); Jiang and Zheng 1998, p. 34; Zheng 2005, p. 342; Deng et al 2007, p. 308.

Specimens examined. One ♂, one ♀, Guangxi, xingan, 4.vi.1994.

Distribution. People's Republic of China: Guangxi.

Alulatettix interrupta Deng et al

Alulatettix interrupta (Deng et al 2006, p. 115; holotype—female, China: Guangxi, Beihai; in the Institute of Zoology, Shaanxi Normal University; Deng et al 2007, p. 307).

Specimens examined. One ♀, Guangxi, Beihai, 8.viii.2005.

Distribution. People's Republic of China: Guangxi.

Alulatettix kunmingensis Zheng

Alulatettix kunmingensis (Zheng 2006, p. 365; holotype—female, China: Yunnan, Kunming; in the Institute of Zoology, Shaanxi Normal University; Deng et al 2007, p. 311).

Specimens examined. Two ♂, four ♀, Yunnan, Luliang, 7 Aug. 2006; two ♂, two ♀, Yunnan, Kunming, 5.viii.2004.

Distribution. People's Republic of China: Yunnan.

Alulatettix leyensis Liang & Jiang

Alulatettix leyensis (Liang & Jiang 2005, p. 56; holotype—female, China: Guangxi, Leye; in the Research Institute of Entomology, Zhongshan University).

Specimens examined. No specimens were examined.

Data is recovered only from the literature.

Distribution. People's Republic of China: Guangxi.

Alulatettix ochrotibis Deng & Zheng

Alulatettix ochrotibis (Deng et al 2009, p. 259; holotype—male, China: Yunnan, Qiubei; in the Institute of Zoology, Shaanxi Normal University).

Figs 1–3 *Alulatettix orthomarginalis* n. sp. female. 1 Lateral view of body; 2 head and pronotum, dorsal view; 3 head and pronotum, lateral view (scale bar 1 mm)

Specimens examined. Two ♂, four ♀, Yunnan, Qiubei, 5. viii. 2006.

Distribution. People's Republic of China: Yunnan.

Alulatettix orthomarginalis n. sp. (Figs 1–3, 4–11, 12)

Description

Female. (Fig 1) Size small. Head not projecting above upper level of pronotum (Fig 4). Anterior margin of vertex curved (Fig 2), slightly protruding beyond eyes, median carina conspicuous, the vertex between eyes 1.6 and 1.7 times wider than width of one eye from above. Vertex and frontal ridge curved in profile, frontal ridge concave between lateral ocelli (Fig 3), frontal ridge protruding archly between antennae, width of longitudinal furrow equal to width of first segment of antennae (Fig 5). Antennae fili-form (Fig 6), 15 segmented, situated between lower margin of eyes (Figs 3–6), the eighth segment about five times as

long as wide. Eyes globular. Lateral ocelli placed between middle of anterior margins of eyes (Figs 2 and 3). Pronotum in dorsal view tectiform, anterior margin obtuse angular (Fig 2), dorsal margin arched in profile (Figs 1 and 3). Posterior process of pronotum short, just reaching two thirds of hind femora, apex of process triangularly incised in middle (Fig 2). Lower margin of hind process straight (Figs 1 and 3), lateral carinae in metazona straight. Lateral carinae in prozona inconspicuous, parallel; humeral angle obtuse. Posterior margin of lateral lobes in lateral view with two concavities (Fig 3), the first extremely shallow; posterior angles of lateral lobes of pronotum turned downwards, with rounded apex. Tegmina smaller, brachypterous (Fig 8), elliptic, visible part of tegmen 3.5 times as long as wide. Hind wings strongly reduced as strips (Fig 8), just reaching the posterior margin of 1st segment of abdomen, in lateral view slightly exposed by the pronotum. Ventral margins of fore and mid femora slightly undulating (Fig 7); mid femur 2.0 times wider than visible part of tegmen. Hind femora stout, 3.0 times as long as wide; dorsal and ventral side of femora gentle dentate; pregenicular spine

Figs 4–11 *Alulatettix orthomarginalis* n. sp. 4 Head, lateral view; 5 head, frontal view; 6 antennae; 7 middle femur, lateral view; 8 elytra and wings, lateral view; 9 ovipositor of female, lateral view; 10 subgenital plate of female, ventral view; 11 subgenital plate of male, lateral view (scale bar 1 mm)

Fig 12 *Alulatettix orthomarginalis* n. sp. male—lateral view of body (scale bar 1 mm)

rectangular; genicular spine acute. Outer side of hind tibia with seven or eight spines, inner side with eight or nine spines. First segment of hind tarsi 1.6 times longer than the third segment; third pulvillus of first tarsus longer than first or second, apices of the first and the second pulvilli sharp, apex of the third pulvillus rectangular. Ovipositor narrow and long: upper valve 3.0 times as long as wide, upper and lower valves with slender saw-like teeth (Fig 9). Length of subgenital plate slightly less than its width; posterior margin of subgenital plate triangularly projecting (Fig 10).

Body dark brown, with a pair of dark spots behind shoulders (Fig 2). Hind tibia dark brown.

Male. (Fig 12) Size in males slightly smaller than in females. Vertex between eyes 1.4 and 1.5 times wider than width of one eye from above, subgenital plate short, cone-shaped (Fig 11). Other structures and coloration same as female.

Measurements. Length of body: ♂ 9.0–9.5 mm, ♀ 11–11.5 mm; length of pronotum: ♂ 6.0–6.5 mm, ♀ 7.5–8.0 mm; length of hind femur: ♂ 5.5–6.0 mm, ♀ 6.0–6.6 mm.

Type material. Holotype: female. China, Guizhou prov., Chishui (Wuzhufeng, Suoluo Nature Reserve), 28.5°N, 105.7°E, 1,000 m asl, 13.viii.2012, collected by Wei-An DENG. **Paratypes.** Four male and two female, same data as for holotype. Material is deposited in the Institute of Zoology, Shaanxi Normal University, Xi'an, China.

Diagnosis

Alulatettix orthomarginalis is similar to *A. wufengensis* and *A. chuxiongensis* from which it differs in the vertex and frontal ridge curved in profile, the width of longitudinal furrow of frontal ridge equal to width of the first segment of antennae, the lower margin of hind process straight, the mid-femur 2.0 times wider than the visible part of tegmen, and in the triangularly projecting posterior margin of female subgenital plate.

Etymology. The species name is derived from the Latin *ortho* and *marginis*, meaning lower margin of hind process straight.

Distribution. People's Republic of China, Guizhou.

Alulatettix qinlingensis Deng et al

Alulatettix qinlingensis Deng et al 2006, p. 114 (holotype—male, China: Shaanxi, Xian; in the Institute of Zoology, Shaanxi Normal University).

Specimens examined. Four ♂, four ♀, Shaanxi, Xian, 4.vi.2005.

Distribution. People's Republic of China: Shaanxi.

Alulatettix rectimargina Zheng

Alulatettix rectimargina (Zheng 2012, p. 8; holotype—female, China: Yunnan, Ruili; in the Institute of Zoology, Shaanxi Normal University).

Specimens examined. One ♀, Yunnan, Ruili, 7.viii.2005.

Distribution. People's Republic of China: Yunnan.

Alulatettix wudangshanensis Wang & Zheng

Alulatettix wudangshanensis (Wang & Zheng 1997, p. 57; holotype—male, China: Hubei, Danjiangkou; in the Institute of Zoology, Shaanxi Normal University; Liang & Zheng 1998, p. 177).

Specimens examined. Nine ♂ eight ♀, Hubei, Danjiangkou, 13 July 1990; One ♀, Hubei, Shennongjia, 21.vii.1990.

Distribution. People's Republic of China: Hubei.

Alulatettix wufengensis Zhong & Zheng

Alulatettix wufengensis Zhong & Zheng 2003, p. 167 (holotype—female, China: Hubei, Wufeng; in the Research Institute of Entomology, Zhongshan University).

Specimens examined. One ♀, Hubei, Wufeng, 15.viii.2000.

Distribution. People's Republic of China: Hubei.

Alulatettix yunnanensis Liang

Alulatettix yunnanensis (Liang 1993; p. 73; holotype—male, China: Yunnan, Kunming; in the Research Institute of Entomology, Zhongshan University; Liang and Zheng 1998, p. 178; Zheng 2005, p. 344; Deng et al 2007, p. 309).

Specimens examined. Two ♂, three ♀, Yunnan, Kunming, 4 Aug. 2005; one ♂, three ♀, Yunnan, Dali, 6.vii.1995.

Distribution. People's Republic of China: Yunnan.

Alulatettix zhengi Niu

Alulatettix zhengi (Niu 1994; p. 35; holotype—male, China: Henan, Xixia; in the Institute of Zoology, Shaanxi Normal University; Liang and Zheng 1998, p. 179).

Specimens examined. One ♂, Henan, Xixia, 6 June 1987; one ♀, Henan, Lushan, 28.iii.1992; one ♀, Henan, Xixia, 30.vi.1986.

Distribution. People's Republic of China: Henan.

Discussion

The original description of the genus was exclusively based on characters from external morphology. The morphology of *Alulatettix* is quite homogeneous and species can be differentiated mostly by the brachypterous elytra and wings. Recent molecular studies based on *A. qinlingensis* cytochrome oxidase I (Fang et al 2010) demonstrated *Alulatettix* to be closely related to the genus *Tetrix* Latreille. *Alulatettix* and *Tetrix* belong to the subfamily Tetriginae, and both of these genera are similar in the head not projecting above upper level of pronotum and the posterior margin of lateral lobes in lateral view with two concavities, but they differ in the shape of pronotum and degree of development of tegmina and hind wings. Tetriginae are one of the most basal members of Tetrigoidea, but the phylogenetic studies focusing on the relationships within Tetriginae are limited. Therefore, phylogenetic relationships between *Alulatettix* and other Tetriginae genera are not well understood.

Species of the genus *Alulatettix* are usually associated with, but not limited to, shady environments, living under fallen leaves or grasses in tropical rainforests. Some (Mao et al 2011) have suggested that the brachypterous hind wings are not adapted for flying. The diet is consisted mainly of algae growing on moist ground, along with lichens and some forms of humus. Species of *Alulatettix* generally overwinter as adults. Almost all species of *Alulatettix* are distributed in the Oriental region, except one species known from the east part of the Palaearctic region (Japan: Honshu Island; Zheng 2012).

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