



**NEW CICADA SPECIES OF THE GENUS *GUYALNA*
(HEMIPTERA: CICADIDAE) FROM BRAZIL**

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Abstract – During the XXIV International BioAcoustic Congress (IBAC) in Pirenópolis, Brazil, two of us (MG and KŠ) found, recorded sounds and collected small cicadas, belonging to the genus *Guyalna* (Cicadidae, Fidicinini). After a comparison with other taxa of this genus, it is evident that we found a new species, which we are describing and naming *Guyalna nadae* sp. nova.

KEY WORDS: Fidicinini, Guyalnina, new species, Neotropics, Acoustics.

Izveleček – NOVA VRSTA ŠKRŽADA IZ RODU *GUYALNA* (HEMIPTERA: CICADIDAE) IZ BRAZILIJE

Dva izmed avtorjev (MG in KŠ) sva se udeležila Mednarodnega bioakustičnega kongresa (XXIV. IBAC) v Pirenópolisu, Brazilija. Takrat sva posnela napeve in tudi ujela majhne škržade, ki pripadajo rodu *Guyalna* (Cicadidae, Fidicinini). Po primerjavi z drugimi vrstami tega rodu se je pokazalo, da sva našla novo vrsto, ki jo v članku opisujemo in imenujemo *Guyalna nadae* sp. nova.

KLJUČNE BESEDE: Fidicinini, Guyalnina, nova vrsta, neotropska regija, akustika.

Introduction

In September 2013 two of us (MG and KŠ) visited Pirenópolis, Brazil, to attend the XXIV International BioAcoustic Congress (IBAC). This scientific meeting was devoted to bioacoustics and, therefore, we had with us the equipment for studies in animal acoustics. During our stay we observed, recorded and collected small cicadas that were later determined to be a new species belonging to the genus *Guyalna* Boulard & Martinelli 1996.

During the process of reviewing the original manuscript it turned out that one of the reviewers has additional material (specimens, sound recordings) about this new species, therefore we invited him (D.H.B. Maccagnan) to be coauthor of this paper.

Material and Methods

The exact locality, where we found these cicadas, is the hotel Pousada dos Pireneus, Pirenópolis, State of Goiás, Brazil. The geographic coordinates of the type locality are 15° 50.6'S, 48° 57.5'W. The type series consists of 2 females and one male of this species collected in this location. However, recently it turned out that additional material of this species exists in the collection of the Universidade Estadual de Goiás, Câmpus Iporá, which is reported below as additional material after the type series.

For acoustic recording we used an ultrasonic detector Pettersson D-200 (heterodyne system) with a Pettersson electret microphone (frequency range 10–120 kHz), mounted in a Renault R-4 front light reflector and connected to the solid state recorder Zoom H2 (sampling rate up to 96 kHz). Recordings of D.H.B. Maccagnan (see appendix) were made with a recorder Marantz PMD-660 or PMD-670 and a microphone Sennheiser ME66/K6.

For sound analyses we used Amadeus Pro 2.0 (HairerSoft), Raven 1.4 (Cornell) and Seewave package (Sueur et al. 2008) as a part of R software platform (R Development Core Team 2008) on a MacBook Pro computer. We first localized cicadas acoustically and then collected them with an entomological net.

Morphological investigations were made on dry prepared specimens. However, for the detailed analysis of a male genital capsule we pulled it out and isolated it after KOH treatment. The photographs of genitalia and some other structures were made with the multifocus system Leitz at the laboratory of the Jovan Hadži Institute of Biology (Scientific Research Centre of the Slovenian Academy of Sciences and Arts).

Morphological terminology follows Moulds (2005). Measurements were taken using Screen Ruler 4.1 with the photographs of the specimens and/or with the calibrated ocular micrometer in the WILD MZ8 stereo microscope. The type material is deposited in the collection of the Slovenian Museum of Natural History (PMSL). Song recordings are deposited in the Slovenian Wildlife Sound Archive of the same museum.

Results

Guyalna nadae sp. nova

Etymology

The species is dedicated to Prof. Nada Gogala, the wife of one of the authors (MG) and the grandmother of another (KŠ), who also took part in the field investigations in Pirenópolis, Brazil and sadly passed away just a couple of month later after returning home to Slovenia.

Morphology

The following material is available: Brazil, Goiás, Pirenópolis, 15° 50.6'S, 48° 57.5'W, 10. 9. 2013, K. Šporar, M. Gogala leg. (Holotype ♂, 2♀ paratypes).

Additional material: Brazil, Goiás, Iporá (Morro do Macaco), 30. 7. 2011, D.H.B. Maccagnan leg. (1♀) (CE-UEG 224). Brazil, Goiás, Iporá, 29.9.2011, D.H.B. Maccagnan leg. (4♂) (CE-UEG 225-228). Brazil, Goiás, Iporá, 16° 24.73'S, 51° 10.44'W, 14. 9. 2015, D.H.B. Maccagnan leg. (10♂, 2♀) (CE-UEG 234-244 and 253). Brazil, Goiás, Iporá, 16° 24.73'S, 51° 10.44'W, 27. 8. 2015, D.H.B. Maccagnan leg. (5♂, 3♀) (CE-UEG 245-252). Brazil, Goiás, Diorama, 21. 8. 2013, D.H.B. Maccagnan leg. (4♀) (CE-UEG 229-232). Brazil, Goiás, Diorama, 16° 14.85'S, 51° 16.93', Cerrado Stricto Sensu, Ligth Trap, 20. 9. 2013, D.H.B. Maccagnan leg. (1♀) (CE-UEG 233).

The body length of *Guyalna nadae* sp. nova is 13.5 mm in the male and 12.9 and 13.6 mm in the females (Figs. 1, 2). Measurements were made only on type material.

The ground colour of the body is dark brown to pale yellow marked with black.

The **head** is wider than mesonotum, dark brown, black transverse mark across vertex enclosing ocelli extending around medial margin of eye to black behind the eye. Dorsal head with short silvery and golden pile, longer posterior to eye. Ocelli red, eyes ochraceous. The head width is 5.9 mm for males and 5.6 – 5.8 mm for females. Width of the eyes seen from above is 1.4 mm and the distance between the eyes 3.4 mm. Ventral head with black fascia between postclypeus and eye. The postclypeus is dark brown, centrally sulcate with transverse ridges pale yellow, a black median fascia on dorsal surface that extends along the ventral side of the postclypeus. The anteclypeus is also dark brown with the exception of the median yellow keel. Rostrum dark brown with a black tip reaching sternite III in males or the middle of sternite V in females (Fig. 6). Antennal segments black, flagellum dark brown.

The **pronotum** is trapezoidal with straight lateral part of pronotal collar, brown with ochraceous anterior margin, with black marks on either side of midline or black band along the midline (see Figs. 12, 13), anterior mark pyramidal, medial mark extending into paramedian fissure, posterior transverse mark across midline, black mark within lateral fissure encircling scute as it continues through ambient fissure, which extends laterally across lateral pronotal collar (Figs. 1, 2, 8). Width of pronotum is 5.8 (♂) and 5.5 mm (♀) and the anterior width 4.5 mm (♂) and 4.3 mm (♀). The

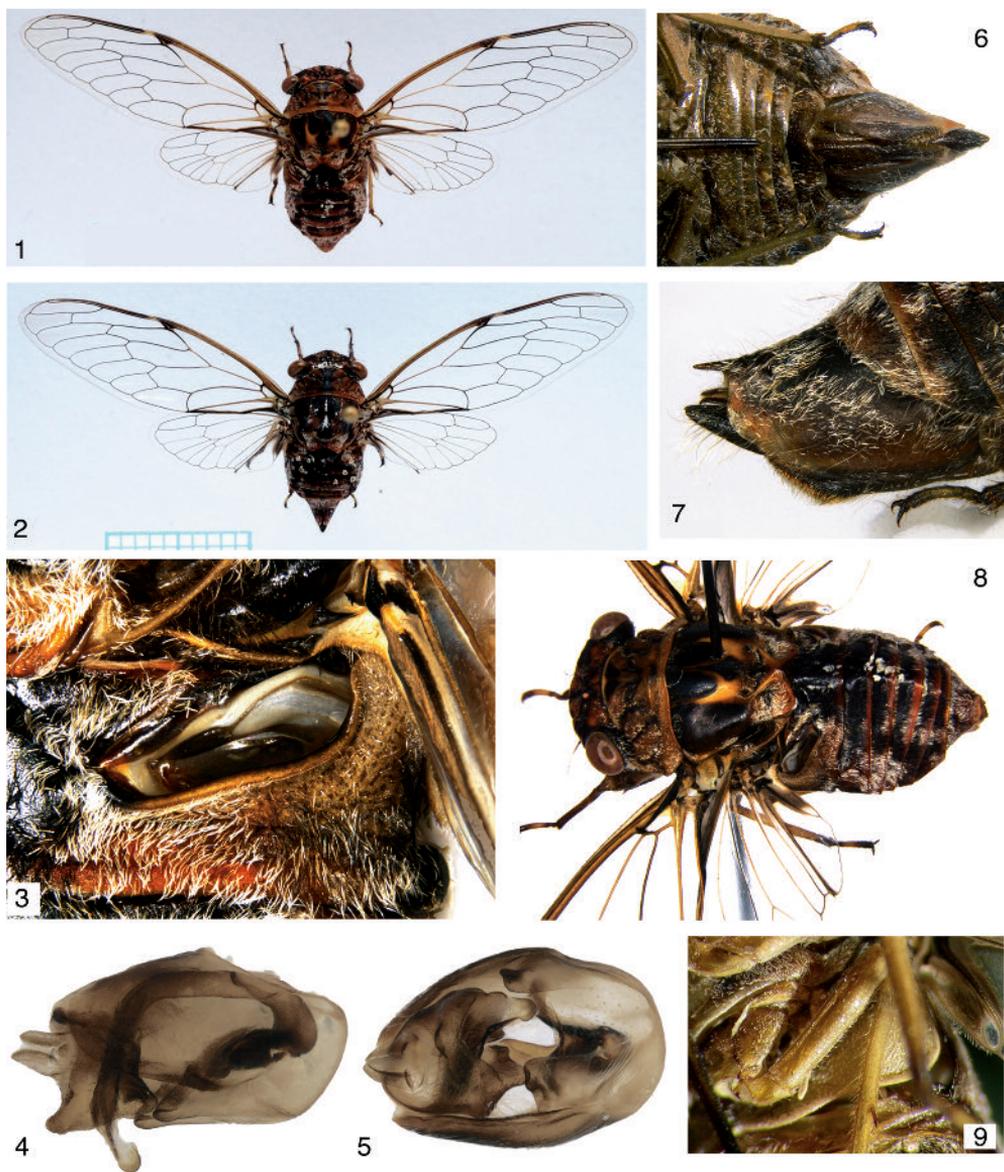
length of the pronotum is 2.2 (♂) and 2.1 (♀) mm. The **mesonotum** is dark brown with orange yellow markings between lateral and submedian sigilla (Fig. 8). This orange yellow coloration also surrounds the submedian sigilla with the exception of the brown middle deltoid field in front of the cruciform elevation and anterior half of lateral surface. Sigillae, lateral margin, and scutal depressions black. The **cruciform elevation** (scutellum) is also yellow darker on posterior with black transverse mark between anterior arms and laterally between anterior and posterior arms. Wing groove dark brown with ochraceous lateral margin. Mesonotum with short silvery pile along anterior margin and laterally, longer pile between arms of cruciform elevation and in wing groove (Fig. 8). **Metanotum** black, laterally yellow. Ventral thoracic segments dark brown with lighter margins covered with short white pubescence.

The fore **wings** (tegmina) are slender and much longer than the hind wings (Figs. 1, 2). The length of tegmina in males is 19.6 and in females 19.6 – 19.7 and the width 6.5 (♂) and 6.4 mm (♀). The length-width ratio of the tegmina is 3 (♂) and 3.1 (♀). The length of the hind wings is 9.4 mm (♂) and 9.9 mm (♀). The number of **apical cells** is 8 in the fore wings and 6 in the hind wings. Fore and hind wings hyaline, venation black except ochraceous costal margin, proximal median vein almost to node, proximal median vein 3+4, proximal cubitus anterior, proximal cubitus posterior+anal vein 1, and spot on costal margin just distal to node. Cubitus anterior curving forming arched cubital cell. Hind wing venation similarly colored. Basal membranes grayish black.

The **legs** are pale yellow, coxae and femora darker, tawny around the tibio-tarsal joints and distal tarsus and do not differ in the sexes. Fore femora with three spines, ochraceous primary spine angled, ochraceous secondary spine largest and upright with small, black, upright tertiary spine. Pretarsal claws tawny with setiform parempodia. Legs with short white pile, tibial spurs and tibial combs castaneous.

Operculum yellow, in the form of right triangle with rounded posterolateral angles, with sinuate posterior margin, barely covering tympanal cavity, covered with short white pubescence (Fig. 9). Medial margin rounded not reaching midline. **Meracanthus** is yellow, more or less triangular, very long in females, with outer lateral edges folded ventrally (Fig. 9). The female operculum reaches medially only to meracanthus. Basal part black.

Timbal has a large timbal plate with 2 long ribs and is partly covered by the timbal cover (Fig. 3). Tergites of the **abdomen** are black with the posterior margins castaneous. Tergites covered with long silvery and black pile, silvery pile more dense laterally and posteriorly, golden pile centrally especially on the anterior tergites. Black pile forms an arch on dorsum. Timbal cover tawny, incomplete exposing timbal dorsally, anterior margin curled posteriorly, straight to anterior extension, black along anterior margin of timbal cavity, anterior apex semicircular, ventral margin slightly angled ventrally. Abdominal sternites are more or less brown to yellow covered with short white and also golden pile. Sternites and epipleurites are anteriorly darker. Sternite VIII in males much shorter (0.6x) than sternite VII. The structure of the female genitalia is seen in Figs 6 and 7. Female sternite VII with single medial notch, posterior margin straight, angled to curved lateral posterior margins. Female abdominal segment



Figs 1-9: 1 - *Guyalna nadae* sp. nova habitus male; 2 - *Guyalna nadae* sp. nova habitus female, same scale; 3 - right timbal with timbal cover; 4 - male genital segment, treated with KOH, lateral view; 5 - idem, ventral view; 6 - female ventrum with terminalia and tip of the rostrum; 7 - idem, lateral view; 8 - latero-dorsal view of the male holotype; 9 - male, sternum with the left operculum and meracanthus. Figures 3 - 8 made with the Leitz multifocus system.

9 black dorsally and along ventral medial margins, dark brown laterally, ochraceous posteriorly, covered with long silvery pile, dense golden pile on posteroventral margin. Dorsal beak extending just beyond black anal styles. Posterior margin of abdominal segment 9 sinuate.

The **male genital segment** is shown in Figs 4 and 5. Pygofer black with rounded distal shoulder, dorsal beak absent. Pygofer upper lobe flattened against pygofer, pygofer basal lobe flattened with straight apex. Median uncus lobes short, recurved dorsally and rounded at terminus. Lateral uncus lobes curving under median uncus lobes, lateral margin curving away from median uncus lobe, posterior margin with curved extension under median uncus lobe, medial margins angled toward midline. Aedeagus strongly curved with a long basal plate attached at the lower lobe of the pygofer.

Female gonocoxite IX dark brown. Gonapophysis IX and X black. Ovipositor sheath extends beyond dorsal beak. Dorsal beak extending just beyond anal styles. Long golden pile on ovipositor sheath.

Acoustics

We were able to record two types of song produced by *G. nadae* sp. nova, the calling song and the courtship song. The calling song is a simple repetition of long echemes with a repetition rate of 1.6 s^{-1} (Table 1, Fig. 10). The duration of echemes is 535 ± 70 ms (mean \pm st.dev.) and the interecheme interval is 79 ± 18 ms (N=214). The courtship song we were able to record just once and therefore the number of the measured echemes is much smaller (N=39) (Table 2). The duration of echemes during the courtship song was much shorter, 72 ± 15 ms and the interecheme intervals 307 ± 154 ms but the repetition rate was slowly changing (average: 2.6 s^{-1} , Fig. 11).

Table 1. *Guyalna nadae* sp. nova, calling song temporal characteristics - see sonagram Fig. 10.

	echeme duration (ms)	Interval (ms)	ratio dur/int	Period	rep. rate (s^{-1})
AVERAGE	535	79	6.807	0.613	1.631
STDEVA	70	18			
MEDIAN	542	81			
QUART 1	511	74			
QUART 3	577	87			
COUNT	214	213			

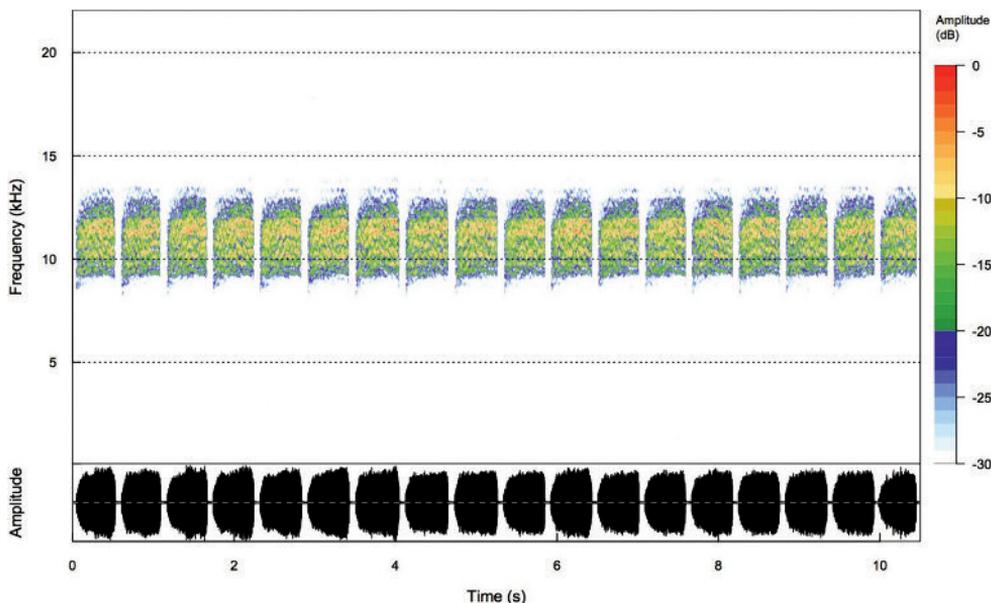


Fig. 10. *Guyalna nadae* sp. nova, oscillogram and spectrogram (above) of the calling song selection (made by Seewave package in R platform: wl = 512, wn = “hanning”).

Table 2. *Guyalna nadae* sp. nova, courtship song temporal characteristics - see sonagram Fig. 11.

	echeme duration (ms)	Interval (ms)	ratio dur/int	Period	rep. rate (s ⁻¹)
AVERAGE	72	307	0.235	0.379	2.640
STDEVA	15	154			
MEDIAN	72	251			
QUART 1	65	188			
QUART 3	77	407			
COUNT	39	39			

Frequency spectrum of the calling song has the maximum at 11 kHz, 5% and 95% frequencies at 9.4 and 12.4 kHz (measured with special routine in Raven software). The courtship song has these values slightly shifted to lower frequencies (10, 8.8 and 11.7 kHz).

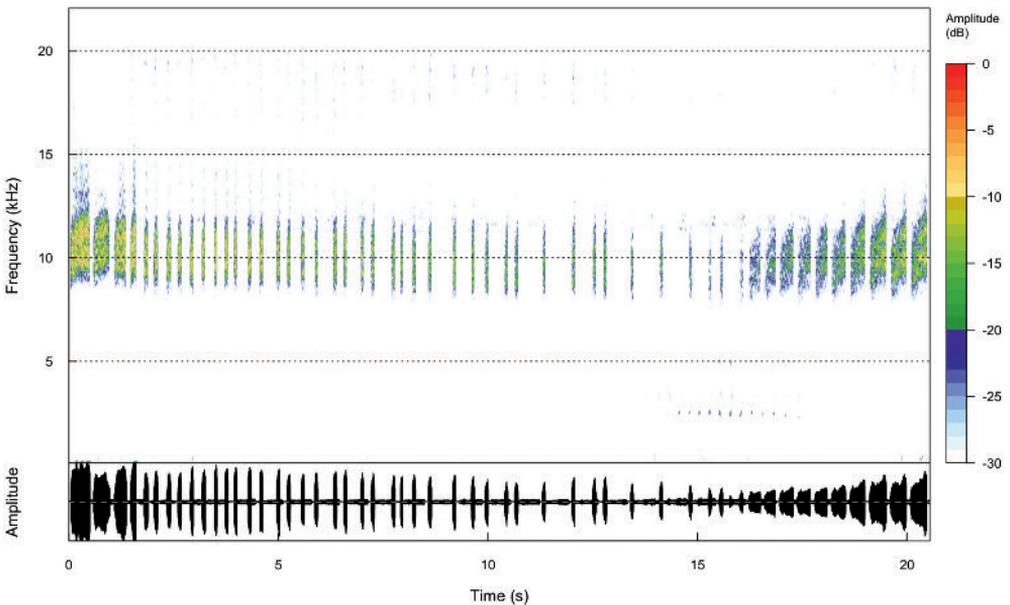


Fig. 11. *Guyalna nadae* sp. nova, oscillogram and spectrogram (above) of the courtship song with transitions from and toward a normal calling song (made by Seewave package in R platform, for details see Fig. 10).

Ecology

We found the first specimens near the hotel Pousada dos Pireneus on a small tree (Fig. 12) near the soccer field. One of the authors (DHBM) found this species in the municipality of Iporá and Diorama (about 300 kilometres from Pirenópolis) with high abundance in the urban areas and beside highways. Its distribution is probably bound to the open spaces of biome Cerrado, Brazilian Savanna, a hotspot of biodiversity (Myers et al. 2000) surrounding Pirenópolis and the Iporá region. The occurrence of the adults of *Guyalna nadae* is from August until the beginning of October at the end of a dry season (with relative humidity about 25% and temperatures reaching over 30°C). Between September and October begins in the same area the emergence of several other species of cicadas (e.g. *G. cuta*, *G. platyrhina*, *Fidicinoides pronoe* (Walker 1850), different species of *Ariasa* spp. and *Dorisiana* sp.). They are all singing at the same time. In general, you can find *G. nadae* also singing in chorus with a synchronization on the echeme production.

Discussion

This new species belongs with certainty to the genus *Guyalna*, described by Boulard & Martinelli (1996). For this statement speaks clearly its habitus with relatively long front wings and short body, the shape of a timbal cover, pronotum



Fig. 12. Female *Guyalna nadae* sp. nova, sitting and about to start feeding on a tree.

clearly shorter than mesonotum, head slightly wider than mesonotum, three segmented tarsi and the shape of male genitalia.

Currently the following species of this genus were described (Boulard 1998, 1999, Boulard & Martinelli 2011, Sanborn & Heath 2014) or transferred (Boulard & Martinelli 1996, Boulard 1999, Boulard & Martinelli 2011) from other genera of Fidicinini (Sanborn 2013): *Guyalna bonaerensis* (Berg 1879), *G. cuta* (Walker 1850), *G. chlorogena* (Walker 1850), *G. rufapicalis* Boulard 1998, *G. nigra* Boulard 1999, *G. atalapa* Boulard & Martinelli 2011, *G. bleuzeni* Boulard & Martinelli 2011, *G. densusa* Boulard & Martinelli 2011, *G. jauffreti* Boulard & Martinelli 2011, and *G. platyrhina* Sanborn & Heath 2014. Compared to all these species, *Guyalna nadae* sp. nova is the smallest (Table 3).

Table 3. Body dimensions of all currently known species of *Guyalna*

Species	Body length [mm]	Fore wing length [mm]
<i>G. bonaerensis</i>	32 – 36	40 – 43
<i>G. atalapae</i>	32	41
<i>G. chlorogena</i>	31.8	43
<i>G. rufapicalis</i>	26	35
<i>G. densusa</i>	25	35 – 37
<i>G. jauffreti</i>	24.3	28 – 28.5
<i>G. bleuzeni</i>	23.1	33
<i>G. nigra</i>	22	29
<i>G. cuta</i>	16.9	24-25
<i>G. platyrhina</i>	13.5-17.3	18.9-24.1
<i>G. nadae</i> sp. nova	12.9 – 13.6	19.2 – 20.1

The closest species in body size are *G. cuta* and *G. platyrhina*. The new species can be distinguished from *G. platyrhina* by the more extensive black coloration particularly on the thorax and arching pattern of the abdomen, the median terminus of the lateral uncus lobes are longer and the medial notch on sternite VII of the female has straight margins toward the central curve in the new species rather than being semicircular. Compared to *G. cuta*, the notch in sternite VII of the female has a straight posterior margin extending from the notch rather than the arching posterior margin found in *G. cuta*, the female meracanthus is folded dorsally on the lateral margins, and the median uncus lobes lack the narrow dorsal extension found in *G. cuta* and the lateral uncus lobes are not recurved and possess a curved extension along their posterior margin in the new species that is lacking in *G. cuta*. In addition, *G. cuta* and *G. nadae* sp. nova are easily distinguished by their songs. The calling song of *G. cuta* is continuous (Boulard 1999) in contrast to *G. nadae* sp. nova. *Guyalna atalapae* has a distinct coloration of the wings clearly different to other members of the genus. The body coloration of the new species is similar to the *G. densusa* and *G. bleuzeni* but the body size of these species is almost two times larger (see Table 3). The published characteristics of the song of the *G. nigra* are similar, but again clearly different from the calling song of *G. nadae* sp. nova. The repetition rate of *G. nigra* is about 3.4 s^{-1} and 1.6 s^{-1} for *G. nadae* sp. nova. Also different is the ratio between the echeme duration and the interecheme interval.

Sanborn (submitted) has also described two new species and transferred *Dorisiana bicolor* (Olivier 1790), *Diceroprocta sublaqueatus* (Uhler 1903) and *Fidicina parvula* Jacobi 1904 to *Guyalna*. The two new species and *D. bicolor* have body lengths greater than 20 mm. *Diceroprocta sublaqueatus* has a body length about 16.5 mm but is black with a primarily brown pronotum and brown posterior abdominal segments. *Fidicina*

parvula is also small (body size about 14 mm) but is greenish with light black markings on the anterior of the mesothorax and a strongly bent costal margin so that these species can also be easily distinguished from the new species described here.

Conclusion

The morphological characters of these specimens are very typical for the genus *Guyalna* as established by Boulard and Martinelli (1996). However, the morphology and the song analysis support the description of a new species for our cicadas. Therefore we name this species ***Guyalna nadae* sp. nova.**

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Appendix

Additional data provided by D.H.B. Maccagnan

Additional recordings of the calling song of *G. nadae* are deposited in the collection DHBM:

Localities, dates and file numbers: Brazil, Goiás, Iporá, Área urbana, 31. 8. 2011: SC-DHBM 01-03, 7. 9. 2011: SC-DHBM 04, 11. 9. 2011: SC-DHBM 05-09, and Brazil, Goiás, Iporá, GO 060, 23. 9. 2011: SC-DHBM 41-44, 21. 9. 2015: SC-DHBM 201, 210-212, 14. 9. 2015: SC-DHBM 175, 179.



Fig. 13. A male specimen of *Guyalna nadae* sp. nova from the Iporá collection (CE_UEG 251).