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## *Graminofolium* Nickle: a new genus of katydid with two species from northern South America

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### Abstract

Two new species of a new genus of katydids collected in the understory of rainforests of northern Peru are described and figured. Observations on one species suggests that both may be predaceous or, at least, opportunistic predators. Placement of this genus into either Copiphorinae or Agraeciinae has not been resolved and demonstrates the need for studies to refine subfamilial and tribal relationships among the tettigoniids.

### Resumen

Dos nuevas especies de un nuevo genero de tettigónidos (Tettigoniidae) recolectadas en el substrato y areas adyacentes del bosque tropical en el norte del Peru son dibujadas y descritas. Observaciones en una de las especies sugiere la posibilidad de que ambas son depredadoras o tal vez depredadores oportunisticos. La pertenencia de este genero a los Copiphorinae o Agraeciinae no ha sido resuelta, esto demuestra la necesidad de más estudios que identifiquen las relaciones de tribu y subfamilia entre los tettigónidos.

### Key words

*Graminofolium*, Loja, Agraeciinae, Copiphorinae, katydid

In a long-term study (1986-1999) on the diversity of orthopteroid and dictyopteroid insects in rainforests of northern Peru (Nickle & Castner 1995), numerous new and unusual katydids have been discovered and described from both understory and canopy strata. Nickle and Naskrecki (1999) described the species *Loboscelis bacatus* (Copiphorinae), comparing it with *L. pilipes*, a species known only from type material from Brazil. Nickle (2001a) revised the micropterous genus *Daedalellus* Uvarov (Copiphorinae), with four new species, two of them distinctly allopatric, separated from one another by the Napo River (upper Amazon basin).

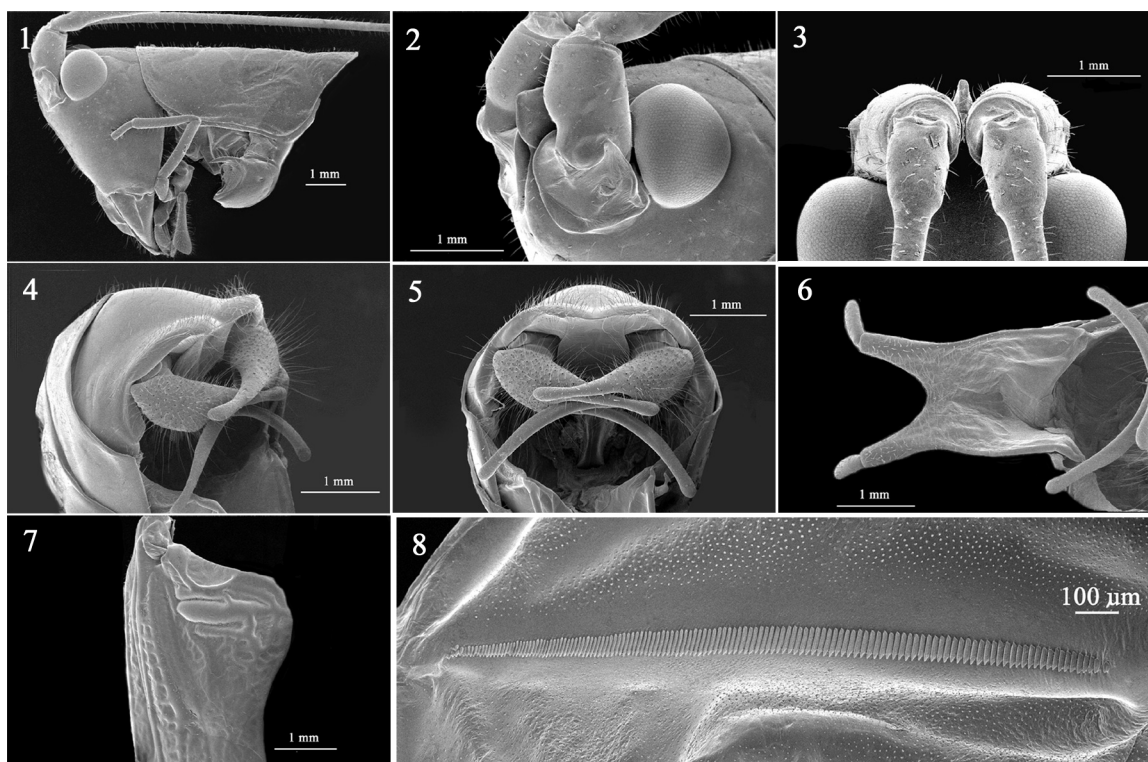
Following Naskrecki's (1997) revision of the copiphorine genus *Acantheremus* Karny, Nickle (2001b) added another new species, *A. arboreus*, based on a series of specimens collected from the canopy using pesticide fogging techniques. Continuing with fogging collecting in the canopy, Nickle (2003) described 17 new species of the genus *Phlugis* (Meconematinae), a genus with neotropical species heretofore known only from the understory of rainforests or from open fields. Montealegre-Z. and Morris (2003) described three species of agraeciine katydids of the genus *Uchuca* Giglio-Tos from Ecuador; these species also occur in the research sites in northern Peru and were also recognized by Nickle and Castner as new. Two minute new species of pseudophylline katydids were also added to the fauna recently by Nickle (2006).

To make names available for an upcoming review of the tettigoniid fauna of northern Peru, two new species are herein described in a new genus, *Graminofolium* Nickle. Although both species are relatively common in the understory, no other specimens could be found in museums with significant neotropical tettigoniid holdings. Specimens of these species are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC [USNM].

*Graminofolium* falls into an uncertain area between the Agraeciinae and Copiphorinae [Tribes Agraeciini and Copiphoriini of some authors (Naskrecki in preparation)] and shares characters most closely with the copiphorine genus *Daedalellus*, Uvarov. These genera share the following features: the elongated shape of the pronotum and inflation of the lateral lobes toward the posterior region of the pronotum, cylindrical cerci with two apical lobes, and very elongated sword-like ovipositors. They differ in several respects: *Daedalellus* lacks prosternal spines and has a fairly broad fastigium with ventrally small tooth (prosternal spines well developed, very narrow fastigium with no ventral tooth in *Graminofolium*).

The present study is based on a series of 10 specimens of the first species, *Graminofolium adustus* Nickle, new species, and 78 specimens of the second species, *G. castneri* Nickle, new species. Specimens were collected at five sites in northern Peru in Loreto Province. Three of them are part of an ecotourist facility, Exploraciones Amazonicas, also known as Explorama, owned and operated by Peter Jenson in Iquitos, Peru. These sites [abbreviated in the text] are as follows: Explorama Inn [INN], 40 km NE Iquitos on Rio Amazon (nr Indiania) 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); and Explornapo Camp [CAMP], 90 km NE Iquitos on Rio Sucusari (1 km upriver from Rio Amazon, lat 3°11' S, long 72°53' W). A fourth site, the Amazon Center for Environmental Education and Research [ACEER] nr Explornapo Camp [CAMP], 90 km NE Iquitos on Rio Sucusari (1 km upriver from Rio Napo, lat 3°11' S, long 72°53' W), is closely linked to Explornapo Camp. A fifth site, Yacumama Lodge—an ecotourist facility owned by Lawrence Bishop and Norman Walters, Iquitos, Peru—is located above the confluence of the Rio Ucuyali: Yacumama Lodge [YACU], on the Rio Yurapa (ca 30 km upstream from Rio Ucuyali, lat 4° 48' S, long 73° 30' W).

Specimens were collected over a 12-year period by 22 of the 24 teams of Earthwatch volunteers (each team comprising the collecting efforts of 11 to 17 persons). Collecting dates for the teams involved in collecting these specimens are as follows: Team 1 (XI.1-18.1986); Team 2 (II.1-14.1987); Team 3 (II.14-28.1987); Team 5 (VII.15-28.1987); Team 7 (VIII.5-19.1989); Team 8 (VIII.19-IX.1.1989);



**Figs 1-9.** *Graminofolium adustus*. 1. Head and pronotum, lateral view; 2. Head, dorsolateral view, showing fastigium and frons; 3. Front of head, dorsal view; showing thinness of fastigium between scapes of antennae; 4. Tip of abdomen of male, dorsolateral view, with subgenital plate extending downward and out of picture; 5. Tip of abdomen, posterior view; 6. Subgenital plate, male, dorsal view; 7. Stridulatory field of left tegmen of male, dorsal view; 8. Stridulatory file, left tegmen of male, ventral view.

Team 9 (VI.23-VII.14.1990); Team 10 (VII.7-20-1990); Team 11 (X.3-17.1990); Team 12 (VI.22-VII.5.1991); Team 13 (VI.22-VII.6.1991); Team 14 (VIII.8-22.1992); Team 15 (VIII.22-IX.3.1992); Team 16 (VIII.5-20.1994); Team 17 (VIII.20-IX.3.1994); Team 18 (VII.15-28.1995); 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); and Team 24 (VII.25-VIII.8.1998).

*Graminofolium adustus* was collected only at ground level during nightly collecting forays along forest trails. Although *Graminofolium castneri* was collected primarily at ground level, six specimens were obtained from rainforest canopy samples obtained by fogging treetops with a mild pesticide (Resmethrin®, 0.5%). An additional two specimens were collected from treetop foliage adjacent to the canopy walkway of the ACEER.

Nickle (2003) demonstrated with *Phlugis* species that although arboreal species occasionally have been found at night at ground level, they are still arboreal in habit. Similarly, based on field observations of numerous species of pseudophylline katydids (Nickle and Castner 1995), understory species move freely up into the canopy during nightly movements, but return to the understory before dawn. The eight specimens of *G. castneri* suggest that this species is likely only sporadically found at canopy levels and is probably also an understory species in habit.

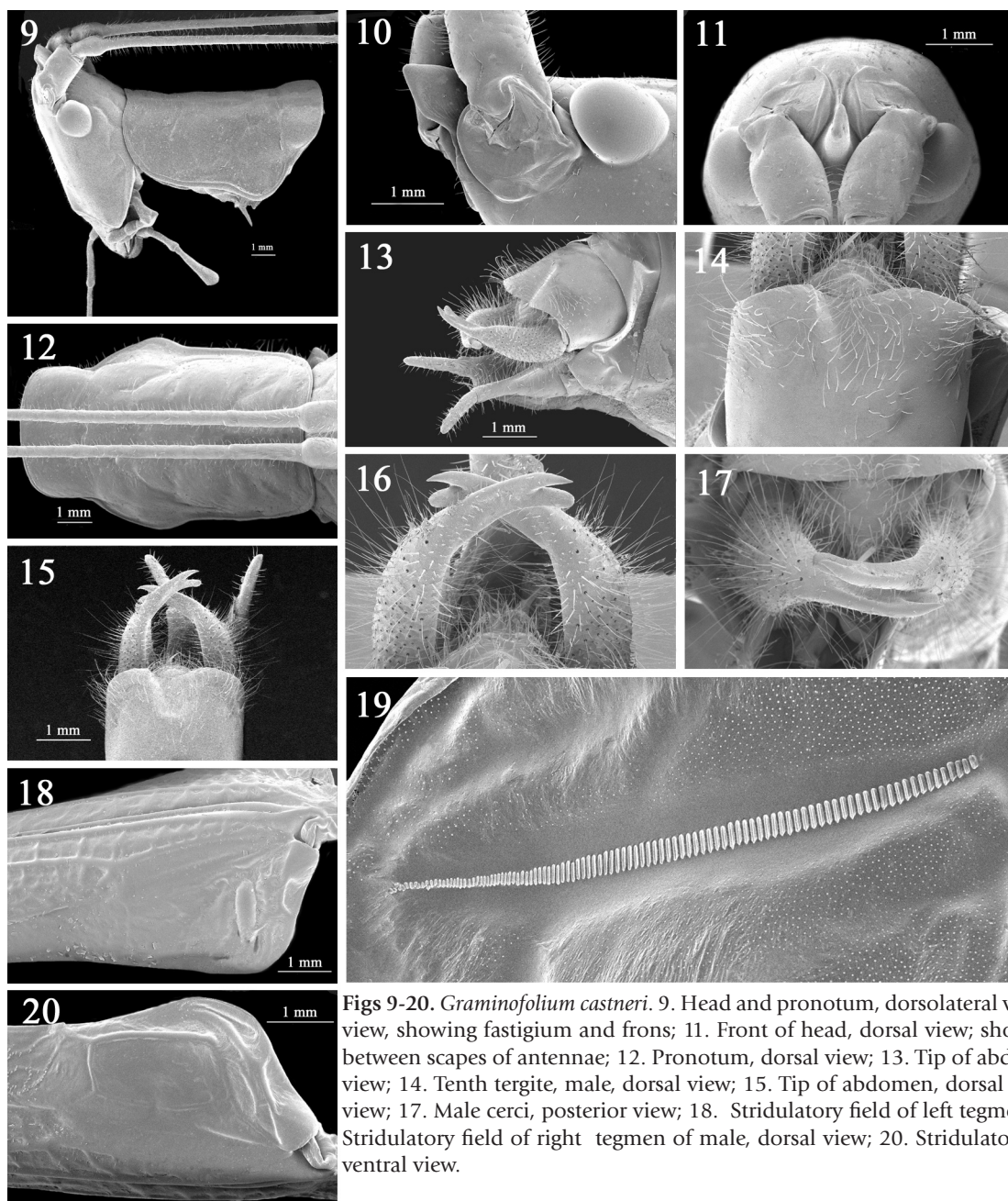
Specimens were measured (in mm) with a device described by Grant (1965), and characters used to evaluate species were essentially those detailed by Emsley *et al.* (1967). Measurements were defined as follows: *total length*, the distance between the frons and apex of abdomen; *length of pronotal disc*, 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 its curvature; *length and width of both fore- and hindfemur*, the greatest dimensions of those structures as seen in lateral view; *length of tegmen*, the length of the tegmen from its point of insertion at the mesothorax to its apex; *width of tegmen*, the greatest width across the tegmen; *length of ovipositor*, the distance from the apex of the ovipositor to the apex of the subgenital plate.

The stridulatory file of a single male of each species was examined and figured (Figs 8, 19). All teeth on the stridulatory file on the left tegmen were counted, and the straight-line distance between first and last tooth on the file recorded as the *length of the file*. Internal genitalia of males of several species could be seen without the aid of dissections and appeared to be quite complex in structure. However, no dissections were made at this juncture, because all species were easily recognizable without the need to examine internal structures.

#### *Graminofolium* Nickle, new genus

**Diagnosis.**— Medium to large (35 to 60 mm) but slender, fully alate katydids with long slender legs. Head elongate, with globular eyes situated high on head, dorsal margin in lateral view rising above dorsum of head. Fastigium dorsoventrally wafer-thin, compressed, with leading margin trapezoidal and ventrally merging with narrow frons (see Fig. 2). Tympana with symmetrical inflated shields. Pronotum elongated, with lateral lobe situated in posterior fourth of its length. Ovipositor long and thin, equal to or greater than length of insect from head to tip of abdomen, sword-shaped.



Figs 9-20. *Graminofolium castneri*. 9. Head and pronotum, dorsolateral view; 10. Head, frontolateral view, showing fastigium and frons; 11. Front of head, dorsal view; showing thinness of fastigium between scapes of antennae; 12. Pronotum, dorsal view; 13. Tip of abdomen of male, dorsolateral view; 14. Tenth tergite, male, dorsal view; 15. Tip of abdomen, dorsal view; 16. Male cerci, dorsal view; 17. Male cerci, posterior view; 18. Stridulatory field of left tegmen of male, dorsal view; 19. Stridulatory field of right tegmen of male, dorsal view; 20. Stridulatory file, left tegmen of male, ventral view.

*Type species.*— *Graminofolium castneri* Nickle, by original designation.

*Etymology.*— [Lt.] n. *gramen*, grass, and n. *folium*, leaf, grassy leaf, referring to the grass-shaped tegmina of the species of this genus.

*Description.*— Head. Elongate, with globular eyes situated high on head, dorsal margin in lateral view rising above dorsum of head. Fastigium dorsoventrally wafer-thin, compressed, with leading margin trapezoidal and ventrally merging with narrow frons.

Thorax. Pronotum as in Fig. 12; surface smooth to weakly punctate. Prosternum with two elongated spines. Mesosternal lobes elevated, apically pointed, metasternal lobes rounded, weakly flanged; mesosternal lobes not overlapping metasternum.

Legs. Long and slender. Tympanum on foretibia with symmetrical, inflated, conchate shields. Fore and midfemora with or without a

single spine on outer genicular lobes, all other genicular lobes each armed with a single spine. Forelegs: femur as long as, or longer than, head and pronotum combined; procoxal spine well developed; femur with 2 to 4 spines on inner ventral margin only; tibia with 5 to 6 spines on each posterior margin. Midlegs: femur slightly shorter than forefemur, with 3 to 4 spines on outer ventral margin only; tibia with 6 to 8 spines on each ventral margin. Hindlegs: femur about 3/4 length of tegmen, with 5 to 9 spines on outer ventral margin and 0 to 6 spines on inner ventral margin; tibia with 15 to 20 spines on each dorsal margin and 15 to 20 spines on each ventral margin; apex with two outer and two inner apical spurs.

Wings. Tegmina well developed, slender, sides parallel, extending in repose beyond apex of abdomen. Hindwings well developed, hyaline; completely concealed beneath tegmina in repose.

Abdomen. Male. Tenth tergite unmodified to weakly emarginate, apical margin pilose. Cerci cylindrical, apically bilobed, modified.

Subgenital plate spatulate, with two articulating styles. Phallus with a series of spiny ridges. Female. Terminal tergite truncate. Ovipositor elongated, straight, sword-shaped, nearly as long as length of abdomen.

#### Key to species of *Graminofolium*

1 Outer genicular lobes of fore- and midfemora without a spine; inner ventral margin of hind femur without spines; apical margin of male tenth tergite distinctly bilobed; male cercus with two elongated finger-like distal lobes; ovipositor of female less than 20 mm, subgenital plate apically rounded . . . . . *G. adustus*  
 1' Outer genicular lobes of fore and midfemora each armed with a sharp spine; inner ventral margin of hind femur with 6 spines; apical margin of male tenth tergite produced but not bilobed; male cercus elongated with two very short distal lobes; ovipositor of female usually greater than 22 mm, subgenital plate apically truncated . . . . . *G. castneri*

#### *Graminofolium adustus* Nickle, new species

(Figs 1-8)

*Diagnosis.*—Elongated, slender katydids, smaller than *G. castneri*, total length from 35 to 42 mm (males) and 44 to 50 mm (females), uniformly castaneous brown in color, without a spine on outer genicular lobe of either fore- or midfemur, and without spines on inner ventral margin of hind femur. Male tenth tergite distinctly bilobed and cercus basally cylindrical with two elongated finger-like lobes. Female ovipositor less than 30 mm long and subgenital plate apically rounded.

*Holotype.*—Male. CAMP. Team 8. [USNM]. Allotype. Female. CAMP. Team 8. [USNM].

*Description.*—Head. Elongate, with globular eyes situated high on head, their dorsal margin in lateral view rising above dorsum of head (Fig. 1). Fastigium dorso-ventrally wafer-thin, compressed, with leading margin trapezoidal and ventrally merging with very narrow frons (Figs 2, 3).

Thorax. Pronotum elongate, with lateral carinae subparallel; lateral lobes inflated along posterior fourth of pronotum. Prosternal lobes with two elongated spines. Anterior margin of metasternum with two small papilliform nodes.

Legs. Fore and midfemora without spines on outer genicular lobes; all other genicular lobes each armed with a single spine. Forelegs: femur with 2 spines on inner ventral margin only; ventral margins of tibia each with 5 well-developed spines; tympana with bulbous well-developed shields. Midlegs: femur with 4 spines on outer ventral margin only; ventral margins of tibia each with 5 to 6 well-developed spines. Hind legs: femur with 6 to 7 spines on outer ventral margin only; ventral margins of tibia each with 5 well-developed spines; dorsal margins of tibia each with 13 to 16 well-developed spines; length/width of hind femur 11.5 to 13.2.

Wings. Tegmen fully developed, in repose more than half its length extending beyond tip of abdomen; length/width of tegmen 10.5 to 11.5. Stridulatory field of male as in Fig. 7. Stridulatory file (Fig. 8) about 1.5 mm in length, with 144 teeth, 96 teeth/mm.

Abdomen. Male. Tenth abdominal tergite apically produced, bilobed, with surface densely covered with long, fine, blonde setae (Fig. 4). Cercus basally cylindrical, narrowing distally into two elongated medially-directed finger-like projections, the dorsal projection about

half the length of ventral one (Fig. 5). Subgenital plate spatulate; medially keeled; apex with a deep V-shaped emargination; with short styles; styles 2× longer than wide (Fig. 6). Female. Ovipositor elongate, sword-shaped, 4.7× longer than pronotum. Subgenital plate spatulate, apically rounded.

*Paratypes.*—7 ♂♂, 1 ♀. CAMP, Team 2, 1 ♂; CAMP, Team 8, 1 ♂; CAMP, Team 10, 2 ♂♂; CAMP, Team 13, 3 ♂♂; ACEER, Team 19, 1 ♂; ACEER, Team 24, 1 ♀.

*Color.*—Uniform light castaneous brown. Tegmina with numerous small speckled brown spots; basal half of antennae with distal half of every fifth segment dark brown, all subsequent segments more-or-less uniform castaneous.

*Measurements.*—in mm (means, range). Total length: male (n=5) 37.6, 35.4 to 41.9; female (n=2) 46.2, 44.6 to 48.8; length pronotum: male 5.61, 4.9 to 5.9; female 6.3, 6.3 to 6.4; width pronotum: male 2.0, 1.9 to 2.1; female 2.5, 2.4 to 2.6; length forefemur: male 8.0, 6.9 to 8.4; female 8.2, 8.0 to 8.4; length midfemur: male 7.3, 7.2 to 7.4; female 7.6, 7.5 to 7.7; length hindfemur: male 20.1, 19.8 to 21.4; female 21.1, 20.8 to 22.4; width hindfemur: male 2.6, 2.4 to 2.7; female 2.6, 2.5 to 2.7; length tegmen: male 36.2, 34.0 to 37.3; female 39.8, 39.4 to 40.6; width tegmen: male 4.7, 4.6 to 4.8; female: 4.8, 4.7 to 4.8; length ovipositor: 18.3, 18.2 to 18.4.

*Etymology.*—(L.) – *adustus*, tanned, brown, an adjective referring to the uniform brown coloration of this species.

#### *Graminofolium castneri* Nickle, new species

(Figs 9-21, Pl. V)

*Diagnosis.*—Elongated, slender katydid, larger than *G. adustus*, total length from fastigium to apex of tegmen 50 to 55 mm (male) and 54 to 59 mm (female), either uniformly green or castaneous brown in color, with a well developed spine on each genicular lobe of all femora, and with 6 to 7 spines on inner ventral margin of hind femur. Male tenth tergite apically produced but not bilobed, and cercus cylindrical, somewhat anteriorly curved, with apex terminating as two small lobes, the dorsal lobe apically pointed, the ventral one apically rounded with two elongated finger-like lobes. Female ovipositor greater than 30 mm long and subgenital plate apically truncated.

*Holotype.*—Male. LODGE. Team 21. [USNM]. Allotype. Female. LODGE. Team 21. [USNM].

*Description.*—Head. Elongate, with globular eyes situated high on head, their dorsal margin in lateral view rising slightly above dorsum of head (Figs 9,10). Fastigium dorsoventrally wafer-thin, compressed, with leading margin trapezoidal and ventrally merging with a very narrow frons; leading edge more angulate than that of *G. adustus* (cf. Figs 2, 10).

Thorax. Pronotum elongate, with lateral carinae subparallel; lateral lobes as in Fig. 12. Prosternal lobes with two elongated spines. Metasternum with two papilliform lateral lobes.

Legs. Genicular lobes of all femora armed with a well-developed spine. Forelegs: femur with 3 to 4 spines on inner ventral margin only; ventral margins of tibia each with 8 well-developed spines; tympana with bulbous well-developed shields. Midlegs: femur with 4 spines on outer ventral margin only; ventral margins of tibia each

with 6 to 8 well-developed spines. Hind legs: femur with 6 to 7 spines on each ventral margin; ventral margins of tibia each with 9 to 10 well-developed spines; dorsal margins of tibia each with 14 to 16 well-developed spines; length/width of hind femur 10.9 to 11.8.

Wings. Tegmen fully developed, in repose extending nearly one half its length beyond apex of abdomen; length/width of tegmen 10.1 to 10.9. Stridulatory field and stridulatory mirror of male as in Figs 18 and 20, respectively. Stridulatory file 1.9 mm in length, with 104 teeth, 55 teeth/mm.

Abdomen. Male. Tenth abdominal tergite apically produced, truncated or, at most, medially weakly concave, distomedially depressed, with surface of distal half densely covered with long, fine, blonde setae (Fig. 15). Cercus cylindrical, narrowing distally into two small apical lobes, the dorsal lobe apically pointed, the ventral one apically rounded. (Figs 16, 17). Subgenital plate spatulate; medially keeled; apex with a deep V-shaped emargination; with two long styles; style 4× longer than wide (Fig. 13). Female. Ovipositor elongate, sword-shaped, 5× longer than pronotum. Subgenital plate spatulate, apically truncate.

*Paratypes*.— 25 ♂♂, 45 ♀♀, 3 nymphs. INN. Teams 15, 9, 15, 19, 21. 4 ♂♂, 8 ♀♀, LODGE. Teams 7-10, 12, 15, 17-19, 20 [fogging site 1], 21, 23 [fogging site 8]. 12 ♂♂, 20 ♀♀. CAMP. Teams 3, 8, 10, 11, 14, 15, 18, 19, 21. 7 ♂♂, 13 ♀♀. ACEER. Teams 17, 21 [walkway], 24 [fogging site 8]. 1 ♂, 2 ♀♀, 3 nymphs.

*Color*.— Dimorphic, either uniform light castaneous brown or light green, with the following markings: rim of lateral lobes of pronotum highlighted shiny black and basal fourth of ventral margin of hind femur shiny black. In addition, tegmina with numerous small brown spots. Antennae uniform in color (in contrast to *G. adustus*, with dark brown markings at regular intervals).

*Measurements*.— in mm (means, range). Total length: male (n=5) 53.2, 49.2 to 55.1; female (n=5) 57.3, 54.5 to 59.8; length pronotum: male 6.8, 6.6 to 7.2; female 7.3, 6.7 to 7.9; width pronotum: male 2.4, 2.2 to 2.9; female 2.7, 2.6 to 3.1; length forefemur: male 9.1, 8.9 to 9.7; female 9.9, 9.7 to 10.4; length midfemur: male 8.2, 7.9 to 8.4; female 8.7, 8.5 to 8.9; length hindfemur: male 23.2, 20.8 to 25.7; female 26.2, 25.6 to 29.4; width hindfemur: male 2.9, 2.7 to 3.3; female 3.5, 3.2 to 3.7; length tegmen: male 39.4, 37.8 to 42.0; female 43.7, 42.1 to 45.0; width tegmen: male 5.1, 4.9 to 5.4; female: 5.7, 5.3 to 5.9; length ovipositor: 25.1, 23.1 to 28.4.

*Etymology*.— A patronym, for Dr. James L. Castner, in appreciation of his dedication to the project and of his friendship since the project began in 1986.

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succeeded. Thanks are extended also to Scott Whittacker, Scanning Electron Microscope Laboratory, U.S. National Museum of Natural History, Smithsonian Institution, Washington, DC, for his help with preparing specimens for images in this paper. Finally, I wish to thank the following individuals for reviewing the manuscript: Michael Gates and Douglass R. Miller, Systematic Entomology Laboratory, USDA, and James L. Castner, Department of Biology, Pittsburg State University, Pittsburg, KS.

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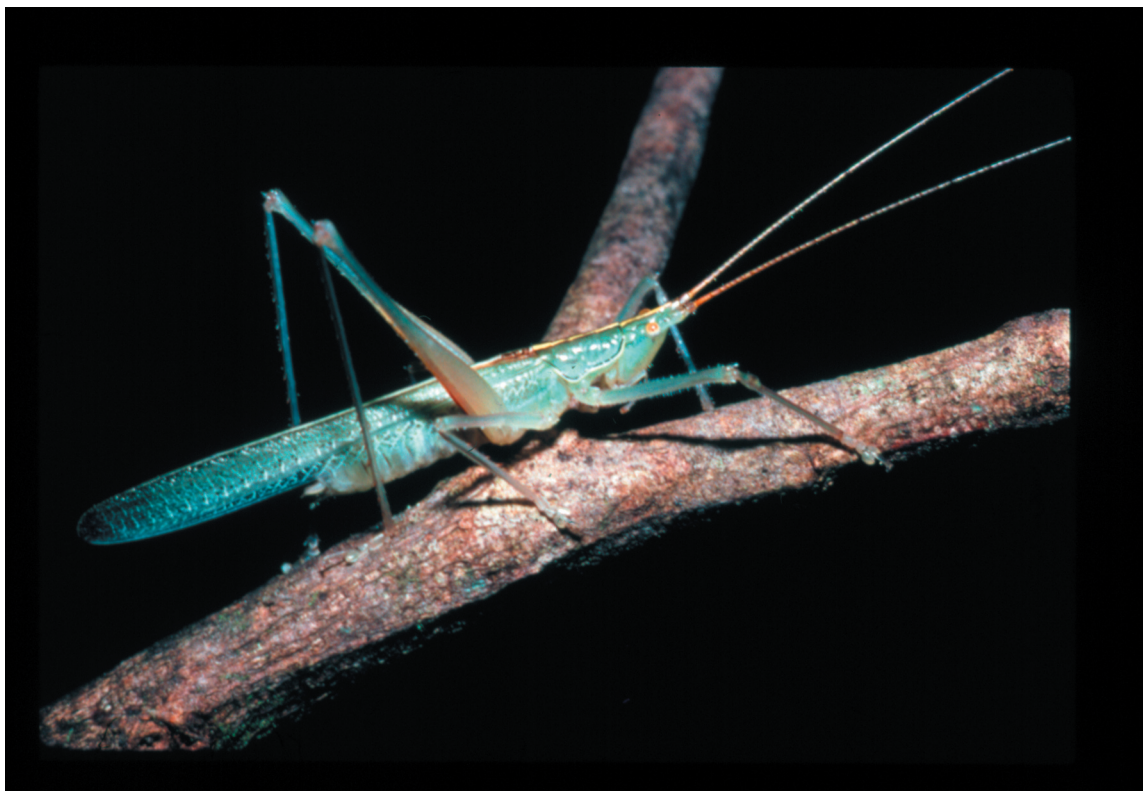


Fig. 21. *Graminofolium castneri* Nickle, new species, green form. ©Photograph by James L. Castner. See also PLATE V.