New Species of the Genus Anisophya Karabag from Chile (Orthoptera: Tettigoniidae: Phaneropterinae)

Author: Nickle, David A.

Source: Journal of Orthoptera Research, 20(2) : 163-172

Published By: Orthopterists' Society

URL: https://doi.org/10.1665/034.020.0204

New species of the genus *Anisophya* Karabag from Chile (Orthoptera: Tettigoniidae: Phaneropterinae)

David A. Nickle

Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Department of Agriculture Beltsville Agricultural Research Center, Building 005, Rm. 137, Beltsville, MD 20705-2350, U.S.A. Email: David.Nickle@ars.usda.gov

Abstract

Many of the most primitive neotropical bush katydids (Phaneropterinae) — including species of *Cosmophyllum* Blanchard, *Stenophylla* Brunner von Wattenwyl, *Marenestha* Brunner von Wattenwyl, *Anisophya* Karabag, *Coryphoda* Brunner von Wattenwyl and *Burgilis* Stål — are endemic to Chile. The Chilean species, *Isophya schoenemanni* Karsch, is herein re-affirmed to belong to the genus *Anisophya*. Two new species of *Anisophya* from Chile are also described. One is dimorphic in wing length. In 1986 APHIS/PPQ intercepted this species in a shipment of apples from Chile, but it is not likely to be a pest of apples or other pome fruits.

Key words

katydid, Chile, Odonturini, Barbitistini

Introduction

In his Monograph of the Phaneropterinae, Brunner von Wattenwyl (1878) established the Group Odonturae, linking several primitive European and southwest Asian genera sharing several characters, but predominantly related through brachyptery. He included within this group *Orphania* Fischer (with one species, this since placed in a different genus [Orthoptera Species File 2010]), *Poecilimon* Fischer (21 species, species redesignated into different genera [OSF]), *Barbitistes* Charpentier (8 species, currently 8 species [OSF]), *Leptophyes* Fieber (5 species, currently 18 species [OSF]), *Odontura* Rambur (5 species; species redesignated into different genera [OSF]), *Dichopetala* Brunner von Wattenwyl (2 species, currently 21 species [OSF]) and *Isophya* Brunner von Wattenwyl (17 species, currently 90 species [OSF]). The Eurasian geographic unity of this group was marred by Brunner's inclusion of the Nearctic/Neotropical genus *Dichopetala* (with no discussion in his introduction to the group for incorporating this inclusion) and with two neotropical species of *Isophya* (*I. brasiliensis* Brunner von Wattenwyl and *I. punctinervis* Stål). Otte (1997) resolved this issue by placing *Dichopetala* in the Tribe Odonturini and *Anisophya* and the other genera in the Tribe Barbitistini.

Giglio-Tos (1894) described two brachypterous species of neotropical phaneropterine katydids from Paraguay — *borellii* Giglio-Tos and *hamata* Giglio-Tos — placing them within the Palearctic genus *Isophya*. Other neotropical species of *Isophya* were added, *I. brasiliensis* Br. v. W., 1878 and *Odontura punctinervis* Stål, 1860 [moved to *Isophya* by Br. v. W. 1878], *I. melanochloris* Rehn, 1911, and *I. schoenemanni* Karsch, 1889. Expanding on the work of Karabag (1960) who placed *I. hamata* and *I. borellii* into a new genus (*Anisophya*), Braun (2010) placed all the remaining neotropical *Isophya* species into this genus. All of these species share at least one character: brachyptery. However, an evaluation of images of females of these species on the Orthoptera Species File Version 2.0/4.0 suggests that this genus is polyphyletic and in need of revision: unfortunately, all species listed within *Anisophya* currently are poorly represented in collections.

On several occasions as identifier of unknown orthopterans intercepted by APHIS/PPQ on agricultural products at various USA ports-of-entry, I encountered an unusual phaneropterine katydid on apples from Chile. This I recognized from specimens in museum collections in the United States.

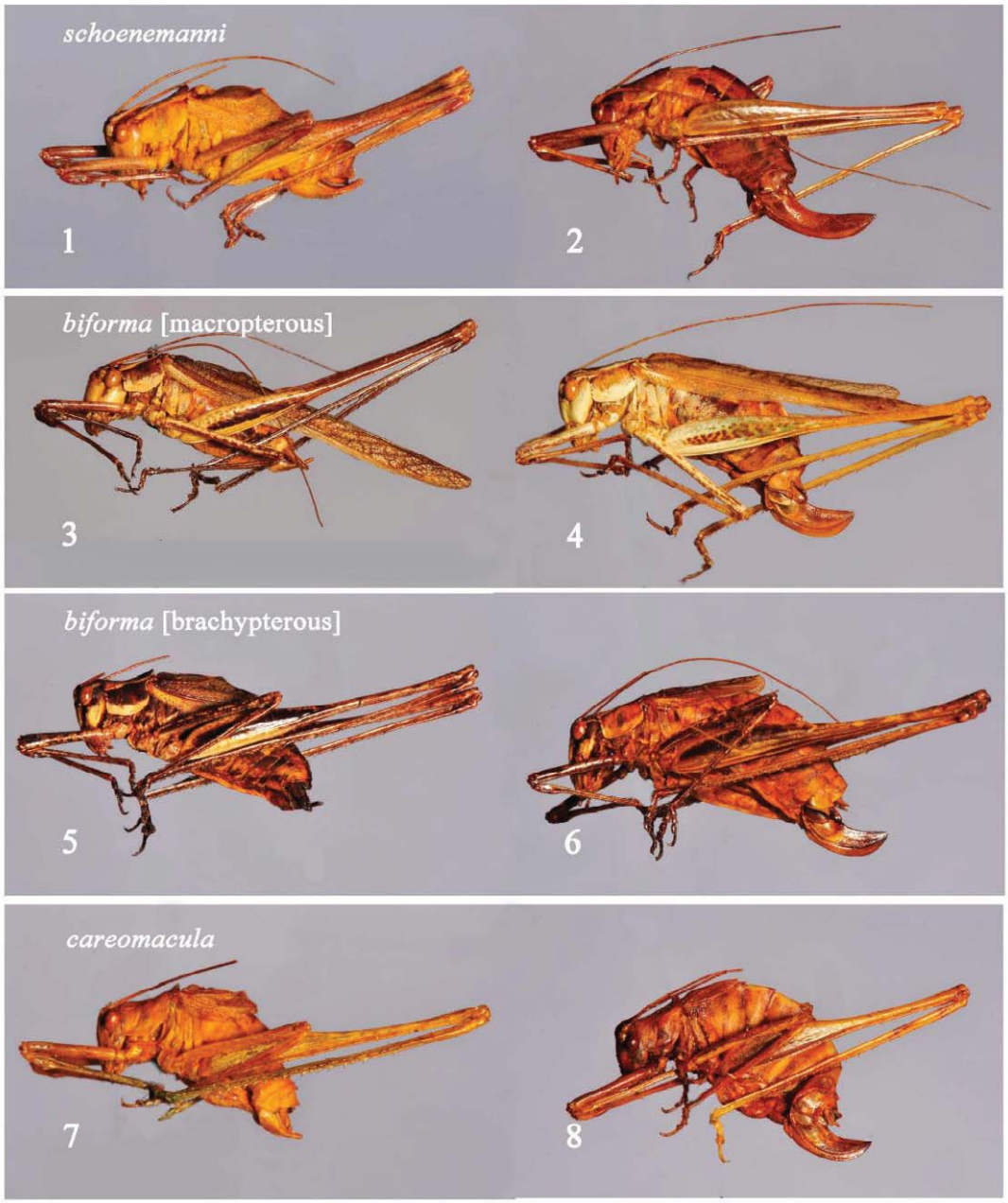
During the course of sorting and reviewing the collections of phaneropterine katydids at the Academy of Natural Sciences (Philadelphia, PA) and at the University of Michigan Museum of Zoology (Ann Arbor, MI), I encountered a series of specimens from Chile of two undescribed species of the genus *Anisophya*. One species is dimorphic in wing length, with both macropterous and brachypterous forms; but additional variation in other aspects of the morphology of this species generates questions regarding its specific parameters. In anticipation of the need to have names of taxa available in a revision of the neotropical genera of the Tribe Odonturini (Tettigoniidae: Phaneropterinae), the genus is here reviewed and new species described.

Materials and methods

The following descriptions are based on 140 adult males and 215 females from Chile. Specimens were collected by Luis E. Peña between 1957 and 1974. They are deposited (as indicated in the descriptions) in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, DC [USNM] and the University of Michigan Museum of Zoology, Ann Arbor, MI [UMMZ].

This study is based on morphological characters reviewed by Emsley *et al.* (1967). In the terminology of Snodgrass (1935) they include the shapes of the fastigium verticis (= vertex) and fastigium frontalis (= frons); development of the antennal suture; shape of the pronotal disc, carinae, and lobes; structure of the periphery of the tympanum; presence or absence of the prothoracic coxal spine; spination of the legs and femoral genae; shape and venation of the tegmen; degree of exposure of the hind wing beyond the distal edge of the tegmen in repose; shape of the meso- and metasternal lobes; development in the male of various components of external and internal genital armature, including tergite X, cerci, epiphallus, and subgenital plate; and in the female, specializations of the posterior abdominal tergites, shapes of the ovipositor and subgenital plate, and development of basal plates of the ovipositor.

Graphs of file patterns represent the linear distribution of teeth on the file. Linear file-tooth distribution is a character which often exhibits acute interspecific differences, but which is intraspecifically relatively constant (Emsley *et al.* 1967). Assuming consecutive tooth strikes upon the file are made on tegminal closure rather than



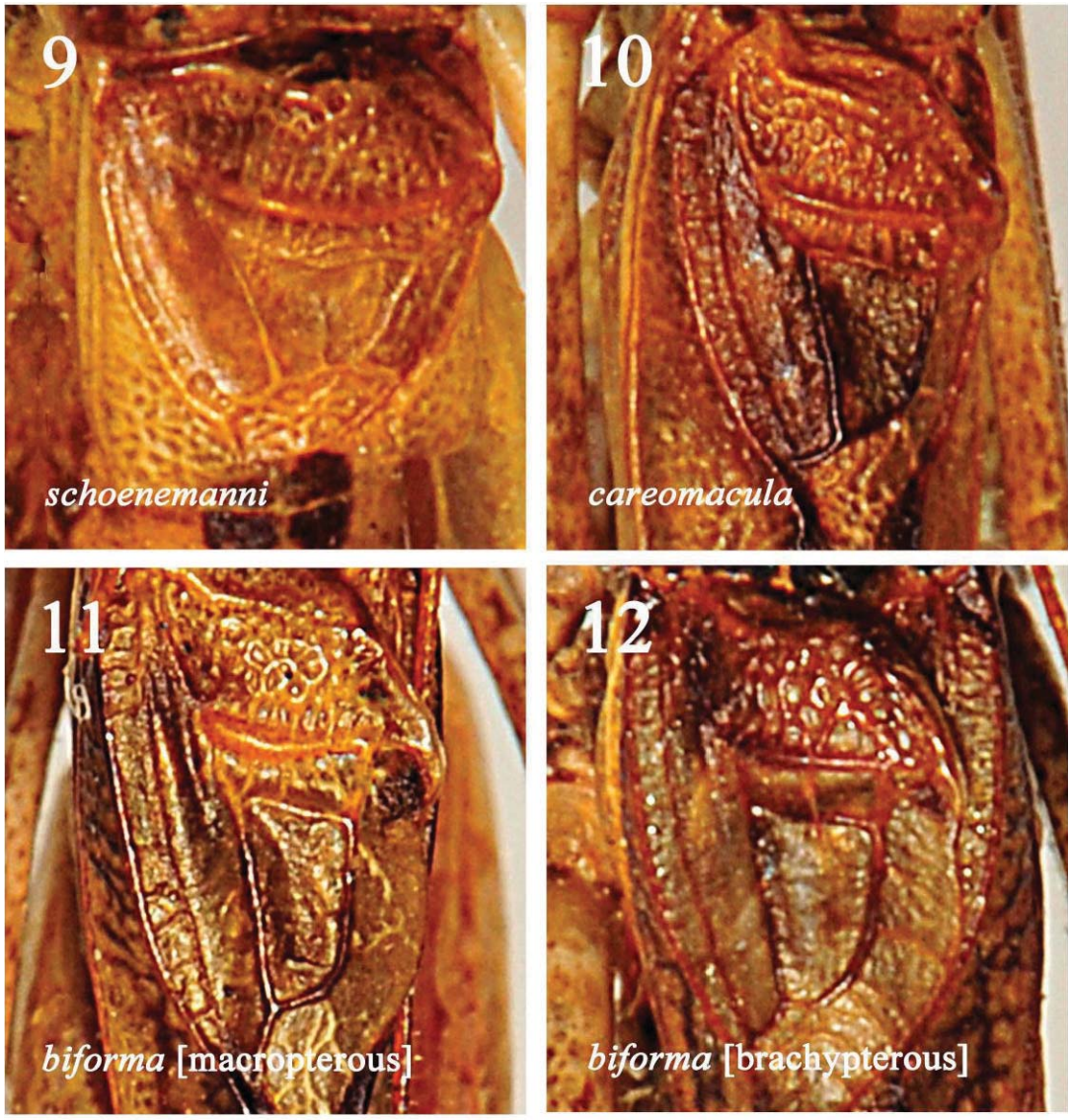
Figs 1-8. *Anisophya* species, left lateral views. 1. *schoenemanni*, ♂. 2. ♀. 3. *biforma*, macropterous form, ♂, collected in Coquimbo Prov., Samo Alto. 4. ♀. 5. *biforma*, brachypterous form, collected in Coquimbo Prov., between La Serena and El Pinon, ♂. 6. ♀. 7. *careomacula*, ♂. 8. ♀.

opening (see Morris & Walker 1976), each graph of file patterns begins with first tooth closest to the anal margin of the tegmen; it ends with a last tooth closest to the costal margin.

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 posterior femur*, the greatest dimensions of that structure as seen in lateral view; *length and width of tegmen*, the greatest dimensions of that structure 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 most species were counted, and the straight-line distance between first and last tooth on the file was measured as the length of the file. Range and means of these measurements are listed in Tables 1 and 2. Measurements of characters and distances between consecutive file teeth were made with the apparatus described by Grant (1965).

Habitus figures (Figs 1-8) were made with a Nikon D300S digital camera with a resolution of 12.30 Megapixels and edited on Adobe Photoshop CS4® for MacIntosh. Drawings were made with a camera lucida attached to a Wild stereomicroscope. Specimens used in scanning electron micrograph (SEM) imagery were softened for *ca* 10 s in hot water (110°F) and dissected. Once dried, structures were glued directly to SEM stubs. Stubs were sputter-sprayed with gold and photomicrographed with an Amray® scanning electron microscope. Images were digitally captured and transferred to Adobe Photoshop® where they were edited for publication quality.

Two new species are described herein as *Anisophya biforma* Nickle



Figs 9-12. Stridulatory field of left tegmen of *Anisophya* species. 9. *schoenemanni*. 10. *careomacula*. 11. *biforma*, macropterous form. 12. *biforma*, brachypterous form.

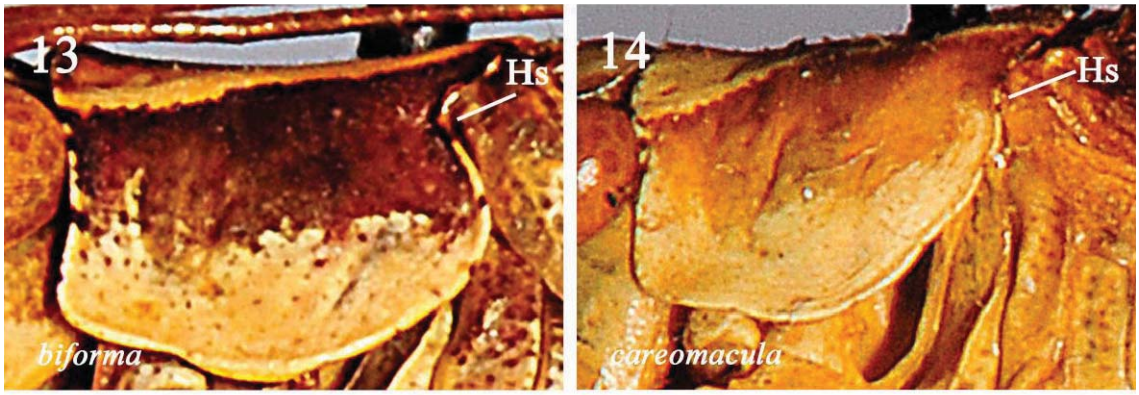
and *A. careomacula* Nickle. Because *A. biforma* is dimorphic, with both brachypterous and macropterous forms, and both forms display variation with respect to coloration and various measurements, the description of *A. biforma* is based on characters displayed by the macropterous form and represented by the macropterous holotype and allotype. Morphological features of the paratypes of this species, including the brachypterous form, are described separately under *Variation*, in case future studies prove to be different from that represented by the holotype and allotype. Intraspecific variation is not a significant factor within the range of *A. careomacula*.

Results

Karabag (1960) proposed the genus *Anisophya* to include two species from Paraguay that had been described as species of the palearctic genus *Isophya* Brunner von Wattenwyl, 1878: *I. borellii* Giglio-Tos, 1894, and *I. hamata* Giglio-Tos, 1894. Specimens of a Chilean species, *Isophya shoenemanni* Karsch, 1889, in the collection at UMMZ should also have been included in Karabag's review of *Anisophya*, and these were just recently re-assigned to that genus as *Anisophya shoenemanni* (Karsch) (Braun 2010). In the Paraguayan species *A. hamata* and *A. borellii*, genicular lobes of all femora are unarmed and the female ovipositor is apically coarsely spinose and at least 1.6× longer than the pronotum. In both new species and *A. schoenemanni*, genicular lobes of fore- and midfemora are usually armed with at least one ventral spine, and the female ovipositor is apically smooth, or at most very finely serrate, and at most, 1.2× longer than the pronotum. Only the Chilean species are discussed in this paper.

Key to Chilean species of *Anisophya*

1. Tegmen extending nearly full length of abdomen, with hind wings extending beyond tegmen apex and terminating several mm beyond abdomen tip . . . . . *A. biforma* (macropterous form) [in part]
– Tegmen extending at most to distal margin of tergite V of abdomen 2
2. Posterior margin of pronotum concave; procoxal spine absent; abdominal tergite X strongly inflated and distally deflexed ventrally nearly completely shielding cerci from view; male cercus with elongated, medially directed pre-apical tooth (Fig. 15A); male sub-



Figs 13-14. Left lateral lobe of pronotum *Anisophya* species. [Hs=humeral sinus of lateral lobe of pronotum.] 13. *biforma*. 14. *careomacula*.

genital plate spatulate, apex with a broad, V-shaped emargination (Fig. 15B); female ovipositor more than twice as long as pronotal disc (Figs 2, 19) . . . . . *A. schoenemanni*

– Posterior margin of pronotum convex; procoxal spine minute, weakly nodiform; abdominal tergite X truncate, unmodified; pre-apical tooth on male cercus short, not so modified (Figs 16A-18A); male subgenital plate apically produced, upcurved, with apex variously modified (Figs 16B-18B); female ovipositor at most only slightly longer than pronotal disc 3

3. Pronotal disc becoming constricted at midpoint, then gradually expanding posteriorly; distal edge of costal margin of tegmen not noticeably narrowing; tegmen extending to tergite IV; cercus as in Fig. 17; basal lobe of ovipositor trapezoidal, its distal ventral corner pointed (*cf.* Figs 20, 21) . . . . . *A. biforma* (brachypterous form) [in part]

– Pronotal disc not so constricted, with lateral margins straight along their entire length; distal edge of costal margin of tegmen noticeably narrowing pre-apically, forming an abbreviated extension to apex; tegmen extending to tergite VI; cercus as in Fig. 18; basal lobe of ovipositor oval with ventral margin straight, its distal ventral corner rounded, not extended into a point (Fig. 22) . . . . . *A. careomacula*

Anisophya biforma Nickle, new species
(Figs 3-6, 11-13, 16-17, 21-24, 26-29, 30B, 31)

Diagnosis.—Elongate, slender, with both macropterous and brachypterous forms, smaller than *A. schoenemanni*. Male differing from *A. schoenemanni* in the following characters: stridulatory file with 60-65 teeth (*A. schoenemanni* has *ca* 110 teeth) and tergite X is simple, truncate (highly modified in *A. schoenemanni*, with tergite X pre-apically inflated and distally deflexed ventrally). It differs from *A. careomacula* in the spatial distribution of teeth on the stridulatory file (*cf.* Figs 30B-30C) and in the shape of the cercus (Figs 16-17 *vs* 18). Females of both forms of *A. biforma* have short, broad ovipositors, only slightly longer than pronotal discs, while *A. schoenemanni* has a slender elongated ovipositor more than twice as long as pronotal disc. *Anisophya biforma* (both sexes) differs from *A. careomacula* in shape of pronotal disc, with lateral margins constricted at midpoint in *A. biforma*, straight in *A. careomacula*.

Holotype.—Macropterous ♂. "CHILE: Prov. Coquimbo, Samo Alto on Rio Hurtado, NE Ovalle. 2Nov1957 Luis E. Peña, G." [UMMZ].

Allotype.— Macropterous ♀. Same data as Holotype. [UMMZ).

Paratypes.—Macropterous: (90 ♂♂, 154 ♀♀) CHILE: Coquimbo, Cerrillos Pobres, W of Ovalles, arid region. 4G. X-13-1957. (Luis E. Peña, G.). 1 ♂; Coquimbo, El Tanque. X-27-1961. (Luis E. Peña, G.). 9 ♂♂, 3 ♀♀; Coquimbo, Rio Chilapa to Illapel. X-27-1965. (Luis E. Peña, G.). 1 ♀; Coquimbo, Estación Higuerita "desert". X-16-1958. (Luis E. Peña, G.). 1 ♀; Coquimbo, Barraza, desert region near coast, 200-500 m. XI-2-1957. (Luis E. Peña, G.). 10 ♂♂, 2 ♀ ♀; Coquimbo, Samo Alto on Rio Hurtado, NE Ovalle. XI-2-1957. (Luis E. Peña, G.). 63 ♂♂, 133 ♀ ♀; Coquimbo, Rio Hurtado XI.5-6.1961. (Luis E. Peña, G.). 3 ♀ ♀; Coquimbo, Ovalle. XI-6-1961. (Luis E. Peña, G.). 7 ♂♂, 11 ♀♀.

Brachypterous: (41 ♂♂; 37 ♀♀) CHILE: Coquimbo, between La Serena and El Pinon "desert". XI-1-1957. (Luis E. Peña, G.).

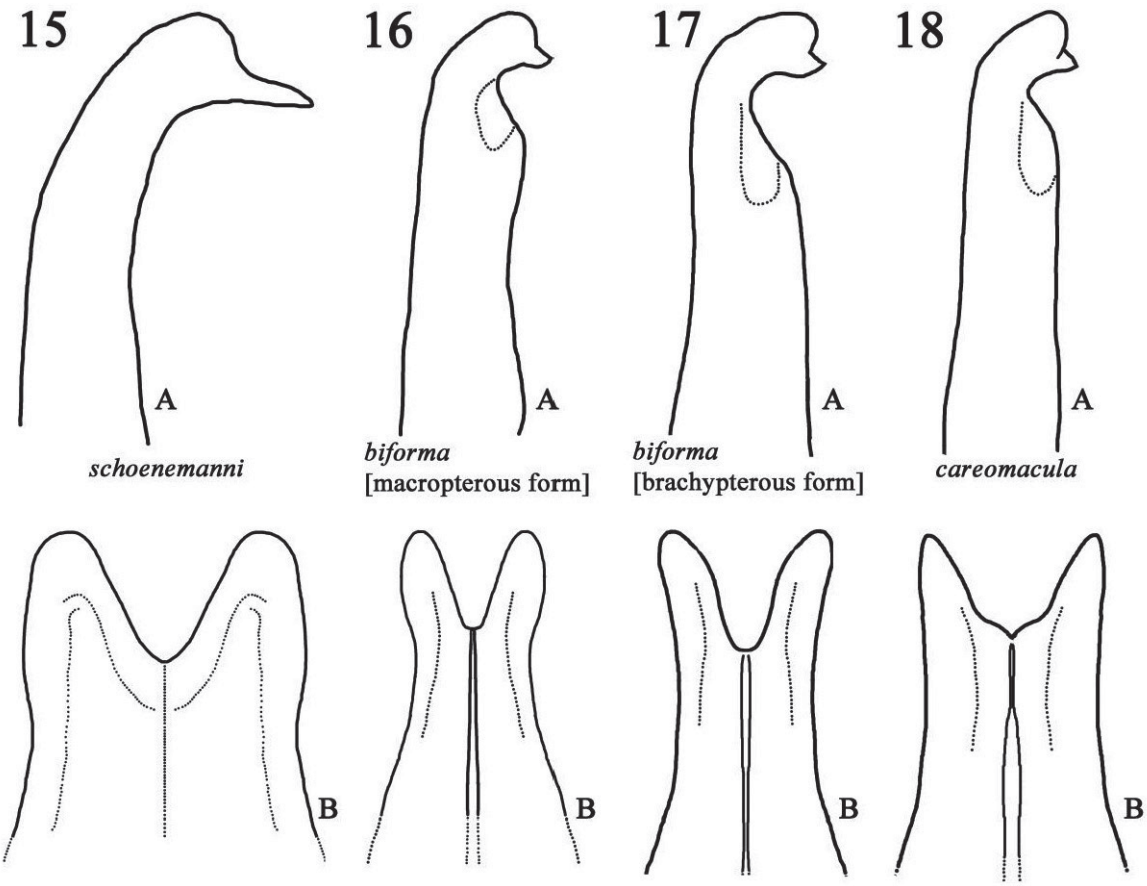
Description.—*Head*. In lateral view, eyes protrusive, dorso-ventrally oval, 1.7× greater in vertical length than horizontal breadth; subocular genal length slightly longer than eye length; occipital rise above dorsal margin of eye *ca* 0.5× eye length; in dorsal view, interocular width *ca* 2.0× width of eye; in frontal view frons broad, apically rounded, as broad as eye width and in contact with weakly truncated fastigium (Fig. 23).

Thorax. Pronotal disc elongate, 1.2× longer than wide; anterior margin of disc weakly concave, posterior margin rounded, lateral margins becoming gradually constricted to midpoint, then expanding to posterior margin; lateral lobe of pronotum longer than deep, with expanded, rounded hind margin and moderately indented humeral sinus (Fig. 13). Meso- and metasterna not overlapping, similar in shape, with posterior lobes weakly expanded and rounded.

Legs. Tympana exposed; forecoxal spine absent; each genicular lobe of forefemur lacking ventro-apical spine (rarely with one spine or with an additional dorso-apical spine); midfemur with inner genicular lobe with one minute ventro-apical spine, outer lobe unarmed (rarely with one ventro-apical spine); both genicular lobes of hind femur unarmed. Ventral margins of all femora without spines. Hind femur *ca* 10× longer than wide.

Wings. (Brachypterous and macropterous forms; Holotype macropterous). Male stridulatory field of micropterous form as in Fig. 11; stridulatory file (Fig. 28) with *ca* 65 teeth, 1.2-1.4 mm in length, 52-56 teeth/mm, and with spatial distribution of teeth as in Figure 30B; tegmen *ca* 6× longer than wide, extending 4-6 mm beyond posterior margin of terminal tergite; hind wings extending *ca* 2 mm beyond apex of tegmen and *ca* 6 mm beyond apex of tergite X.

Abdomen. Tenth tergite weakly produced, apically truncate, with a minute apical notch; cercus cylindrical, straight along 4/5 of its length, with distal fifth curving medially, apically rounded, armed at pre-apical medial margin with a moderately developed medially-directed tooth, and with medial face at base of hook forming a dorso-ventrally flattened expanded flange (Figs 16A, 26); subgenital plate



Figs 15-18. Right ♂ cercus [A] and ♂ subgenital plate [B] of *Anisophya* species, dorsal view. 15. *schoenemanni*. 16. *biforma*, macropterous form. 17. *biforma*, brachypterous form. 18. *careomacula*.

spatulate with a well-developed medial keel at basal half, upcurved distally beyond cerci to or above level of dorsal margin of tergite X, distally narrowing, apex with a narrow U-shaped emargination generating two narrow pseudostyles (Fig. 16B).

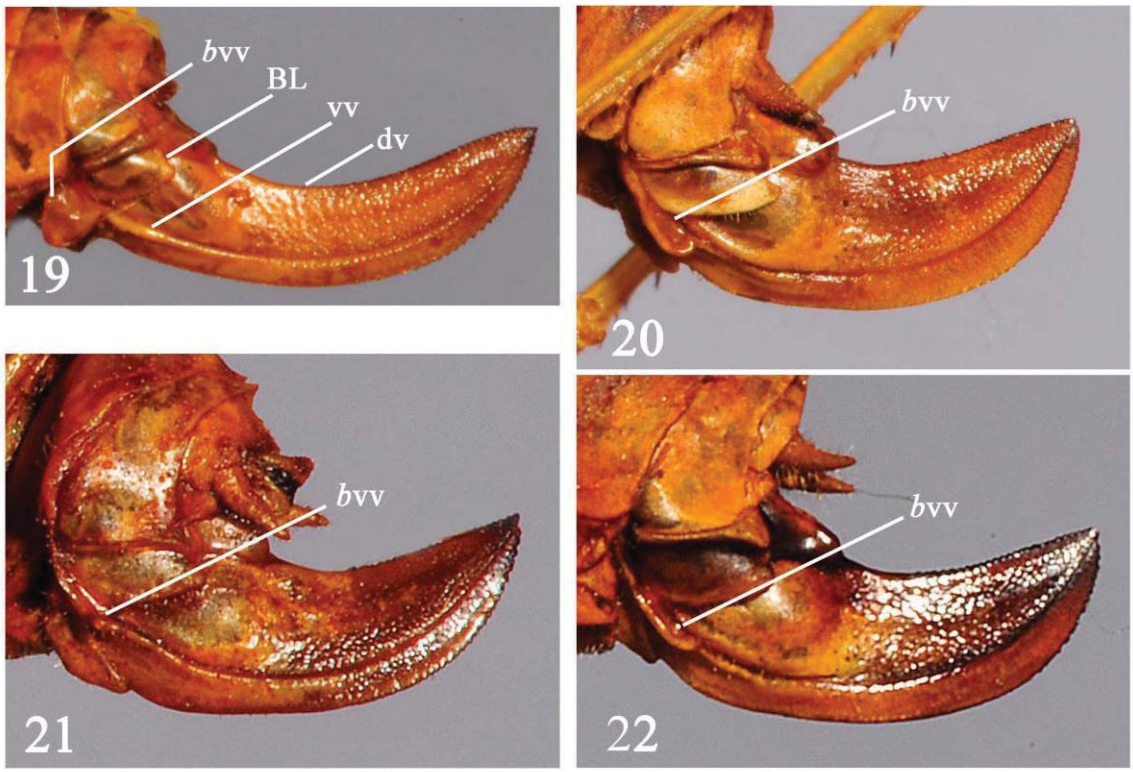
Allotype.—Terminal tergite truncate, unmodified. Ovipositor (Fig. 21) short, stout, about equal in length to pronotal disc; basal half inflated, distal half contrastingly flat, gradually upcurved, and apically pointed; edges smooth, very weakly serrated to unserrated; basal lobe of ovipositor trapezoidal, with dorsoposterior corner weakly extended and pointed; dorsal margin of ventral valve of ovipositor beneath basal lobe weakly inflated laterally but only weakly extending ventrolaterally.

Coloration.—Tan with dark brown markings (*Note*: base color may be green, not tan, since some paratypes display small remnants of green in base coloration). Face with two narrow brown bands originating at base of antennal insertions and extending ventrally halfway to clypeus; in lateral view, broad brown band originating at clypeus, extending to compound eye, and from beneath eye terminating as a broader band at posterior margin of head; occiput dark brown except for a thin tan band along midline to fastigium, and two small lateral bands originating at posterior margin of occiput and extending forward midway between ocellus and midline of occiput. Pronotal disc base color tan with a dark brown medial band of various widths running length of disc; dorsal half of lateral lobe of pronotum dark brown, ventral half tan. Fore- and midleg mottled with dark brown patches, hind femur base color tan, with central third brown along its axis. Tegmen of both macropterous and brachypterous forms dark brown with tan region on costal margin near insertion to body. Ovipositor basally tan, becoming brown along flattened portions of ovipositor valves; basal lobe basally dark brown, margins tan. Dorsal third of abdominal tergites variously either tan, mottled brown, or dark brown, with a tan band separating a dark brown area just dorsad of tergal-sternal suture.

Measurements.— Holotype (h), allotype (a): (mean, range) in mm. Macropterous form: holotype (h), allotype (a): total length: (h) 9.8, (a) 13.2; length pronotum: (h) 2.1, (a) 2.8; width pronotum: (h) 1.8, (a) 2.1; length tegmen: (h) 13.4, (a) 14.3; width tegmen: (h) 2.1, (a) 2.7; length forefemur: (h) 3.4, (a) 4.5; length hind femur: (h) 13.2, (a) 16.6; width hind femur: (h) 1.3, (a) 1.8; length ovipositor: (a) 4.4. (See also Table 1).

Etymology.— (Latin, fm.) *bi*, meaning two or double and *forma*, meaning shape or figure, referring to two-winged (dimorphic) forms of this species.

Variation.—The most significant departure in the paratypes from the Holotype of *A. biforma* is the presence of brachypterous as well as macropterous forms. Some variation is demonstrated in the shapes of the frons and fastigium (Figs 23 *biforma*, macropterous; 24 *biforma*, brachypterous; 25 *careomacula*) and length of the stridulatory harp (see Figs 11-12): the harp is more elongate in macropterous *biforma* (Fig. 11); but the stridulatory file for both forms has 62-66 teeth, with a spatial distribution of teeth as in Fig. 30B. Both male (Figs 26-27) and female (Figs 21-22) genitalic structures exhibit little variation between forms (Figs 16-17, 26-27).



Figs 19-22. Ovipositor of *Anisophya* species, left lateral view. [BL=basal lobe of ovipositor; vv= ventral valve of ovipositor; dv= dorsal valve of ovipositor; *b*vv=modified ridge at base of ventral valve of ovipositor.] 19. *schoenemanni*. 20. *careomacula*. 21. *biforma*, macropterous form. 22. *biforma*, brachypterous form.

Color variation is noted within populations of macropterous *biforma*. Specimens from Barraza are lighter in base color, and their dark brown patterns, though still in place, are less strongly expressed: facial bands are lighter and not as broad, pronotal disc is mainly tan with a faint brown patch along midline, and the basal half of the hind femur is mainly tan, though the distal half is completely dark brown; the ovipositor is completely dark brown. Specimens from Ovalle differ in the following respects: face is mainly tan, and facial bands are barely visible; in lateral view, band running from clypeus to eye is lost and only the portion that extends from behind the eye to posterior margin is retained. In dorsal view there is a large tan area behind the eyes, which appears to be an expansion of the two narrow bands between the ocellus and midline of the head, as found in the holotype.

Anisophya careomacula Nickle, new species
(Figs 7, 8, 10, 14, 18, 20, 25, 30C, 31)

Diagnosis.—*Anisophya careomacula* (both sexes) differs from *A. biforma* in shape of pronotal disc, with lateral margins constricted at midpoint in *A. biforma*, straight in *A. careomacula*. The humeral sinus of the lateral lobe of the pronotum is obsolete in *A. careomacula* but well developed in *A. biforma* (Figs 13, 14).

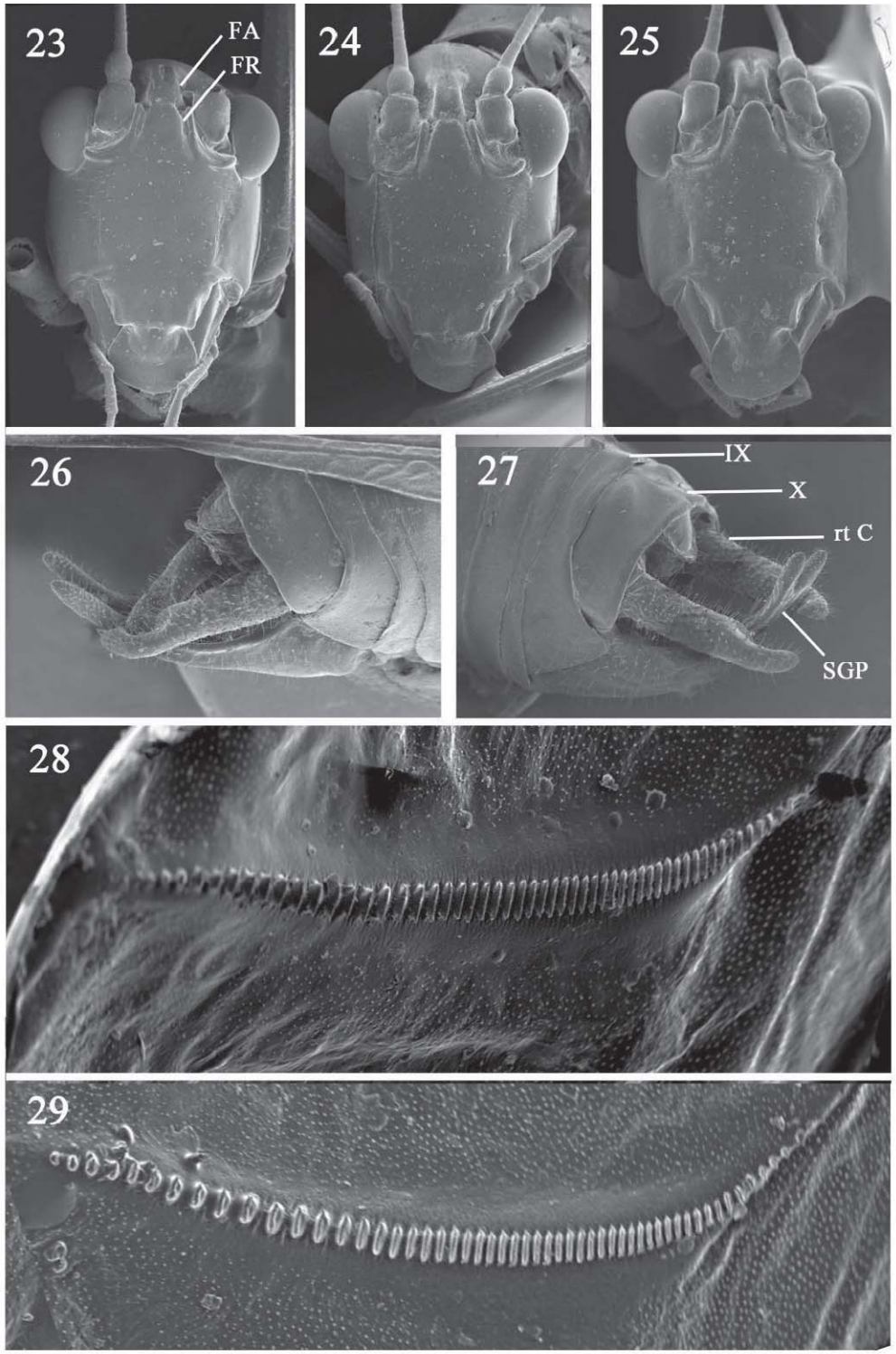
Anisophya careomacula also differs from *A. biforma* in the spatial distribution of teeth on the stridulatory file (*cf.* Figs. 30B–30C), in the shape of the cercus (Figs 18A *vs* 16A-17A) and in the degree of emargination of the male subgenital plate (Figs 18B *vs* 16B–17B).

Holotype.—Brachypterous ♂. "Coquimbo, Socos. 27 Nov 1961. Luis E. Peña, G." [UMMZ]. Allotype. Brachypterous ♀. Same data as holotype. [UMMZ). Paratypes (3♂♂, 16♀♀). Coquimbo, Socos. X-27-1961. (Luis E. Peña, G.). 3♂♂, 14♀♀; Coquimbo, Socos, on south coast "desert". X-1-1974. (Luis E. Peña, G.). 2♀♀.

Description.—Similar to the brachypterous form of *A. biforma*, differing in the following characters: *Head*. In lateral view, eyes protrusive, dorsoventrally oval, 1.4× greater in vertical length than horizontal breadth; subocular genal length about equal to eye length; occipital rise above dorsal margin of eye *ca* 0.3× eye length; in dorsal view,

Table 1. Measurements of macropterous and brachypterous forms of *Anisophya biforma*.

Anisophya biforma macropterous (10 ♂ ♂, 10 ♀ ♀)				
	♂ Mean	Range	♀ Mean	Range
total body length	9.9	9.3-10.7	13.4	11.0-14.1
length pronotum	2.1	2.0-2.3	2.8	2.3-3.2
width pronotum	1.8	1.5-2.0	2.2	2.0-2.4
length tegmen	13.5	13.3-14.0	14.4	14.2-14.7
width tegmen	2.2	1.9-2.3	2.6	2.4-2.8
length forefemur	3.3	3.0-3.8	4.6	4.2-5.2
length hind femur	13.4	12.9-13.8	16.7	16.0-17.2
width hind femur	1.2	1.1-1.5	1.9	1.6-2.0
length ovipositor			4.2	3.8-4.6
A. biforma brachypterous (10 ♂ ♂, 10 ♀ ♀)				
	♂ Mean	Range	♀ Mean	Range
total body length	11.3	10.7-11.6	14.6	14.0-15.1
length pronotum	2.4	1.9-2.9	3.0	2.8-3.5
width pronotum	1.9	1.7-2.1	2.2	2.0-2.5
length tegmen	5.5	5.1-5.7	6.3	6.1-6.6
width tegmen	1.9	1.7-2.1	2.7	2.5-2.8
length forefemur	3.9	3.7-4.2	5.1	4.8-5.6
length hind femur	13.7	13.3-14.2	17.8	15.0-20.2
width hind femur	1.5	1.2-1.8	1.9	1.6-2.3
length ovipositor			4.2	3.9-4.6



Figs 23-29. Scanning electron micrographs of morphological features of *Anisophya* species [FA=fastigium verticis; FR=fastigium frontalis; IX=tergite IX; X=tergite X; rtC=right cercus; SGP=subgenital plate.] 23-25. Face, frontal view. 23. *biforma*, macropterous form. 24. *biforma*, brachypterous form. 25. *careomacula*. 26, 27. Male tip of abdomen, dorsolateral views. 26. *biforma*, macropterous form. 27. *biforma*, brachypterous form. 28, 29. Stridulatory file on underside of left tegmen. 28. *biforma*. 29. *careomacula*.

interocular width *ca* 1.5× width of eye; in frontal view, frons broad, apically rounded, narrower than eye width, and in contact with weakly rounded, bilobed fastigium (Fig. 25).

Thorax. Pronotal disc elongate, 1.4× longer than wide; anterior margin of disc weakly concave, posterior margin rounded, lateral margins straight, with anterior width of pronotum slightly more narrow than posterior width; lateral lobe of pronotum longer than deep, with expanded, rounded hind margin; humeral sinus obsolete (Fig. 14).

Legs. Tympana exposed; forecoxal spine minute, weakly nodiform; inner genicular lobe of forefemur lacking ventro-apical spine, outer genicular lobe with one spine (sometimes absent); midfemur with

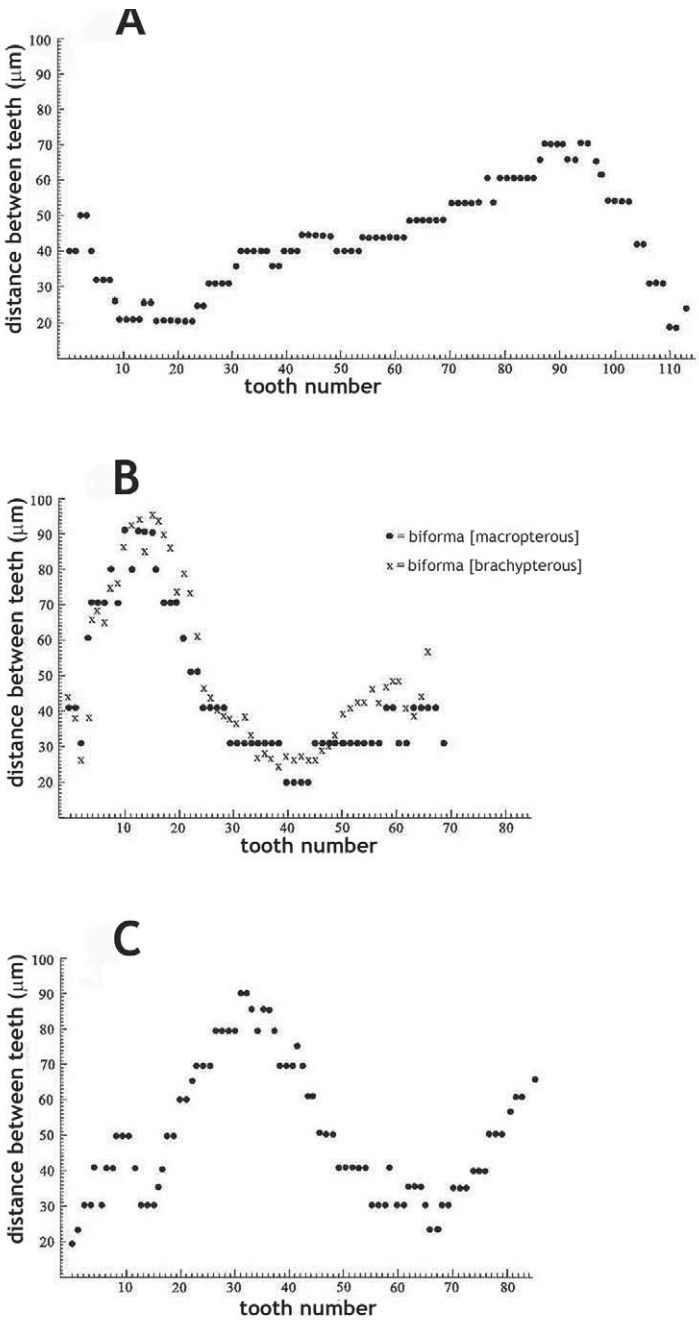


Fig. 30 A-C. Stridulatory file-tooth configurations of *Anisophya* species. The horizontal axis represents successive teeth from the anal margin (1) to costal margin (n) of the file. The vertical axis represents the measured spacing of adjacent teeth (in microns). A. *schoenemanni*. B. *biforma*. C. *careomacula*.

inner genicular lobe with one minute ventro-apical spine, outer lobe unarmed (sometimes with one ventro-apical spine); both genicular lobes of hind femur unarmed. Ventral margins of all femora without spines. Hind femur *ca* 12× longer than wide.

Wings. Brachypterous. Male stridulatory field as in Fig. 10; stridulatory file (Fig. 29) with *ca* 85 teeth, 1.4-1.6 mm in length, 58-62 teeth/mm and with spatial distribution of teeth as in Fig. 30C; tegmen *ca* 2.5-3.0× longer than wide (2.4-2.6× longer in brachypterous *biforma*), extending to apical margin of tergite VI (male), tergite V (female); distal edge of costal margin of tegmen noticeably narrowing pre-apically, forming an abbreviated extension to apex.

Abdomen. Tenth tergite weakly produced, apically truncate; cercus cylindrical, straight along 5/6 of its length, with distal sixth curving medially, apically rounded, armed at pre-apical medial margin with a small medially directed tooth, and with medial face at base of hook forming a dorsoventrally flattened expanded flange (Fig. 18A); subgenital plate spatulate with a well-developed medial keel at basal half, upcurved distally beyond cerci to or above level of dorsal margin of tergite X, distally narrowing, apex with a broad, bracket-shaped ("{") emargination generating two narrow pseudostyles (Fig. 18B).

Allotype.—Terminal tergite truncate, unmodified. Ovipositor (Fig. 20) short, stout, about equal in length to pronotal disc; basal half inflated, distal half contrastingly flat, gradually upcurved, and apically pointed; edges smooth, very weakly serrated to unserrated; basal lobe of ovipositor oval, with dorsoposterior corner weakly extended and drawn into a point; dorsal margin of ventral valve of ovipositor beneath basal lobe weakly inflated laterally and extending ventrolaterally as an ear-shaped lobe.

Coloration.—Uniformly tan [*Note*: tan coloration may be discoloration of green due to desiccation], with light brown markings as follows: postocular band extending from posterior margin of compound eye to posterior margin of head; in dorsal view, narrow brown band extending from medial edge of eye nearly to posterior margin of head; occiput mottled brown; fore- and midlegs mottled light brown; hind femur with horizontal brown band extending entire length of femur; tergites mottled light brown; ovipositor basally tan, becoming brown at distal third.

Measurements.— Holotype (h), Allotype (a): (mean, range) in mm. Brachypterous form: holotype (h), allotype (a): Total length: (h) 10.8, (a) 13.5; length pronotum: (h) 2.8, (a) 3.4; width pronotum: (h) 2.0, (a) 2.4; length tegmen: (h) 13.4, (a) 14.3; width tegmen: (h) 2.1, (a) 2.7; length forefemur: (h) 4.2, (a) 4.5; length hind femur: (h) 14.4, (a) 15.3; width hind femur: (h) 1.5, (a) 1.9; length ovipositor: (a) 4.4. (See also Table 2).

Etymology.— (Latin, fm.) *careo*, meaning to be without, or poorly expressed, and *macula*, meaning marking or spot, referring to the weakly expessed dark marking of this species as compared with *A. biforma*.

Discussion

Dimorphism of wing length.— The two forms of *A. biforma* are nearly identical except in wing length. Although the ranges of these forms overlap, no specimens of the brachypterous form are topotypic with the macropterous form. Although stridulatory files are identical for both forms, this does not necessarily imply they are the same species (Morris and Walker 1976). Across southeastern United States, *Amblycorypha floridana* and *A. carinata* have identical files, as do several species of the field cricket genus *Gryllus*. These species are similar morphologically, but they utilize their files differently, producing markedly different calling songs (Walker 1964).

Brachyptery in phaneropterine katydids is a common occurrence in arid regions of the world. For example, in North America, the brachypterous genera *Dichopetala* Brunner von Wattenwyl, 1878 (with 16 species), *Arachnitus* Hebard, 1932, and *Psilinsara* Hebard, 1932 (each with 1 species) are all found in arid regions from south Texas to Mexico. Brachyptery is common also in phaneropterines found in arid regions of the Palearctic Region: with more than 100

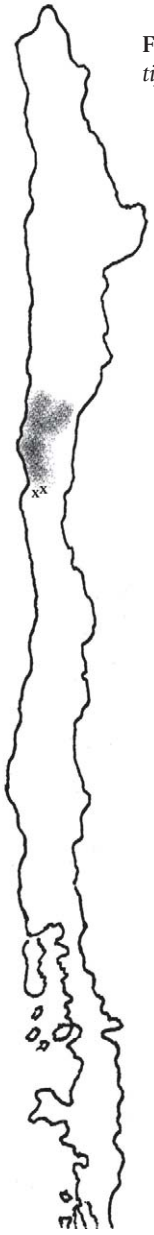


Fig. 31. Distribution in Chile of *Anisophya multiforma* (shaded area) and *A. careomacula* (X).

species combined in the genera *Barbistes* Charpentier, 1825, *Isophya* Brunner von Wattenwyl, 1878, and *Poecilimum* Fischer, 1853, which are distributed from southern Spain, across North Africa, and Asia Minor (Otte 1997). All species within these genera are exclusively brachypterous. *Anisophya biforma* is the first instance of a species with two winged forms. Reasons for this phenomenon are as yet unknown.

Wing-length dimorphism is found in numerous species of crickets, especially among Nemobiinae and Gryllinae. However, in these groups differences in wing length are generally expressed as a function of the hind wing only, and tegminal length is essentially the same for both long-winged and short-winged forms (Masaki & Schimizu 1995). In these groups factors determining wing polymorphism include climate during nymphal development and overcrowding of individuals within populations (Olvido *et al.* 2003). In the Tettigoniidae (including Phaneropterinae) there are no reported cases of wing-length dimorphism. Within the geographic range of *A. biforma*, there is no locality in which both forms were collected, either separately (in different seasons or years) or together. It is therefore possible that the dimorphism expressed in *A. biforma* may be misinterpreted, and they are in reality two sibling species. Bioacoustical analysis of calling songs and/or DNA analysis could eventually resolve this issue.

Table 2. Measurements of *Anisophya careomacula*.

Anisophya careomacula (3 ♂♂, 10 ♀♀)				
	♂ Mean	Range	♀ Mean	Range
total body length	10.9	10.6-11.1	13.6	13.0-13.9
length pronotum	2.7	2.6-3.0	3.6	3.1-3.9
width pronotum	2.0	1.8-2.2	2.3	2.1-2.6
length tegmen	5.6	5.4-6.0	6.6	6.4-6.8
width tegmen	1.9	1.8-2.0	2.7	2.6-2.9
length fore femur	4.1	3.9-4.4	4.6	4.1-4.8
length hind femur	14.5	14.0-15.0	15.4	15.1-15.6
width hind femur	1.5	1.3-1.7	1.8	1.6-2.2
length ovipositor			4.6	3.7-4.9

Acknowledgments

I would like to thank Dr. Theodore C. Cohn, University of Michigan Museum of Zoology, for facilitating the loan of specimens. Scanning electron micrographs were rendered with the help of Mr. Scott Whittacker, Scanning Electron Microscopy Laboratory, U.S. National Museum of Natural History, Smithsonian Institution, Washington, DC. Habitus photographs were rendered by Dr. P.K. Wittman of Canopy Quest, during a recent visit to the Museum. I thank Drs Gary L. Miller and Michael G. Pogue, Systematic Entomology Laboratory, USDA, and James L. Castner, Pittsburgh State University, Pittsburgh, KS, for valuable suggestions to improve the manuscript.

Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA. The USDA is an equal-opportunity provider and employer.

Literature citations

Braun H. 2010. On the neotropical species described under the genus *Isophya* (Orthoptera, Tettigoniidae, Phaneropterinae). Zootaxa 2444: 58-60.

Brunner von Wattenwyl C. 1878. Monographie der Phaneropteriden. Wien. K. K. Zoologische-Botanische Gesellschaft. II, 401 pp., VIII, foldout pl.

Charpentier T.De. 1825. Horae Entomologicae. Wratislaviae. 255 pp.

Emsley M.G., Nickle D.A., Moss W.W. 1967. The value of the stridulatory file and other characters in tettigoniid taxonomy (Orthoptera). Notulae Naturae No. 404: 1-9.

Fischer H. 1853. Orthoptera Europaea. Lipsiae. 454 pp.

Giglio-Tos T. 1894. Bolletin Musei Zoologia ed Anatomia Comparata della *R.* Universite di Torino 9: 36.

Grant H. J. Jr. 1965. A measuring device for use in insect systematics. Entomological News 76: 249-251.

Hebard M. 1932. The Orthoptera of Minnesota. Minnesota Agricultural Experimental Station Technical Bulletin 85: 1-61.

Karsch F. 1889. Orthopterologische Mitteilungen. 3. Über von Herrn Oskar Schönemann in Chili gesammelt Phaneropteriden. Entomologishe Nachrichten 15: 124-127.

Karabag T. 1960. A new South American genus of Phaneropterinae. Eos. Revista Espanola de Entomologia, Madrid 36: 413-415.

Masaki S., Shimizu T. 1995. Variability in wing form of crickets. Researches on Population Ecology 37:119-128.

Morris G.K., Walker T.J. 1976. Calling songs of *Orchelimum* meadow katydids (Tettigoniidae) I: mechanism, terminology, and geographical distribution. Canadian Entomologist 108: 785-800.

Olvido A.E., Elvington E.S., Mousseau T.A. 2003. Relative effects of climate and crowding on wing polymorphism in the southern ground cricket, *Allonemobius socius* (Orthoptera: Gryllidae). Florida Entomologist 86: 158-164.

OSF 2010. Eades, D.C.D. and D. Otte. Orthoptera Species File Online. [09/15/2010]. < http: //OrthopteraSpeciesFile.org>

Otte D. 1997. Orthoptera Species File 7, Tettigonioidea. Publication on Orthoptera Diversity. Academy of Natural Sciences of Philadelphia. 373 pp.

Rehn J.A.G. 1911. Notes on Paraguayan Orthoptera, with descriptions of a new genus and four new species. Entomological News 22: 247-258.

Snodgrass R.E. 1935. Principles of Insect Morphology. McGraw-Hill Book Co., Inc., New York & London. 667 pp.

Stål C. 1860. Konliga Svenska Fregatten Eugenies resa omkring jorden under befall af C. A. Virgin åren 1851-1853. Zoology i. Insecta, pp. 299-350.

Walker T.J. 1964. Cryptic species among sound producing ensiferan Orthoptera (Gryllidae and Tettigoniidae). Quarterly Review of Biology 39: 345-355.