

## **New species of katydids (Orthoptera: Tettigoniidae) of the neotropical genera *Arachnoscelis* (Listroscelidinae) and *Phlugiola* (Meconematinae), with taxonomic notes**

Author: Nickle, David A.

Source: Journal of Orthoptera Research, 11(2) : 125-133

Published By: Orthopterists' Society

URL: [https://doi.org/10.1665/1082-6467\(2002\)011\[0125:NSOKOT\]2.0.CO;2](https://doi.org/10.1665/1082-6467(2002)011[0125:NSOKOT]2.0.CO;2)

---

BioOne Complete ([complete.BioOne.org](https://complete.BioOne.org)) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](https://www.bioone.org/terms-of-use).

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

# New species of katydids (Orthoptera: Tettigoniidae) of the neotropical genera *Arachnoscelis* (Listroscelidinae) and *Phlugiola* (Meconematinae), with taxonomic notes

DAVID A. NICKLE

Systematic Entomology Laboratory, Agricultural Research Service, PSI, USDA, Beltsville Agricultural Research Center, Bldg. 005, Rm. 137, 10300 Baltimore Ave., Beltsville, MD 20705-2350. E-mail: dnickle@sel.barc.usda.gov

## Abstract

The predaceous katydid species *Arachnoscelis meriti*, n. sp. (Listroscelidinae) and *Phlugiola arborea*, n. sp. (Meconematinae) are described herein. Keys to species of both genera based on morphological differences are also provided. Both species were collected from rainforest canopies in northern Peru. Based on the numbers of additional new forms collected, sorted and identified during the course of this study, many species in addition to these are new to science, providing evidence of a very rich and diverse arboreal fauna in northern Peru. After reviewing literature on the tribe Phlugidini, *Tenuiphlugis* Kevan (with 4 species) is herein synonymized with the genus *Lucienola* Gurney.

## Resumen

Se describen las especies de grillos carnívoros *Arachnoscelis meriti*, n. sp. (Listroscelidinae) y *Phlugiola arborea*, n. sp. (Meconematinae). Se incluyen claves de las especies de ambos géneros basadas en diferencias morfológicas. Ambas especies fueron recolectadas del dosel de las selvas tropicales en el norte peruano. De acuerdo con los números de las nuevas formas recolectadas, clasificadas e identificadas en el transcurso de este estudio, existe fuerte evidencia de una fauna muy rica y diversa en la región norte del Perú. Después de una revisión de la literatura en de la tribu Phlugidini, el género *Tenuiphlugis* Kevan (con 4 especies) pasa a ser sinónimo del género *Lucienola* Gurney.

## Key words

*Arachnoscelis*, arboreal, katydid, keys, *Lucienola*, Peru, *Phlugiola*, rainforest, *Tenuiphlugis*

## Introduction

In a long-term study on the biodiversity of orthopteroid and dictyopteroid insects of northern Peru, I discovered two new species of predaceous katydids in samples recovered from rainforest tree-top canopies. These species represent new additions to the genera *Arachnoscelis* Karny 1911 (Listroscelidinae) and *Phlugiola* Karny 1907 (Meconematinae). To provide names for ongoing behavioral studies, these new species are described herein, and an identification key of species of each genus provided.

*Arachnoscelis* and *Phlugiola* were both originally placed in the subfamily Listroscelidinae, but Karny (1924) transferred *Phlugiola* and several related genera into the subtribe Phlugidina of the tribe Phisidini (Meconematinae), all of them having open, unconcealed tympana and lacking well-defined prosternal spines. However, clear-cut differences separating these subfamilies are lacking (Zeuner 1940, Rentz 1979), and a phylogenetic analysis is greatly needed either to define them or combine them.

Karny (1911) erected *Arachnoscelis* to include the species *Listroscelis arachnoides* Redtenbacher 1891, based on a single male from Colombia, to which Karny added his description of the female. Later, Hebard (1927) described the Panamanian species *A. magnifica*, and Randell (1964) described the Costa Rican species *A. rehni*. Most recently, Bowen-Jones (1994) described another Costa Rican species, *A. feroxnotha*. To date, two species are South American and three are Central American; whether the genus is South or North American in origin has, as yet, not been determined.

Karny (1907) erected the monotypic genus *Phlugiola* to include the species *redtenbacheri*, based on a single female from Surinam. Despite its brachyptery, this species is widespread and has been collected in several northern South American countries, including Brazil and Peru (Rehn 1918, Gurney 1975); in the research sites of this study it is relatively common (Nickle pers. observ.). Eichler (1938) described a second species of *Phlugiola* — *P. dahlemica* — found inhabiting greenhouses in the Botanical Gardens at Berlin-Dahlem, Germany. Although its native homeland is unknown, it was well established in this, albeit artificial, environment for many years, and Eichler (1939a,b; 1952) published on aspects of its biology. An air attack in 1945 resulting in the partial collapse of the greenhouse, apparently eliminated this species from its non-native homeland (Ley 1951: 292). However, based on a comparison of femoral and tibial spurs among similar genera (Table 1), it is probably of South American origin and may be eventually re-collected in its place of origin. A third species, *Phlugiola gressitti* Chopard 1969, from the Solomon Islands, was reassigned by Gurney (1975) into a new genus — *Lucienola* — to separate that taxon from neotropical species of *Phlugiola*.

## Materials & Methods

The present study is based on 61 specimens (33 ♂♂, 22 ♀♀, 6 nymphs) collected at 4 sites in northern Peru in Loreto Province. Specimens were collected over a 12-y period by 14 of 24 teams of Earthwatch volunteers (each team comprising the collecting efforts of 11 to 17 persons, supervised primarily by D. A. Nickle and J. L. Castner, coprincipal investigators). Collecting dates for each team are as follows: Team 1 (XI.1-18.1986); Team 3 (II.14-28.1987); Team 8 (VIII.19-IX.1.1989); Team 10 (VII.7-21.1990); Team 11 (X.3-17.1990); Team 15 (VIII.22-IX.3.1992); Team 17 (VIII.20-IX.3.1991); Team 19 (VII.29-VIII.12.1995); Team 20 (VIII.17-31.1996); Team 21 (VIII.31-IX.14.1996); Team 22 (VII.26-VIII.9.1997); Team 23 (VIII.9-23.1997); Team 24 (VII.25-VIII.8.1998).

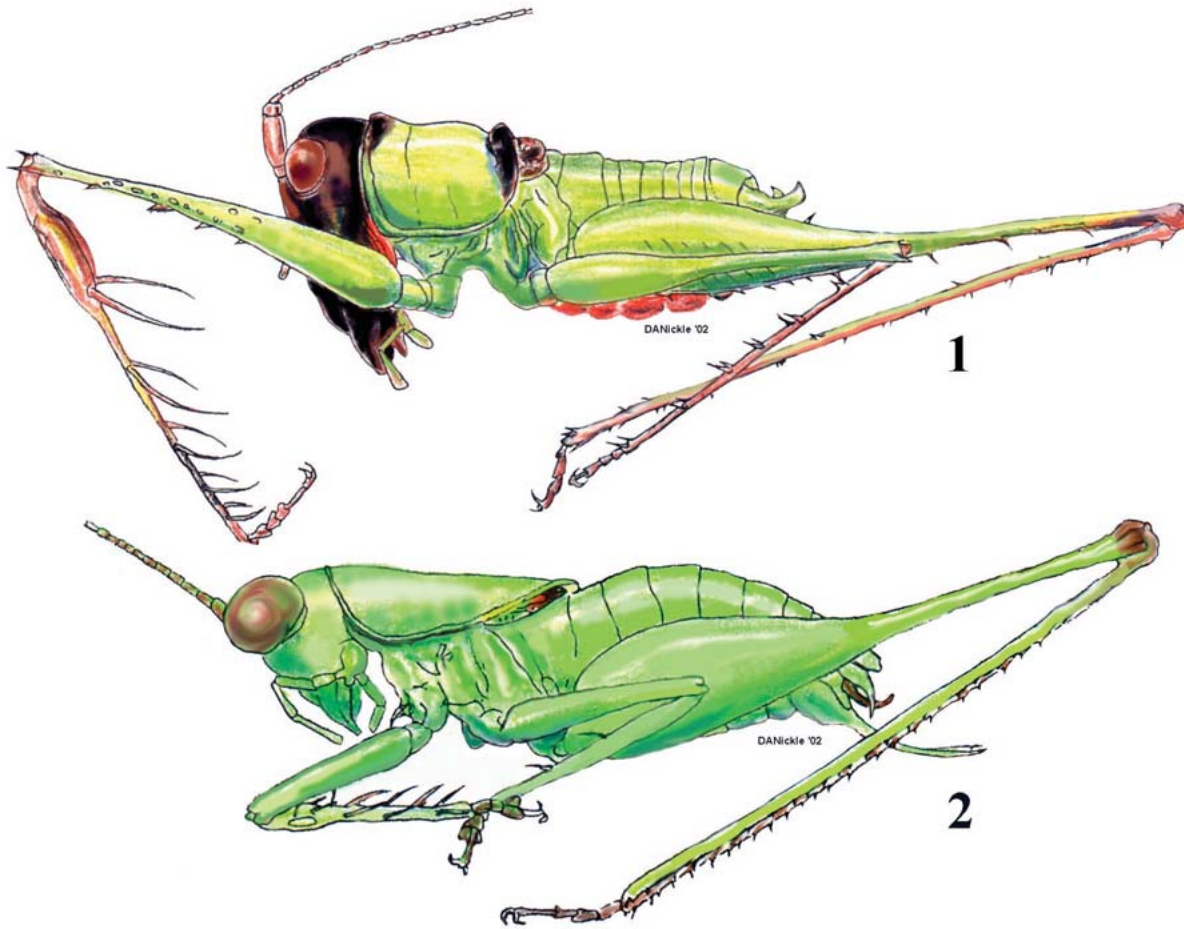


Fig. 1. *Arachnoscelis meriti*, new species, habitus. Actual length from fastigium to tip of hind femur: 29.74 mm.  
 Fig. 2. *Phlugiola arborea*, new species, habitus. Actual length from fastigium to tip of hind femur: 23.22 mm.

The sites are part of an ecotourist facility, Exploraciones Amazonicas, (known locally as Explorama), and they are located [and abbreviated in the text of this paper] as follows: Explorama Inn [INN], 40 km NE Iquitos on Rio Amazon (nr Indiana) lat 3°26' S, long 73°02' W; Explorama Lodge [LODGE], 80 km NE Iquitos on Rio Yanamono (1 km upriver from Rio Amazon, lat 3°30' S, long 73°05' W); Explornapo Camp [CAMP], 90 km NE Iquitos on Rio Sucusari (1 km upriver from Rio Amazon, lat 3°11' S, long 72°53' W); and the Amazon Center for Environmental Education and Research [ACEER], nr Explornapo Camp, 90 km NE Iquitos on Rio Sucusari (1 km upriver from Rio Napo, lat 3°11' S, long 72°53' W).

Specimens were collected both on the ground during nighttime collecting forays along forest trails in northern Peru and from rain-forest canopy samples obtained by fogging treetops with a pesticide (Resmethrin®, 0.5%). The pesticide was administered from canopy level (via standard rope-ascending methods, wherein one individual carried the fogging device to the canopy) or aimed into the canopy from ground level. The fogging device was a Golden Eagle® Model 2610E, Series 3 Dyna-Fog insecticide fog generator. As they reacted to the pesticide and fell to the ground, specimens were collected on clear plastic drop sheets, placed around the base of each target tree.

Two species — *Arachnoscelis meriti* Nickle, new species (subfamily Listroscelidinae) and *Phlugiola redtenbacheri* (subfamily Meconematinae) — were collected both on the ground and from

canopy samples. The other species, *P. arborea* Nickle, new species, was collected only from fogging samples from the canopies of two trees.

*Measurements.*— Specimens were measured (in mm) with a device described by Grant (1965), and characters used to evaluate species are essentially those detailed by Emsley *et al.* (1967). Measurements were defined as follows: *total length*, the distance between the frons and apex of abdomen; *length of pronotal disc*, the median length of the disc from anterior to posterior margin; *width of pronotal disc*, the width across the posterior margin of the pronotum as the shortest distance between the two points at the base of the curvature of the posterior margin; *length and width of both fore- and hind femur*, the greatest dimensions of those structures as seen in lateral view; *length of ovipositor*, the distance from the apex of the ovipositor to the apex of the subgenital plate. All teeth on the stridulatory file on the left tegmen of *P. arborea* were counted, and the straight-line distance between first and last tooth on the file recorded as the *length of the file*.

*Depository.*— Specimens are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC [USNM].

## Subfamily Listroscelidinae

*Arachnoscelis* Karny 1911

*Type species.*— *Listroscelis arachnoides* Redtenbacher 1891, by monotypy.

Karny 1911: 346; Karny 1912: 3.

*Diagnosis.*— Small (ca 2 to 3 mm), brachypterous katydids with slender, elongated legs and large, hypognathous heads. Differing from other neotropical listroscelidine genera, *Cerberodon* Perty 1832, *Monocerophora* Walker 1869 and *Listroscelis* Serville 1831, by having tegminal pads instead of fully developed tegmina and wings; differing from the (also brachypterous) genus *Carliella* Karny 1911, by having long, more gracile forefemora and in males by having concealed symmetrical mandibles (in *Carliella* these are protrusive and asymmetrical).

Key to species of *Arachnoscelis* (based primarily on the male sex)

- 1 Species from South America; male cercus elongated, extending well beyond apex of 10<sup>th</sup> tergite in dorsal view; subgenital plate spatulate with apex medially undeveloped . . . . . 2
- 1' Species from Central America; male cercus short, concealed or nearly so beneath apex of 10<sup>th</sup> tergite in dorsal view; subgenital plate modified with apex medially developed into a narrow forked or bilobed projection (Fig. 7) . . . . . 3
- 2 Head and pronotum fuscous, with black markings on pronotum extending from ventral lobes to both anterior and posterior margins of disc . . . . . *arachnoides*
- 2' Head black (male) or green to reddish brown with blackened margins and two black bands on face (female); pronotum green, with black markings limited to anterior and posterior margins of disc . . . . . *meriti*
- 3 In dorsal view lateral flanges of tergite X extending to apex of subgenital plate or beyond . . . . . 4
- 3' In dorsal view lateral flanges of tergite X extending only half to two thirds length of subgenital plate . . . . . *magnifica*
- 4 In dorsal view lateral flanges of tergite X extending well beyond apex of subgenital plate; pronotum lacking black markings on margins . . . . . *feroxnotha*
- 4' In dorsal view lateral flanges of tergite X extending only to apex of subgenital plate; pronotum with well developed black markings on margins . . . . . *rehni*

*Arachnoscelis meriti* Nickle, new species  
(Figs 1, 3-9)

*Diagnosis.*— Most similar to *A. arachnoides*, differing in color patterns of head and pronotum: head of male glabrous black around edges, with dark brown genae, frontal region somewhat lighter reddish-brown, head of female green to reddish, with black markings on posteromarginal rim of head and with two bands on face extending from bases of antennae to lateral corners of clypeus; clypeus, labrum, and labium reddish, pronotum green with black anterior and posterior margins (Fig. 1). *Arachnoscelis meriti* is also smaller with relatively shorter legs than *A. arachnoides*. Differing from Central American species by having long, exposed (not short, concealed) male cerci and a simple, spatulate, male subgenital plate (in Central American species it is apically modified and developed

into a forked or bilobed projection). Based on the measurements presented by Randell (1964) of other species of *Arachnoscelis*, *A. meriti* is the smallest species of this genus.

*Holotype.*— ♂. PERU: ACEER: Team 24, Fogging site 11. [USNM].

*Allotype.*— ♀. Same data as holotype.

*Paratypes.*— 4 ♂♂, 5 ♀♀, 3 nymphs. INN: Team 3, 1 ♀; Team 20, 1 ♀; CAMP: Team 3, 1 ♀; Team 21, Fogging sites 1 and 2, 2 ♂♂, 1 ♀, 3 nymphs. LODGE: Team 22, Fogging site 7, secondary, 1 ♂. ACEER: Team 20, 1 ♀; Team 23, Fogging site 19, 1 ♂. [USNM]

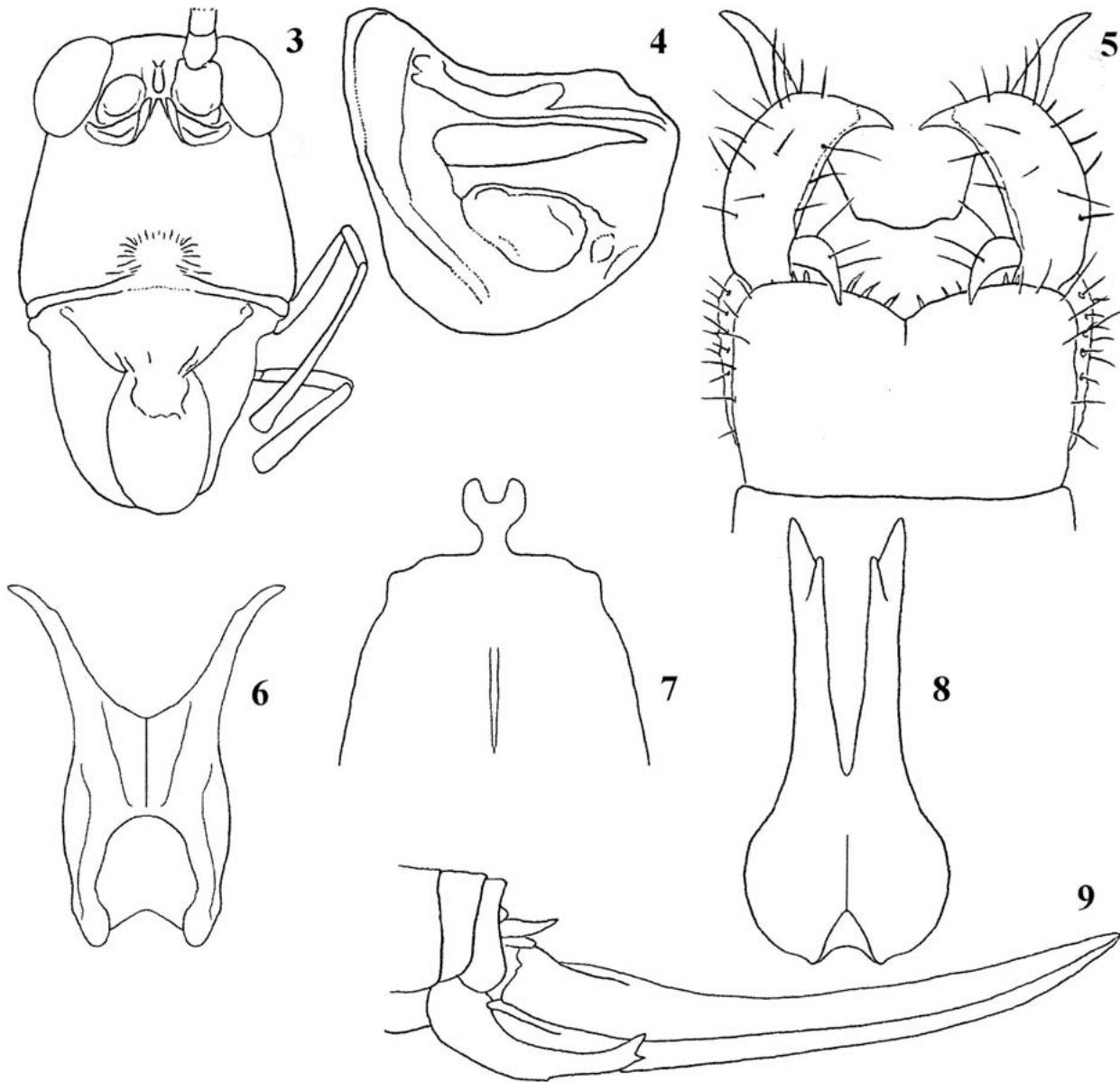
*Description.*—Head: Head large, in side view more than 2X longer than depth of lateral lobe of pronotum; in frontal view, frons forming a narrow, triangulate, apically pointed area between antennal sockets, 0.5X as wide as diameter of antennal socket. Fastigium weakly inflated, laterally compressed, 4X longer than wide, ca 5X broader than apex of frons (Fig. 3).

Thorax: Surface smooth, anterior margin weakly upturned, posterior margin more acutely upturned, in dorsal view metazona weakly concave; ventral anterolateral margin of prothorax expanded as a condyle behind ventroposterior surface of face. Prosternum with 2 small digitiform spines. Meso- and metasternum each with larger, apically rounded, papilliform, lobulate, paired spines.

Legs: Genicular lobes of all legs with one large dorsal spine and one small ventral sharp spine. Forelegs: femur 3X longer than pronotum, basally weakly inflated, gradually narrowing toward apex; ventral margins with 6 small median spines and 7 small lateral spines; tympana bilaterally equally shielded; forefemur 13 to 14X longer than wide; ventral margins of tibia each with 5 long articulating spurs, laterals slightly smaller than medials. Midlegs: femur basally weakly inflated, narrowing apically, ventral margins with 4 small lateral spines and 1 small median spine. Hind legs: basal third of femur greatly inflated, abruptly narrowing along distal 2/3 to apex; ventral margins with 11 to 16 small spines extending along entire length of femur; hind femur 6.0 to 7.5X longer than wide.

Wings: Brachypterous males, micropterous females; entire tegmen of male exposed in dorsal view beyond hindmargin of pronotum (Figs 1, 4); tegmen of female paddle-shaped, not overlapping.

Abdomen: ♂: Tenth tergite apically produced, medially declivent, with paired cerciform processes: each process appearing to arise ventromedially from cercus, but actually originating above cylindrical base of cercus; basal half cylindrical, extending ventrolaterally beneath base of cercus, distal half becoming laterally flattened and blade-like, recurving dorsally mesad of distal half of cercus, apically narrowing into a sharpened point. Cercus well developed, elongated, basally cylindrical, with lateral surface rounded, medial surface concave, and dorsomedial edge developed into a blade, apically becoming slightly inflated and recurving medially into a sharp tooth (Fig. 5). Subgenital plate spatulate; apical margin with deep V-shaped cleft; lateral margins well developed apically into two elongated, apically pointed lobes (Fig. 6). Female: Tenth tergite bilobed. Subgenital plate elongated, medio-apically deeply cleft, with each apical lobe bearing a small preapical ventral tooth (Fig. 8). Ovipositor elongated, weakly upcurved along its length, apically pointed, with both dorsal and ventral margins unserrated (Fig. 9).



Figs 3-9. Morphological features of *Arachnoscelis*. *A. meriti*: 3. Head, frontal view; 4. Left tegmen, dorsal view; 5. Apex of male abdomen, dorsal view; 6. ♂ subgenital plate, ventral view. 7. *A. magnifica*, ♂ subgenital plate; 8. ♀ subgenital plate, ventral view; 9. ♀ abdomen, left lateral view.

**Color.**— Head of male black or reddish umber becoming black posteriorly; head of female greenish to reddish in color with broad posteromarginal areas black to reddish black and two black bands on face extending from scape of antenna to lateral corner of clypeus; vertexial ridge of fastigium yellow (red in a few specimens). Clypeus, labrum, maxilla, and labium reddish. Both sexes: pronotum green (appearing tan in discolored specimens) with anterior and posterior margins of disc glossy black. Tegmen of male brownish-red with major veins darkened to glossy black. Tegmen of female green to reddish. Abdomen and legs in general green, with abdominal sternites and tibiae red. Distal half of all spines and spurs on legs darkened in various degrees from completely black in some specimens to black only at tips of spines and becoming increasingly light brown to midpoint.

**Variation.**—Most variation within this sample occurs in the color of the face. Males range in facial color from dark reddish-brown to nearly black; facial colors of females are more consistently green, with well-defined black markings as described above. The degree of development of the subapical tooth of the female subgenital plate varies from well-defined as in Fig. 8, to nearly nonexistent.

**Measurements.**— (mean, range) in mm. Total length: ♂ (n=5) 11.6, 11.2 to 12.8; ♀ (n=5) 16.5, 14.4 to 18.5; length pronotum: ♂ 2.5, 2.1 to 2.6; ♀ 3.1, 2.9 to 3.3; width pronotum: ♂ 2.1, 2.0 to 2.3; ♀ 2.6, 2.4 to 2.8; length forefemur: ♂ 7.7, 7.3 to 7.9; ♀ 8.4, 8.0 to 9.1; length hindfemur: ♂ 14.3, 14.0 to 14.6; ♀ 17.3, 17.0 to 18.8; width hindfemur: ♂ 1.9, 1.7 to 2.2; ♀ 2.5, 2.2 to 2.7; length tegmen: ♂ 1.5, 1.4 to 1.8; ♀ 0.8, 0.7 to 0.9; length ovipositor: ♀ 11.7, 11.1 to 12.3.

*Etymology*.— The name of this species is a modified form of a nickname honoring my volunteer assistant, Mary Dimperio.

### Subfamily Meconematinae

#### *Phlugiola* Karny 1907

*Type species*.— *Phlugiola redtenbacheri* Karny 1907, by monotypy.

Karny 1907: 103; Karny 1912: 3, 7; Bruner 1915: 362; Zacher 1928: 77; Eichler 1938: 8; Eichler 1939a: 501; Eichler 1939b: 126; Eichler 1952: 28; Harz 1969: 177; Gurney 1975: 428.

*Diagnosis*.— Small, green, brachypterous katydids resembling *Phlugidia* and *Lucienola*. Differing from them in having 5 inner and 4 outer spurs on ventral margins of foretibia (4 and 2 in *Phlugidia*;  $\leq 4$  and  $\leq 3$  in *Lucienola*) and in having 2 spurs on outer ventral margin of midtibia (1 in *Phlugidia*; 0 in *Lucienola*). Differing from both in having a conspicuous acoustic prothoracic spiracle and well developed lateral lobes of the pronotum.

#### Key to species of *Phlugiola*

- 1 L/W hind femur  $\sim 6.5$  . . . . . *dahlemica* Eichler 1938
- 1' L/W hind femur  $\sim 5.5$  . . . . . 2
- 2 Inner ventral margin of forefemur with 2 spurs; apex of male subgenital plate with broad U-shaped emargination and two broadly divergent articulating styles . . . . . *redtenbacheri* Karny 1907
- 2' Inner ventral margin of forefemur with 3 spurs; apex of male subgenital plate with very narrow U-shaped emargination and two parallel articulating styles . . . . . *arborea* new species

#### *Phlugiola arborea* Nickle, new species

(Figs 2, 10-17)

*Diagnosis*.— Small, brachypterous katydids with hind femur similar to that of *P. redtenbacheri*, strongly inflated with its greatest width about 4X its narrowest (in *P. dahlemica* greatest width of hind femur only 3X narrowest). Differing from *P. redtenbacheri* by following features: ventral margin of forefemur with 1 outer and 3 inner spurs (Fig. 17) [*cf.* 1 and 2 spurs, respectively, in *P. redtenbacheri* (Fig. 16)]; abdominal tergites and posterior margin of pronotum lacking black markings (present in *P. redtenbacheri*); male cercus with distolateral lobe apically sharply pointed but proximomesal lobe apically rounded (both lobes apically pointed in *P. redtenbacheri*); male subgenital plate medioapically extended but only weakly very narrowly emarginate, with 2 parallel articulating elongated straight styles (styles arcuate and broadly separated in *redtenbacheri*); female subgenital plate elongated, apically rounded (apically more nearly pointed in *redtenbacheri*).

*Holotype*.— ♂. PERU: LODGE: Team 22, Fogging Site 3. [USNM].

*Allotype*.— Same data as holotype.

*Paratypes*.— 5 ♂♂, 3 ♀♀: LODGE: Team 22, Fogging site 3. [USNM]

*Description*.— Head: Large tumescent eyes rising above dorsum of head and extending forward of facial plane (Fig. 10). Ratio of width of head at compound eyes as seen in dorsal view to width of head behind compound eyes 1.2 to 1.3.

Thorax: Pronotum 1.6X longer than deep; metazonal suture bisecting pronotum near midpoint; anterior margin truncate, hindmargin elliptical; L/W pronotal disc 1.9 to 2.5.

Legs: Genicular lobes of all legs unarmed. Forelegs: Femur basally weakly inflated, tapering distally, L/W 5.6 to 5.8; inner ventral margin with 3 spines (Fig. 17), outer ventral margin with 1 spine. Tympana exposed. Tibia with ventral spurs long (inner spurs somewhat longer than corresponding outer spurs), somewhat evenly spaced, with five spurs on each margin, most basal spurs arising behind tympanum; lateral apical spine lacking in several specimens, giving ventral foretibial spine count of 5 to 4. Midlegs: Femur basally weakly inflated, tapering distally, unarmed ventrally. Tibia with 2 outer ventral spurs, 1 inner ventral spur. Hind legs: Femur L/W *ca* 5.4; ventrally unarmed. Tibia unarmed ventrally, but with 22 to 24 minute spurs on each dorsal margin.

Wings: Both sexes brachypterous, with tegmina concealed beneath pronotum. Right tegmen as in Fig. 11. Stridulatory file with 69 teeth, 0.93 mm in length, 74.1 teeth  $\text{mm}^{-1}$  (Fig. 18).

Abdomen: ♂. Tenth tergite truncate, medioapically weakly concave. Cercus bilobed, lateral lobe basally cylindrical, gradually incurved, with a fine shallow ridge extending along mesal face from midpoint to apex, apically terminating as a sharp tooth; basal medial lobe digitiform, short, less than 0.2X length of lateral lobe, apically recurved anteriorly (Fig. 12). Subgenital plate basally broad, narrowing apically, extending medioapically into a narrow prolongation with two closely spaced, articulating styles; each style nearly as long as basal portion of subgenital plate, apical half weakly divergent from other style in dorsal view, and medioapically bearing delicate, membranous flange (Fig. 13). ♀. Tergite X truncate. Cercus elongated, cylindrical, tapering apically to a point. Subgenital plate elongated, spatulate, apically rounded (Fig. 14). Ovipositor in lateral view as in Fig. 15.

*Color*.— Light chartreuse green *in vivo*, light green to tan in preserved specimens. Dark band present in some individuals extending along metazonal midline to posterior margin of pronotum; most individuals with a shallow, weakly defined band extending entire length of midline of pronotum and in some specimens extending posteriorly along abdomen. Apical margin of tegmina black. Apex of hind femur with weakly defined, slightly discolored, brown pigmentation.

*Variation*.— Midtibial ventral spurs vary from 2 outer spurs (typical of most specimens) to 4 in one specimen. Exposure of tegmina beneath pronotum varies from totally concealed to half exposed. Because genitalic structures of several specimens in the series were deformed in preparation of the specimens in the field, it is not possible to determine variation of key characters for identifying this species. In other respects, however, individuals do not overlap significantly with *P. redtenbacheri*.

*Measurements*.— (means, range) in mm. Total length: ♂ (n=4) 10.7, 10.2 to 11.2; ♀ (n=4) 10.7, 10.4 to 11.5; length pronotum: ♂ 5.8, 5.6 to 5.9; ♀ 4.1, 3.9 to 4.3; width pronotum: ♂ 2.3, 2.0 to 2.4; ♀ 2.2, 2.0 to 2.3; length forefemur: ♂ 3.1, 2.9 to 3.2; ♀ 3.4, 3.3 to 3.5; length hind femur: ♂ 11.1, 11.0 to 11.2; ♀ 12.7, 12.0 to 12.8; width hind femur: ♂ 2.1, 1.9 to 2.2; ♀ 2.2, 2.1 to 2.5; length tegmen: ♂ 1.3, 1.0 to 1.5; ♀ NA; length ovipositor: ♀ 5.4, 5.1 to 5.6.

*Numbers of spines and spurs on leg margins*.— (both sexes). Ventral margins, forefemur: inner (anterior) 3; outer (posterior) 1; midfemur inner (posterior) 0; outer (anterior) 0; hind femur inner (posterior)



Figs 10-17. Morphological features of *Phlugiola*. *P. arborea*: 10. Head and pronotum, right lateral view; 11. Right tegmen, dorsal view; 12. ♂ abdominal apex, dorsal view; 13. ♂ subgenital plate, ventral view; 14. ♀ subgenital plate, ventral view; 15. ♀ abdomen, right lateral view; 16, 17. Inner face of foreleg: 16. Right foreleg of *P. redtenbacheri* showing 2 spurs on femur; 17. Left foreleg of *P. arborea* showing 3 spurs on femur.

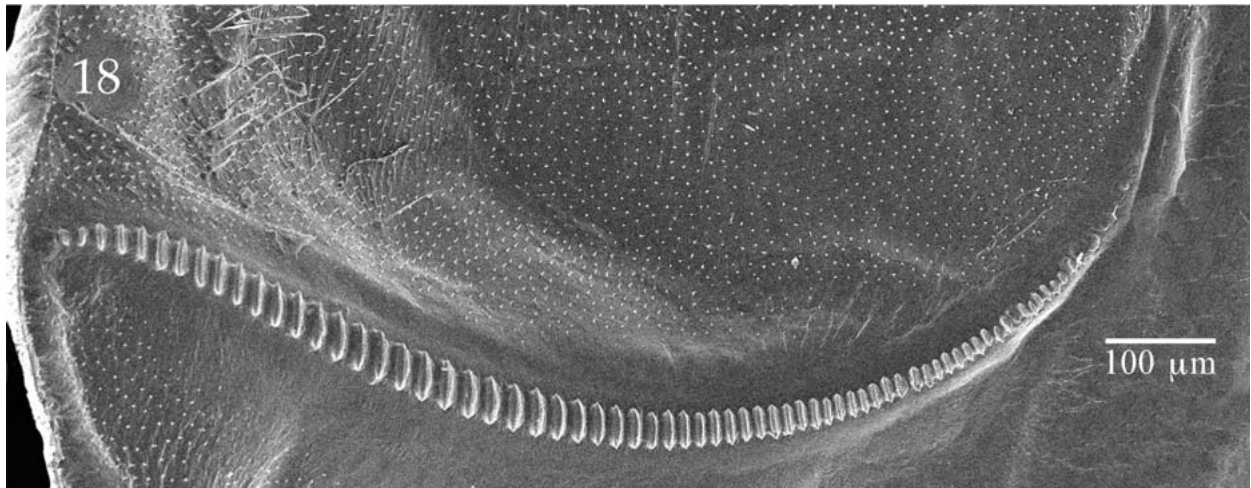


Fig. 18. Stridulatory file of male *P. arborea*, ventral view.

0; outer (anterior) 0. Ventral margins, foretibia: inner (anterior) 5; outer (posterior) 4; midtibia inner (posterior) 0; outer (anterior) 2; hind tibia inner (posterior) 0; outer (anterior) 0. Dorsal margins, foretibia: inner (anterior) 0; outer (posterior) 0; midtibia inner (posterior) 0; outer (anterior) 0; hind tibia inner (posterior) 30-34; outer (anterior) 30-33.

*Etymology*.— (Latin) *arbor* – of trees, referring to arboreal habit of this species.

#### *Phlugiola redtenbacheri* Karny 1907

Karny 1907: 104 (type species by monotypy) Karny 1912: 3, 7; Bruner 1915: 362; Eichler 1938: 8; 1939a: 501; Harz 1969: 177; Gurney 1975: 429.

*Diagnosis*.— Differing from both *P. arborea* and *P. dahlemica* in having 2 (instead of 3) spurs on inner ventral margin of forefemur. Differing from *P. arborea* in having distinctive color markings as follows: 1. pronotum with distinct broken dark band running along midline and posterior margin dark brown for *P. redtenbacheri*, compared with sallow, weakly discolored continuous band extending the midline length for *P. arborea*; 2. dark marking on midline of tergite IV to VI for *P. redtenbacheri*, compared with all tergites unicolorous for *P. arborea*; and 3. apex of hind femur dark brown for *P. redtenbacheri*, compared with hind femur unicolorous for *P. arborea*.

*Specimens examined*.— 22 ♂♂, 12 ♀♀, 3 nymphs. ACEER: Team 17, 1 ♂, 2 ♀♀; Team 24, Fogging site 9, secondary. 1 ♀, 1 nymph. CAMP: Team 3, 1 ♂. INN: Team 10, 1 ♂; Team 19, 1 ♂; Team 21, 1 ♂, 1 ♀; Team 22, Fogging site 1, 1 ♂; Team 23, 1 ♂. LODGE: Team 1, 1 ♂, 1 ♀; Team 8, 2 ♀♀; Team 11, 1 nymph; Team 15, 2 ♂♂, 1 ♀; Team 17, 3 ♂♂; Team 19, 1 ♀; Team 20, 4 ♂♂, 3 ♀♀; Team 21, 1 ♂; Team 22, Fogging site 2, 1 ♂; Team 24, Fogging site 5, 2 ♂♂.

#### Discussion

The presence of *A. meriti* in Peru significantly extends the southern range of *Arachnoscelis*, a genus predominantly found in lower Central

America. Males of the Central American species differ significantly in external genitalic characters from South American forms, and as more information becomes available (e.g., comparisons of yet to be discovered females of some of the species, DNA analysis, pair formation behavior), the species of these regions may eventually be separated into different genera when a phylogenetic analysis is made.

Eichler (1938) proposed the present tribe Phlugidini (his Phlugini) to include those genera with open or unconcealed tympana. Jin and Kevan (1991) reviewed its validity and Kevan and Jin (1993) emended it to include only 4 genera: *Phlugis* Stål 1860, *Phlugiola*, and 2 genera described by Kevan [in Kevan and Jin (1993)] — *Phlugidia* and *Tenuicornis*. Otte (1997) reduced Phlugidini to subtribal status (Phlugidina) but failed to include *Phlugis* in it, although this probably was an oversight.

Gurney (1975) compared the australasian species *P. gressitti* Chopard with neotropical *Phlugiola* species, finding differences that warranted establishment of a new genus *Lucienola* to separate neotropical species from their australasian sister group. Unfortunately, Kevan and Jin (1993) [as well as Otte (1997)] overlooked Gurney's (1975) paper when they described *Tenuiphlugis*, also using *P. gressitti* as their type species and adding three additional species — *T. maai* Jin, *T. brittoni* Jin, and *T. malkini* Jin. Because *Lucienola* takes temporal priority over *Tenuiphlugis*, *Tenuiphlugis* is here placed as a junior synonym of *Lucienola*, and its included species herein become species of *Lucienola*.

The questionable homeland of *Phlugiola dahlemica* also attracted the attention of Kevan and Jin (1993), who suggested that it may have origins in Africa, not South America. Their conclusions were based on its superficial resemblance to their East African species *Phlugidia africana*. Comparing the numbers of femoral and tibial spurs found in these and other related meconematines (Table 1), *P. dahlemica* shares more features with the known neotropical species of *Phlugiola* than with any other of the species examined. It seems more reasonable that the greenhouse population of *P. dahlemica* was derived from nursery stock obtained somewhere in South America.

Most of the specimens of *A. meriti* and all of the specimens of *P. arborea* were collected from fogging sites in Peru. Compared with previous collections of other species of these genera, the collec-



tions made in rainforest canopies clearly point to the conclusion that these species are commonly found in an arboreal habitat, well above the ground level areas usually investigated by insect collectors. Although *P. arborea* was found only in treetop canopies, its more commonly collected sibling species, *P. redtenbacheri*, was frequently encountered at both ground level and in fogging samples. Although *A. meriti* and *P. redtenbacheri* were collected both on the ground and from canopy sampling, sheer numbers suggest that all 3 species are predominantly arboreal in habit.

*P. redtenbacheri* frequently was observed in nature feeding at night on small insect prey (aphids and small flies, including—but not limited to—Agromyzidae and Dolichopodidae); *P. redtenbacheri* was also observed on three occasions during the day rapidly coming up to its prey from underneath a leaf, grasping the prey with its forelegs and feeding on top of the leaf. By remaining under a leaf during the day, the katydid is protected from view of predators from above; at the same time it may be able to visually perceive potential prey from the prey's silhouette projected onto a leaf. Although not actually observed, both of the new species also are presumed to be exclusively predaceous.

### Acknowledgments

Much of the research on katydids was funded to David A. Nickle and James L. Castner by Earthwatch Institute, 3 Clock Tower Place, Maynard, MA, to which I express my gratitude. My deep appreciation is extended to Peter Jenson, Exploraciones Amazonicas, Iquitos, Peru, for providing innumerable services to Jim and me during our recurrent stays at his facilities in Peru. I continue to thank the many Earthwatch volunteers who helped to collect the specimens on nightly and early morning collecting forays into the rainforests of our study area. Without their help this project could not have

succeeded. I sincerely appreciate Mary Dimperio, volunteer at my office, for her extensive help with the curation of the collection and review of this manuscript. Finally, I wish to thank the following individuals for reviewing the manuscript: Natalia J. Vandenberg and Douglass R. Miller, Systematic Entomology Laboratory, USDA, and J. L. Castner, Department of Biology, Pittsburg State University, Pittsburg, KS.

### Literature Cited

- Bowen-Jones E. 1994. A description of *Arachnoscelis feroxnotha* sp. nov. (Tettigoniidae: Listrosclidinae) from Southwest Costa Rica. *Journal of Orthoptera Research* 2: 46-47
- Bruner L. 1915. Notes on tropical American Tettigonoidea (Locustidae). *Annals of the Carnegie Museum* 9: 284-404.
- Chopard L. 1969. Un extraordinaire tettigoniide des Iles Salomon (Orthoptera). *Memorie della Società Entomologica Italiana* 48: 47-51.
- Eichler W. 1938. Lebensraum und Lebensgeschichte der Dahlemer Palmenhausheuschrecke *Phlugiola dahlemica* nov. spec. (Orthopt. Tettigoniid.). (Studien zur deutschen Gewächshausfauna I.) In: Inaugural-Dissertation der mathematisch-naturwissenschaftlichen Fakultät der Universität Berlin. Neu Brandenburg, 201 pp.
- Eichler W. 1939a. Lebensraum und Lebensgeschichte der Dahlemer Palmenhausheuschrecke *Phlugiola dahlemica* nov. spec. (Orthopt. Tettigoniid.). (Studien zur deutschen Gewächshausfauna I.) In: Inaugural-Dissertation. *Deutsche Entomologische Zeitschrift* 73: 498-570.
- Eichler W. 1939b. *Zoologischer Anzeiger* 127: 126-130.
- Eichler W. 1952. *Tierwelt. Gewächshäuser*, Leipzig, p. 28.
- Emsley M. G., D. A. Nickle and W. W. Moss 1967. The value of the stridulatory file and other characters in tettigoniid taxonomy (Orthoptera). *Notulae Naturae Academy of Natural Sciences of Philadelphia* 404: 9 pp.
- Grant H. J., Jr. 1965. A measuring device for use in insect systematics. *Entomological News* 76: 249-251.

**Table 1.** A comparison of the numbers of spurs on the inner and outer ventral margins of fore- and midlegs of selected species of meconematine katydids.

| Species                        | Region       | Forefemur inner | Forefemur outer | Foretibia inner | Foretibia outer | Midfemur inner | Midfemur outer | Midtibia inner | Midtibia outer |
|--------------------------------|--------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|----------------|----------------|
| <i>Lucienola maai</i>          | Australasian | 3               | 3               | 3               | 3               | 0              | 0              | 0              | 0              |
| <i>Lucienola brittoni</i>      | Australasian | 3               | 0               | 4               | 0               | 0              | 0              | 0              | 0              |
| <i>Lucienola gressitti</i>     | Australasian | 3               | 0               | 4               | 1               | 0              | 0              | 0              | 0              |
| <i>Lucienola malkini</i>       | Australasian | 3               | 0               | 4               | 2               | 0              | 0              | 0              | 0              |
| <i>Meconema thalassinum</i>    | Palaearctic  | 0               | 0               | 4               | 4               | 3              | 3              | 0              | 0              |
| <i>Phlugiolopsis henryi</i>    | ??           | 0               | 0               | 4               | 4               | 0              | 4              | 0              | 0              |
| <i>Xiphidiopsis</i> species    | Australasian | 0               | 0               | 4               | 4               | 4              | 4              | 0              | 0              |
| <i>Xiphidiopsis lita</i>       | Australasian | 0               | 0               | 4               | 5               | 4              | 5              | 0              | 0              |
| <i>Phlugidia africana</i>      | Ethiopian    | 3               | 0               | 4               | 2               | 0              | 0              | 0              | 1              |
| <i>Phlugis teres</i>           | Neotropical  | 4               | 3               | 4               | 4               | 0              | 0              | 0              | 2              |
| <i>Phlugiola redtenbacheri</i> | Neotropical  | 2               | 1               | 5               | 4               | 0              | 0              | 0              | 2              |
| <i>Phlugiola arborea</i>       | Neotropical  | 3               | 1               | 5               | 4               | 0              | 0              | 0              | 2              |
| <i>Phlugiola dahlemica</i>     | ??           | 3               | 1               | 5               | 4               | 0              | 0              | 0              | 2              |
| <i>Phlugis abnormis</i>        | Neotropical  | 3               | 4               | 5               | 5               | 0              | 0              | 0              | 2              |
| <i>Phlugis poecila</i>         | Neotropical  | 3               | 4               | 5               | 5               | 0              | 0              | 1              | 2              |
| <i>Phisis philippinum</i>      | Australasian | 4               | 5               | 7               | 7               | 2              | 4              | 7              | 7              |
| <i>Phisis willemsii</i>        | Australasian | 4               | 5               | 7               | 7               | 2              | 4              | 7              | 7              |

- Gurney A. B. 1975. The male of the South American katydid genus *Phlugiola*, and a new related genus from the Solomon Islands (Orthoptera: Tettigoniidae, Meconematinae). *Proceedings Entomological Society of Washington* 77: 426-433.
- Harz K. 1969. Die Orthopteren Europas. The Orthoptera of Europe. Vol. I. Series Entomologica. vol. 5. Dr. W. Junk N. V., Publishers. The Hague. The Netherlands. 750 pp.
- Hebard M. 1927. Studies in the Tettigoniidae of Panama (Orthoptera). *Transactions Entomological Society of America* 53: 79-156.
- Jin X.-B. and D. K. McE. Kevan. 1991. Taxonomic revision and phylogeny of the tribe Phisidini (Insecta: Grylloptera: Meconematidae). Koenigstein Koeltz Scientific Books. 360 pp.
- Karny H. 1907. Revisio Conocephalidarum. *Abhandlungen der K. K. Zoologischen-Botanischen Gesellschaft in Wien* IV: 1-114.
- Karny H. 1911. Descriptiones *Conocephalidarum novarum*. *Verhandlungen der Zoologischen-Botanischen Gesellschaft in Wien* 61: 334-347.
- Karny H. 1912. Orthoptera. Fam. Locustidae. subfam. Listrocelinae. *Genera Insectorum* 131: 1-20.
- Karny H. 1924. Prodomus der Malayischen Meconeminae. *Treubia* 5: 105-136.
- Kevan D. K. McE. and X.-B. Jin. 1993. Remarks on the Tribe Phlugidini Eichler and recognition of new taxa from the Indo-Malayan region and East Africa (Grylloptera: Tettigonioidae: Meconematidae). *Invertebrate Taxonomy* 7: 1589-1610.
- Ley W. 1951. *Dragons in Amber*. New York. 328 pp.
- Nickle D.A. 1992. Katydids of Panama (Orthoptera: Tettigoniidae), pp. 142-184. In: *Insects of Panama and Mesoamerica* (Quintero D., Aiello, A. (Eds). Oxford University Press, 692 pp.
- Otte D. 1997. Orthoptera Species File 7: Tettigonioidae. *Publications on Orthopteran Diversity. The Orthopterists' Society at Academy of Natural Sciences of Philadelphia*. 373 pp.
- Perty M. 1832. *Delectus Animalium Articulorum quae in itinere per Brasiliam*. pp. 116-128.
- Randell R. L. 1964. Notes on the genus *Arachmoscelis* Karny (Conocephalidae) and a new species. *Canadian Entomologist* 96: 1608-1610.
- Redtenbacher J. 1891. Monographie der Conocephaliden. *Verhandlungen der Zoologischen-Botanischen Gesellschaft in Wien* 41: 315-562.
- Rehn J. A. G. 1918. On a collection of Orthoptera from the State of Pará, Brazil. *Proceedings Academy of Natural Sciences of Philadelphia*: 144-236.
- Rentz D. C. F. 1979. Comments on the classification of the Orthopteran family Tettigoniidae, with a key to subfamilies and description of two new subfamilies. *Australian Journal of Zoology* 27: 991-1013.
- Serville A. 1831. *Revue methodique des Insectes de l'ordre des Orthopteres*. *Ann. Sc. Nat. Paris* 22: 134-167.
- Stål C. 1860. Insecta. Insecter [IV]. Orthoptera species novas descripsit pp. 299-350, pl. V. In "Kongliga Svenska fregatten Eugenie resa omkring jorden under befäl af C. A. Virgin åren 1851-1853" K. Svenska Vetenskaps-Akademien. Stockholm, 2 (Zoologi).
- Walker 1869. *Catalogue of the Specimens of Dermaptera Saltatoria in the Collection of the British Museum*. London, vol I. 224 pp.
- Zacher F. 1928. Zur Kenntnis von *Phlugiola redtenbacheri* Karny. (Orthopt.). *Deutsche Entomologische Zeitschrift*: 77-80.
- Zeuner F. 1940. *Phlugiopsis henryi* n. g., n. sp., a new tettigoniid, and other Saltatoria (Orthop.) from the Royal Botanic Gardens, Kew. *Journal of Society for British Entomology* 2: 76-84.