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# Description of the female and new characteristics of the male of *Phlugis gracila* Nickle, 2003 (Orthoptera: Tettigoniidae: Meconematinae) with new behavioral data

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## Abstract

The description of the female of *Phlugis gracila* and the addition of new characters to the original male description are provided. The description of the male stridulatory file and genitalic morphology is noted for the first time. This is the first record for the species in Brazil (Amazonas) and its natural history is noted.

**Key words:** Predatory katydids, Seasonally flooded white-water forests, Aquatic macrophytes

## Resumo

É feita a descrição da fêmea de *Phlugis gracila* e adição de novos caracteres a descrição original do macho, incluindo morfologia da fileira estridulatória e da genitália. É feito pela primeira vez o registro da espécie para o Brasil (Amazonas) e são registradas observações de campo sobre a sua história natural.

**Palavras-chave:** Esperanças predadoras, Florestas de várzea amazônicas, Macrófitas aquáticas

## Introduction

The genus *Phlugis* Stål, 1861 of the tribe Phlugidini Eichler, 1938 currently includes 40 species of small predatory katydids, with almost exclusively Neotropical distributions. The exception is the Malaysian species *Phlugis buruensis* Karny, 1924 (Eades *et al*. 2017). Among the Neotropical species, *Phlugis gracila* Nickle, 2003, was described from a single male specimen from Peru. Despite this, the morphology of the concealed male genitalia, stridulatory file and information of the natural history are unknown for both sexes.

This paper aims to increase the taxonomic and biological knowledge of *P. gracila*, adding the female description and noting of new taxonomic characters for the male. We also provide notes on the species behavior and provide additional geographical records.

## Material and methods

The studied specimens were collected diurnally between 08:00 and 17:00, on aquatic macrophytes floating on the margins of lakes and small tributaries of the Solimões River, near the community of Caburini, in the Alvarães city, Amazonas, Brazil. These specimens were deposited in the Invertebrates Collection of Instituto Nacional de Pesquisas da Amazônia (INPA).

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The genitalic terminology used follows Chamorro-Rengifo & Lopes-Andrade (2014). The photographs of the lateral view of the specimens were taken using a Nikon D3000 digital camera, with a 60 mm 2:8 lens. The other images were taken with a Leica DFC295 attached at a stereoscopic microscope M205. The illustrations were made using the Adobe Illustrator CS6 and Adobe Photoshop CS6.

The following abbreviations were used for measurements (in mm): total body length, TL; maximum tegmen length, TegL; maximum tegmen height, TegH; maximum frontal width, WF; pronotum dorsal length at midline, PL; length of the fore femur, FF; length of the fore tibia, FT; length of the mid femur, MF; length of the mid tibia, MT; length of the hind femur, HF; length of the hind tibia, HT; length of the subgenital plate, Lplac; Length of the cercus, LC; length of the ovipositor, OL.

## Results

### *Phlugis gracila* Nickle, 2003

(Figs. 1–8)

**Diagnosis.** Body narrow and elongate (Figs. 1A, 5A). Fore femur with 3 internal spines and 4 external ventral spines (Figs. 1F, 5G). Left stridulatory file slightly sinuous, medially thickened and narrowing gradually to the apex (Fig. 3A). Right stridulatory file curved, medially thickened and narrowing abruptly at the beginning of distal region (Fig. 3B). Subgenital plate sinuous, medially with dorsal margins making two triangular projections, posteriorly straight and distally rectangular in lateral view (Fig. 1I–K). Tenth tergite with two triangular projections posterolateral and convex posteromedial (Fig. 1I). Male cocealed genitalia elongate, with dorsal lobes laterally projected with blunt apex, which makes the genitalia similar to an anchor (Fig. 4A–D). Titillator forming two slightly curved sclerotised triangular projections, with a blunt apex trespassing posterior margin of the lower folds of ventral lobe (Fig. 4A–D). Posterior portion of genitalia with an aperture located medially between projections of titillator (Fig. 4A–D).

**Specimens examined.** 4♂ - 6♀: BRASIL, *Amazonas*, Alvarães, Rio Solimões, próximo da Comunidade Caburini, 24–25.iii.2017, coleta manual em bancos de herbáceas aquáticas flutuantes, (D.M.M. Mendes & J.C. Oliveira *leg.*) [03°09'26"S / 64°45'48.6"W](3♂ - 5♀); *idem*, Manaus, Ilha da Majantaria, 28.iv.1990, armadilha de luz, (M.F. Vieira & L. Aquino *leg.*)(1♂ - 1♀).

**Geographic distribution.** Peru: Loreto; Brazil (new record): Amazonas (Fig. 08).

**Description. Male.** We include here only characteristics that were not used in the original description made by Nickle (2003).

*Wings.* Tegmen narrow and elongate, length 10 times longer than width, measued in medial region (Fig. 2). Costal margin of tegmen with the base briefly sinuous and posteriorly straight to the apex (Fig. 2). Anal margin of tegmen slightly sinuous from the base to the beginning of apical region, where it curves to the apex (Fig. 2). Left stridulatory file slightly sinuous, medially thickened and narrowing gradually to the apex (Fig. 3A). Basal and apical teeth small, enhancing in length and width towards medial region of the row. Total length of the row: 0.3 mm; Maximum width of the vein: 0.1 mm; Total number of teeth: 39. Right stridulatory vein curved, medially thickened and narrowing abruptly at the beginning of distal region, with same width to the apex (Fig. 3B). Total length of the row: 0.2 mm; Maximum width of the vein: 0.1 mm; Total of teeth: 21.

*Male internal genitalia*. Shape elongate (Fig. 4A–D). Ejaculatory vesicles reniform with an ejaculatory duct shorter than half the length of ejaculatory vesicle (Fig. 4A–D). Upper folds of ventral lobe narrow and elongate, trespassing lateral margin of the ventral lobe (Fig. 4A–B). Dorsal lobes laterally projecting, blunt apex, which makes the genitalia similar to an anchor (Fig. 4A–D). Dorsal folds elongate, slightly narrowing from the base to the apex and trespassing dorsal lobes margins. Titillator sclerite forming two slightly curved triangular projections, with a blunt apex trespassing posterior margin of the lower folds of ventral lobe (Fig. 4A–D). Posterior portion of genitalia with an aperture located medially between projections of titillator (Fig. 4A–D). Lower folds of ventral lobe short, wrinkled, with various small protuberances and posteriorly forming a projection with blunt apex (Fig. 4C–D).

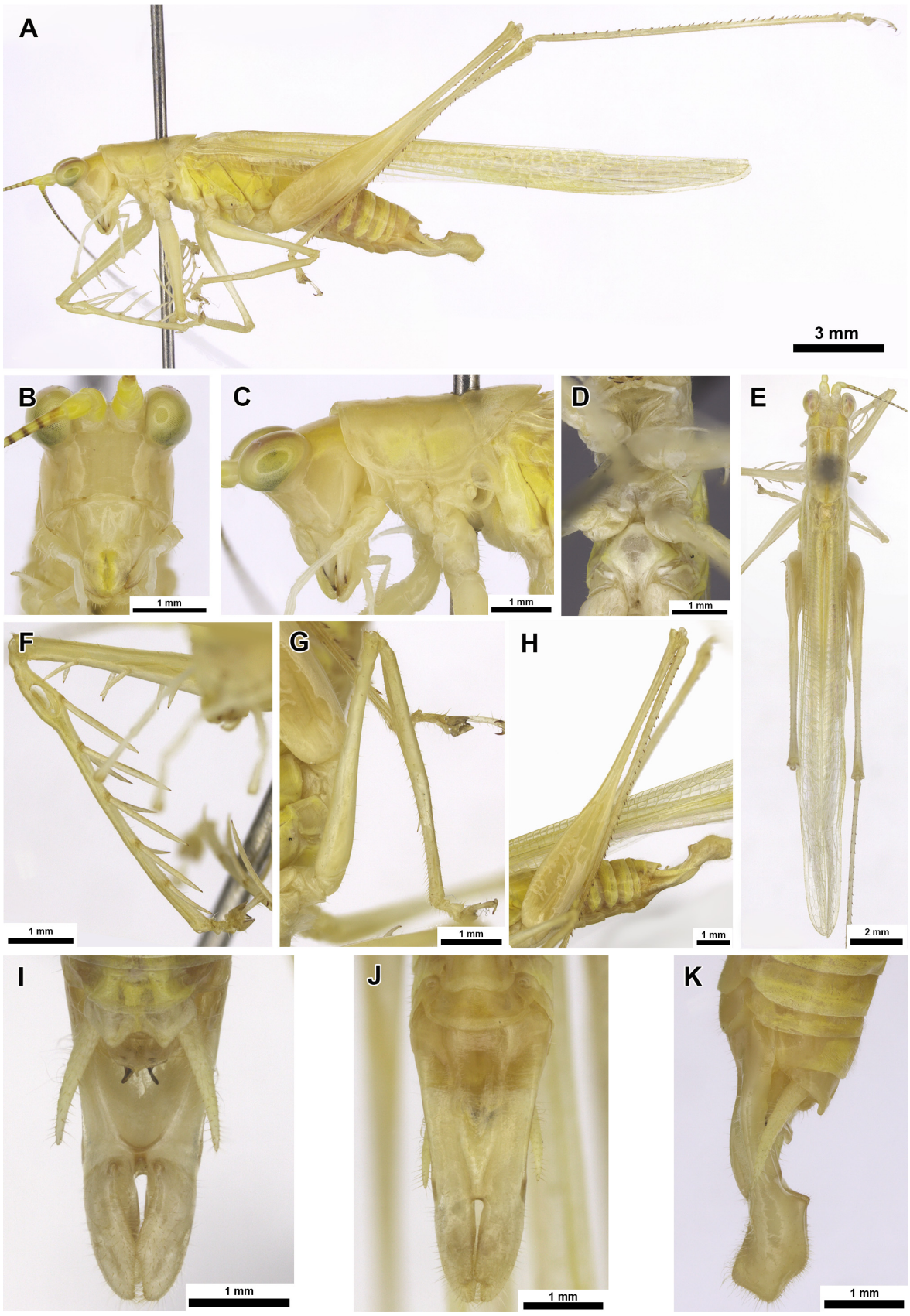


**FIGURE 1**. Male of *Phlugis gracila*. A: *habitus* in lateral view; B: head in frontal view; C: Pronotum in lateral view; D: Thoracic sternites in ventral view; E: Body in dorsal view; F: Foreleg in lateral view; G: Middle leg in lateral view; H: Hind leg in lateral view; I–K: Terminalia in dorsal, ventral and lateral view, respectively.

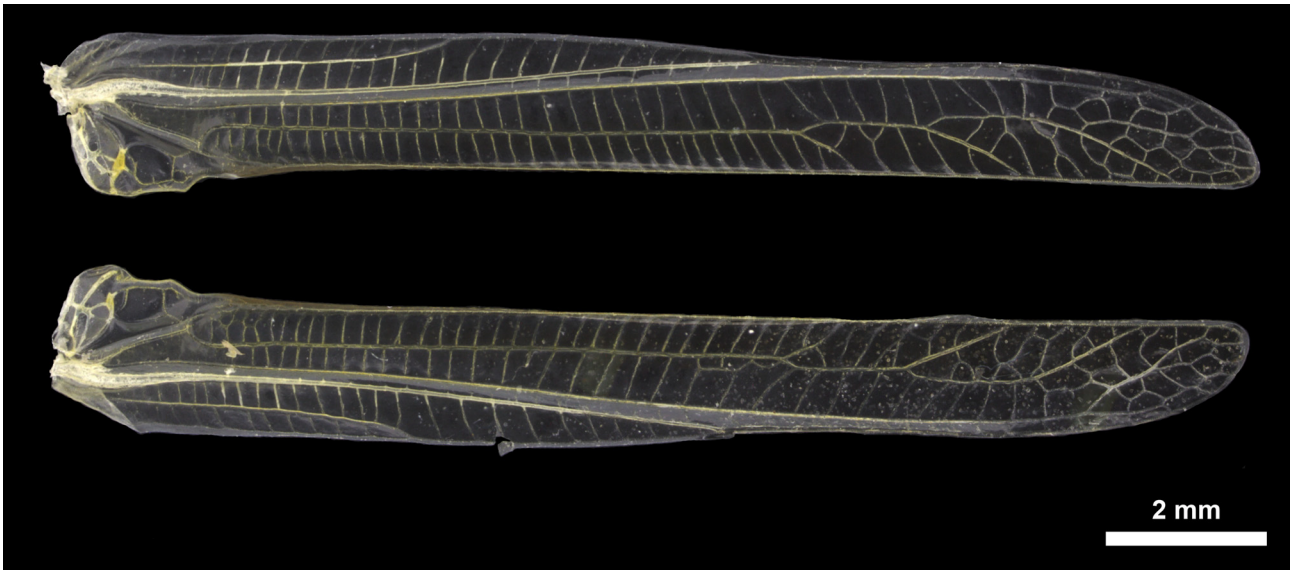


**FIGURE 2.** Male tegmen of *Phlugis gracila* in dorsal view.

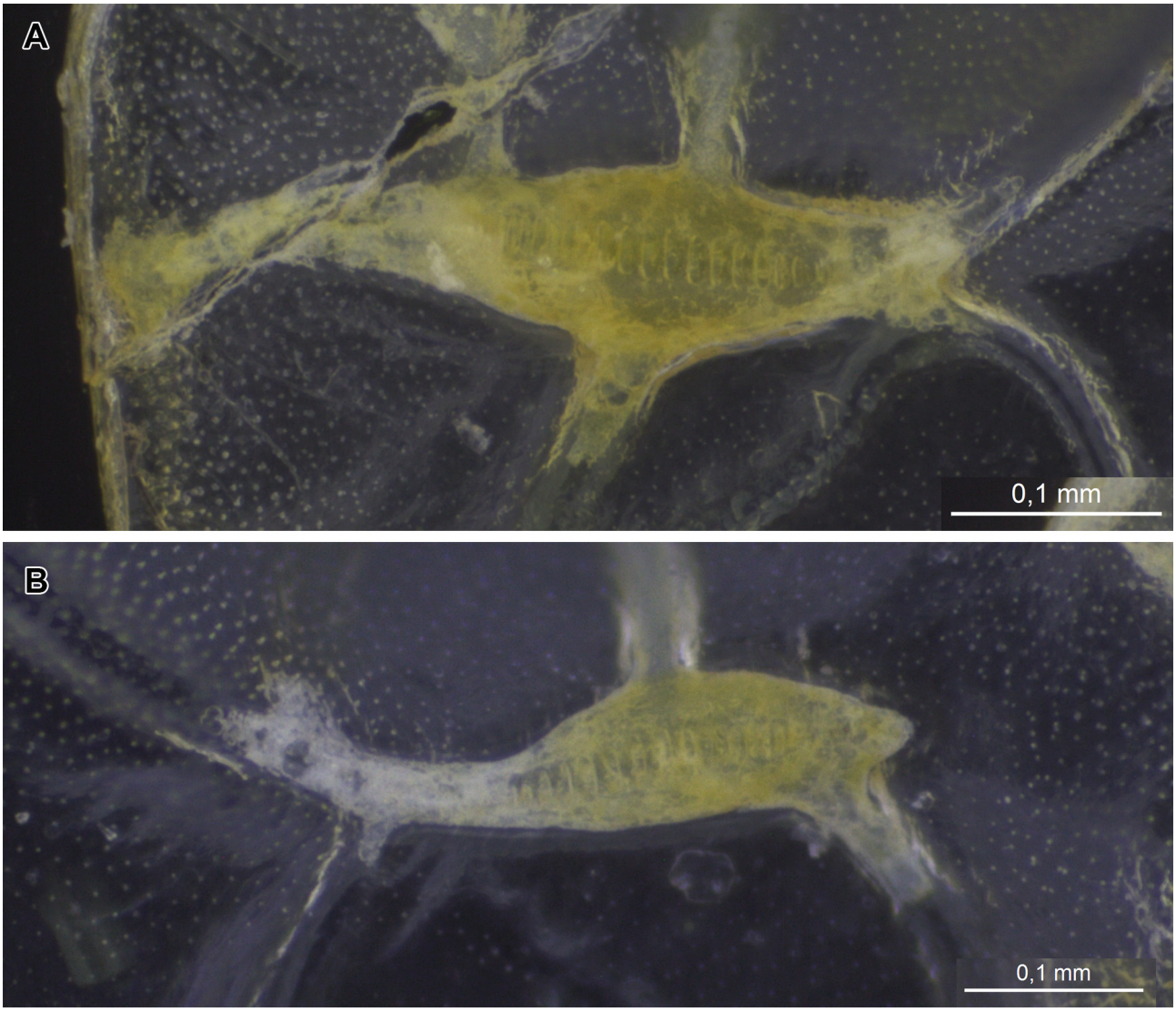


**FIGURE 3.** Stridulatory file of *Phlugis gracila*. A: left file; B: right file.

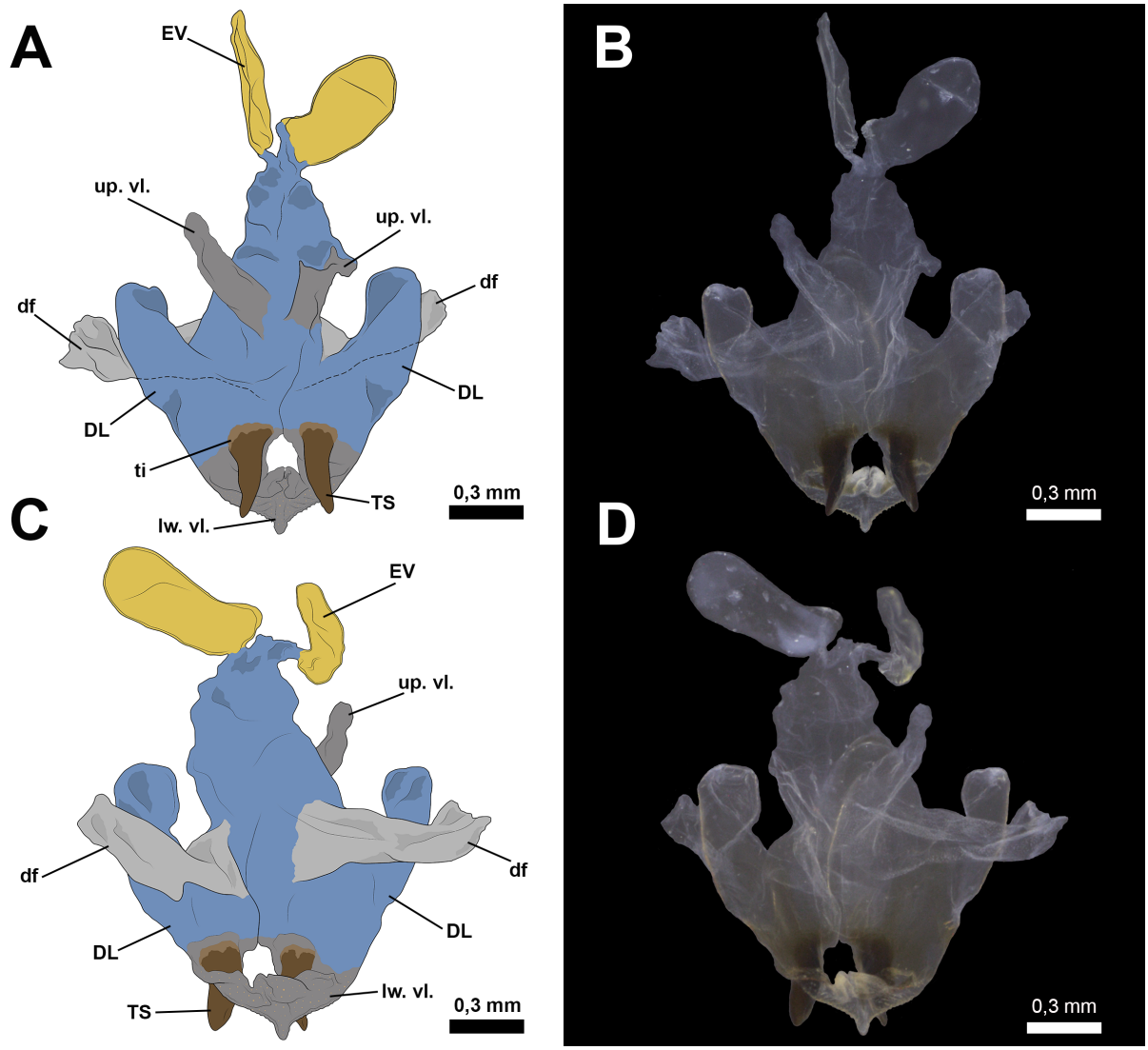


**FIGURE 4.** Internal genitalia of *Phlugis gracila*. A-B: phallus in ventral view; C-D: phallus in dorsal view. Abbreviations: DF: dorsal fold; DL: dorsal lobe(s); EV: ejaculatory vesicles; TI: titillator process; TS: titillator sclerite; Lw. vl.: lower folds of ventral lobe; Up. vl.: upper folds of ventral lobe.

*Coloration.* Color described based on photos of living specimens (Fig. 6A–B). Body light green with some dark-green areas. Antennae light green with the intersection between antennomeres brown spotted. Eyes anteriorly light green, medially yellow with an orange dorsal spot and posteriorly dark-green. Dorsal region of the gena with yellow spot behind the eyes. Pronotum dorsally with two yellow bands which are connected with the spots of the gena and follows parallel to the tegmen base. Tegmen when closed with yellow stripe on dorsal margin and anteriorly overlapped by a small brown stripe. Legs, cerci and subgenital plate light green.

**Female.** *General*. Morphology essentially equal to male (Fig. 5A–K), except for the following characteristics:

*Head*. Head apex straight and without projections (Fig. 5B). Compound eyes elliptical (Fig. 5B–D). Frons, clypeus and labrum smooth, with medial height of the frons 1.5 times higher than medial height of the clypeus (Fig. 5B).

*Thorax*. Pronotum dorsally straight, with posterior portion of pronotal disc slightly elevated in lateral view (Fig. 5D). Dorsal carinae curved towards the lateral margins of pronotum in dorsal view (Fig. 5C). Posterior portion of pronotal disc anteriorly bilobed and posteriorly concave in dorsal view (Fig. 5C). Lateral lobes smooth, with ventral anteromedial margin concave and posteriorly straight in lateral view (Fig. 5D). Maximum height of the lateral lobe less than 2 times than dorsal length of pronotum (Fig. 5D). Mesobasisternum trapezoidal shaped, posteriorly with triangular concavity (Fig. 5F). Metabasisternum diamond shaped, medially with small triangular concavity (Fig. 5F).

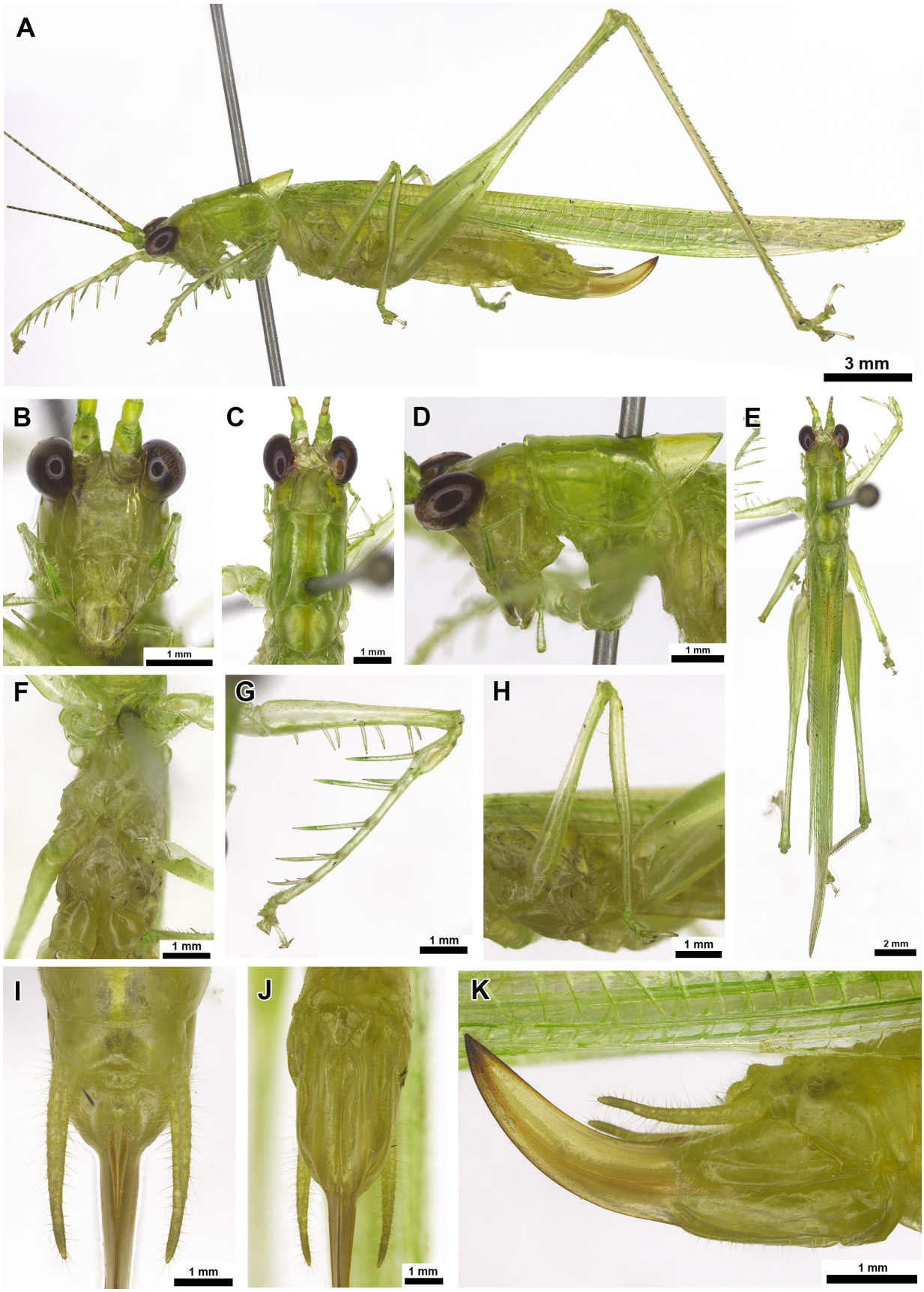


**FIGURE 5.** Female of *Phlugis gracila*. A: *habitus* in lateral view; B: head in frontal view; C: Pronotum in lateral view; D: Thoracic sternites in ventral view; E: Body in dorsal view; F: Foreleg in lateral view; G: Middle leg in lateral view; H: Hind leg in lateral view; I–K: Terminalia in dorsal, ventral and lateral view, respectively.

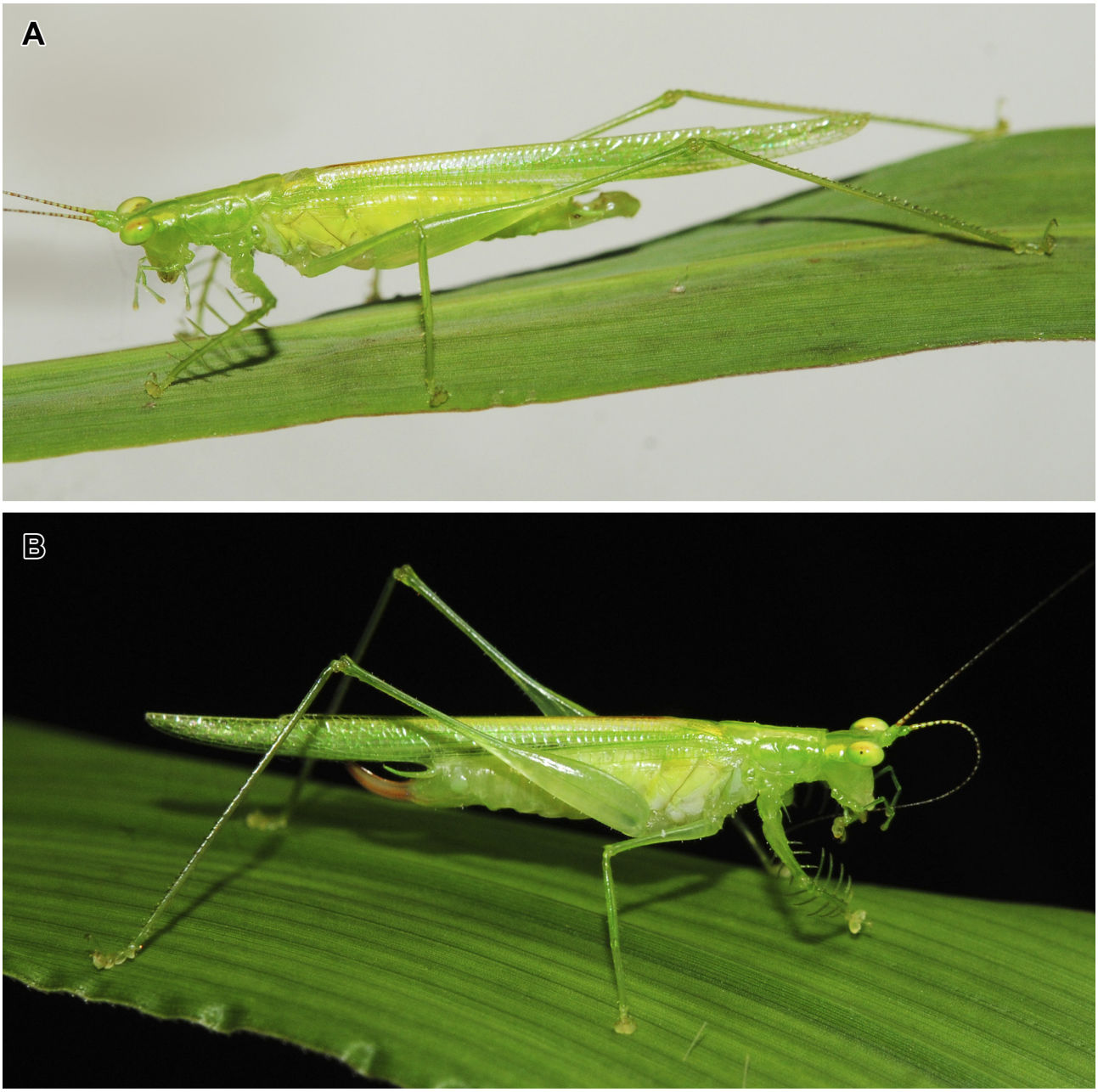


**FIGURE 6**. Living examples of *Phlugis gracila*. A: adult male; B: adult female.

*Abdomen*. Cerci slightly curved, conical, distally acuminate and with the apex reaching the medial portion of the ovipositor (Fig. 5I–K). Subgenital plate triangular and lacking stiles (Fig. 5J). Ovipositor slightly curved, with base expanded and progressively narrowing to distal region, ending in an acuminated apex (Fig. 5K). Distal region of ovipositor with small teeth, larger teeth on ventral valve (Fig. 5 K).

**Measurements (mm).** TL: male 15.1–16 / female 17.7–18.1; TegL: male 20.8–19.8 / female 20.5–21.2; TegH: male 1.9–2.3 / female 2–2.1; WF: male 1.6–1.7 / female 1.9–2; PL: male 4.2–5 / female 3.7–3.9; FF: male 4.2–5.2 / female 3.8–4.3; FT: male 5.4–6 / female 5.5–5.6; MF: male 4.7–5.6 / female 4.8–5.5: MT: male 5,2–6.1 / female 5.7–5.9; HF: male 11.8–11.9 / female 12.2–12.7; HT: male 11.8–12.3 / female 12.4–12.6; Lplac: male 3.6–3.7 / female 1.4–1.6; LC: male 2.6–2.7 / female 2–2.3; OL: 4.6–4.8.

**Natural history notes.** The collecting was made in Amazonian floodplain forests, also known as *várzeas*, during flooding period, when the water of the rivers and tributaries spreads to the forest. In that habitat occurs great proliferation of various species of floating aquatic macrophytes, mainly some Poaceae (grasses) (Fig. 7A). Specimens of *P. gracila* were found associated to *Echinochloa polystachya* (Poaceae) (Fig. 7B).


**FIGURE 7**. Environments used by *Phlugis gracila*. A: Caburini Lake, Amazonas, Brazil; B: Grouping of Canaranas (*Echinochloa polystachya*).

## Discussion

Nickle (2003) originally described *P. gracila* based on a single male specimen collected in Amazonian rainforest at the margins of Amazon River, in Peru, by fogging the canopy (Fig. 8A). The collecting was done in July 1987, in the beginning of the dry season of Amazon River and its tributaries, which occurs between July and December (Bittencourt *et al*. 2007). Comparatively, in this study, we collected the specimens on floating macrophytes between February and April 2017 (Fig. 8B), during the rainy season, which occurs from January to June (Bittencourt *et al*. 2007).

The different environments in which *P. gracila* was collected, in Peru and Brazil, may be related to the rainfall season of the Amazon. We hypothesize that during the dry season these katydids live in the canopy, but during the rainy season, the proliferation of macrophytes become a microhabitat with great supply of food, due to the microfauna associated with these plants. Therefore, *P. gracila* may perform a vertical migration seasonally for feeding, alternating from the canopy in dry season to the macrophytes in rainfall season.

Another behavior observed was the preference of *P. gracila* for banks of *E. polystachya*, a species of large

macrophyte, common in floodplains of Central Amazon (Piedade *et al*. 1997). We also searched for specimens of *P. gracila* on other macrophytes, including *Paspallum repens*, a small grass and one of the most common in Amazon floodplains (Junk & Howard-Williams, 1984). There we found specimens of *Phlugis teres* (De Geer, 1773) and *Phlugis* sp. It is possible that differences in the macrophytes morphology are important for these insects, since the larger size of *P. gracila* compared with the other species of *Phlugis* correlates with a choice for a larger macrophyte as *E. polystacha*.

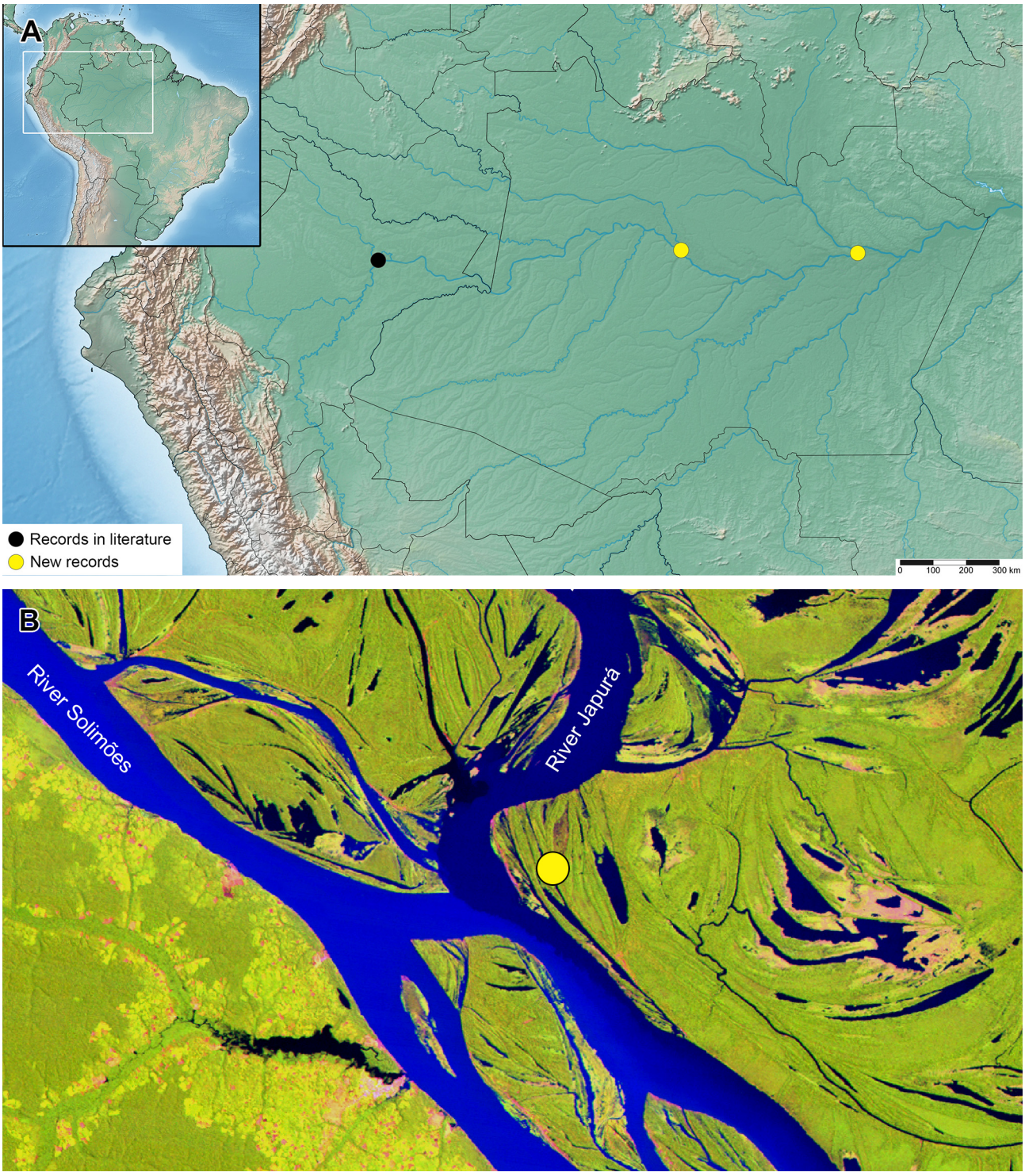


**FIGURE 8**. Geographical records of *Phlugis gracila*. A. Known geographical distribution. B. Seasonally flooded white-water forest area where *P. gracila* was collected, in Alvarães municipality, Amazonas, Brazil.

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## References

Bittencourt, M.M. & Amadio, S.A. (2007) Proposta para identificação rápida dos períodos hidrológicos em áreas de várzea do rio Solimões-Amazonas nas proximidades de Manaus. *Acta Amazonica*, 37 (2), 303–308. https://doi.org/10.1590/S0044-59672007000200019

Chamorro-Regifo, J. & Lopes-Andrade, C. (2014). The phallus in Tettigoniidae (Insecta: Orthoptera: Ensifera): revision of morphology and terminology, and discussion on its taxonomic importance and evolution. *Zootaxa*, 3815 (2), 151–199. http://dx.doi.org/10.11646/zootaxa.3815.2.1

Eades, D.C., Otte, D., Cigliano, M.M. & Braun, H. (2016) Orthoptera Species File. Version 5.0/5.0. Available from: http://Orthoptera.SpeciesFile.org (accessed 5 June 2017)

De Geer, C. (1773) *Memoires Pour Servir A L'Histoire Des Insectes: Tome Troisieme*. Pierre Hesselberg, Stockholm, 458 pp.

Eichler, W. (1938) Lebensraum und Lebensgeschichte der Dahlemer Palmenhausheuschrecke *Phlugiola dahlemica nov. spec.* (Orthopt. Tettigoniid.).(Studien zur deutschen Gewächshausfauna 1). *In*: *Inaugural-Dissertation der mathematisch-naturwissenschaftlichen Fakultät der Universität Berlin*, 1938, pp. 1–201.

Junk, W.J. & Howard-Williams, C. (1984) Ecology of aquatic macrophytes in Amazonia. *In*: Sioli, H. (Eds.), *The Amazon*. Springer, Dordrecht, pp. 269–293. https://doi.org/10.1007/978-94-009-6542-3_10

Karny, H.H. (1924) Beiträge zur Malayischen Orthopterenfauna VII. Prodromus der Malayischen Meconeminen. *Treubia*, 5, 105–136.

Nickle, D.A. (2003) New neotropical species of the genus *Phlugis* (Orthoptera: Tettigoniidae: Meconematinae). *Journal of Orthoptera Research*, 12 (1), 37–56. http://dx.doi.org/10.1665/1082-6467(2003)012[0037:NNSOTG]2.0.CO;2

Piedade, M.F., Junk, W.J. & Long, S.P. (1997) Nutrient dynamics of the highly productive C4 macrophyte *Echinochloa polystachya* on the Amazon floodplain. *Functional Ecology*, 11 (1), 60–65. https://doi.org/10.1046/j.1365-2435.1997.00066.x

Stål, C. (1861) *Zoology i. Insecta*. *In*: *Konliga Svenska Fregatten Eugenies resa omkring jorden under befall af CA Virgin aren 1851-1853*. Almqvist & Wiksells, Uppsala, pp. 299–350.