

Is it a bird, is it a frog or a bush cricket? On an enigmatic nocturnal calling song recorded at different locations in southern Bahia, Brazil

(Orthoptera, Tettigoniidae, *Paracycloptera grandifolia*)

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After more than ten years of fieldworks in southern Bahia registering an enigmatic vocalization we were finally able to identify the source of it. The calls were emitted by *Paracycloptera grandifolia*, a katydid belonging to the Tettigoniidae. Its call lasts between 0.5–1.3 seconds and consists of 7–8 groups of pulses. The dominant frequency lies at 3 kHz.

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Introduction

The sounds emitted by animals have several different functions in various contexts of intra- and interspecific interactions. These could serve to attract partners, to aid in spatial orientation, to defend territories (Chamorro-Rengifo et al. 2007) and to alert and/or scare predators (Obrist et al. 2010).

Vocalizations are deemed to be reliable characters to allow identification, diagnose and define bird (Payne 1986, Isler et al. 1998) and amphibian species (Portillo & Greenbaum 2014, Köhler et al. 2015). The number of bioacoustical studies focusing on insects is far lower than those targeting amphibians and birds. However, parameters of sounds and the mechanisms of its production are also used to define limits between taxonomic groups (Montealegre-Z 2009, Mankin et al. 2011). Therefore, bioacoustics is widely used to identify species and is a recommended tool in biodiversity monitoring and/or fauna inventories (Obrist et al. 2010).

Results

During fieldwork undertaken over the last ten years targeting amphibian inventories at different areas in the Atlantic Forest (municipalities: Almadina, Amargosa, Arataca, Barro Preto, Camacan, Guaratinga, Igrapiúna, Ilhéus, Itamaraju, Itarantim, Potiraguá and Wenceslau Guimarães) in Southern Bahia in Brazil, our team registered an enigmatic vocalization. The sound echoed loudly inside forests, reminding the whistle of a traffic police officer. The sound was emitted always from the same locations in the canopy, and most of the time we had the feeling that the vocalization were coming from inside big bromeliads. These characteristics led us to consider that the sound could be emitted by an amphibian belonging to the genus *Phyllodytes* Wagler (Hyllidae). The genus *Phyllodytes* comprises eleven described species; six of them can be found in southern Bahia (Frost 2016). This diversity is certainly underestimated given the large number of unidentified species

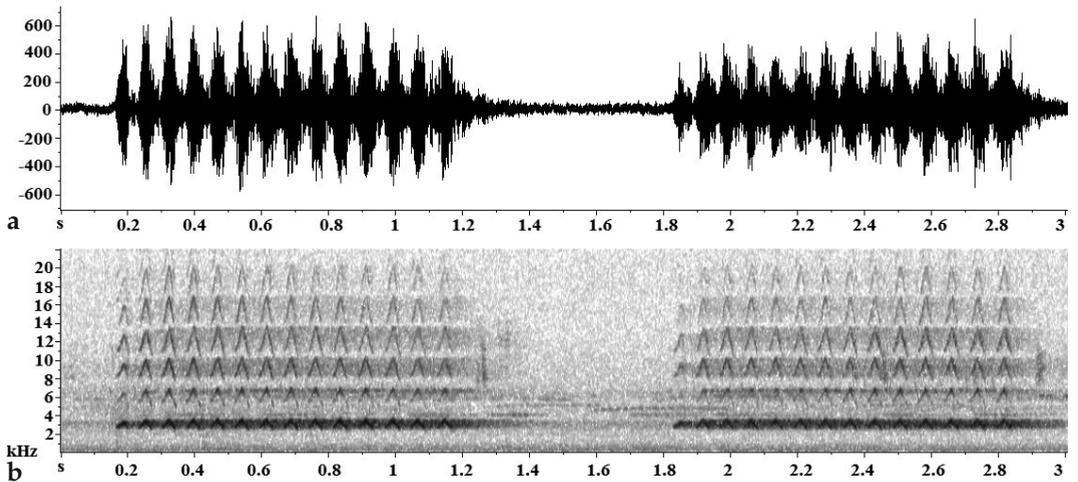


Fig. 1. Song of *Paracycloptera grandifolia* from Serra da Jibóia (recorded on 2 March 2015, around 1:00 a.m., 21.9 °C). **a.** Oscillogram and **b.** audiospectrogram of two calls.

belonging to this genus which were mentioned in inventories published recently from the region (Dias et al. 2014a,b). The species belonging to this genus use bromeliads during all their life cycles (Peixoto 1995). While this peculiar behavior may be a facilitator to locate species inhabiting soil bromeliads as *Phyllodytes luteolus* (Wied-Neuwied), it mostly hampers detectability as most species use arboreal bromeliads located at more than five meter height (Caramaschi et al. 2004).

During our several frustrated attempts to capture the animals which were producing those sounds, we noted that the individuals did not change the place where they were, not even with the noise done by our team, neither during the attempts to climb the tree to bring the bromeliad down. Most of the time, the sound continued being emitted from the same place. Therefore we discarded the hypothesis that the source of the sound could be a bird, which probably would have taken flight due to the disturbance caused by us.

We still considered two other options: It could be an enormous insect able to emit very loud

stridulations, or a frog belonging to a species with an undescribed advertisement call or even an undescribed species. One of the facts that led our team to suppose that we could be dealing with an amphibian was the spectral characteristics of the sound, which were recorded in two populations (Uruçuca and Santa Teresinha) with a Sennheiser ME45 microphone and a Marantz PMD 660 recorder and a Tascam DR-1 recorder. The recordings were analyzed using the software Raven Pro 1.4. The call ($n=40$) lasts between 0.5–1.3 seconds and consists of 7–18 (12 ± 4.1) groups of pulses and most of the times 2 to 4 (1–11) repetitions are emitted in sequence. The interval between calls emitted in a series is 0.462–1.034 s (0.673 ± 0.17). The dominant frequency is of about 3 kHz (2.62–3.27 kHz) (Fig. 1; Table 1). Most frequencies emitted by insects are higher and start at about 5 kHz (Montealegre-Z 2009).

Each group of pulses is frequency modulated, with an upward trend in the beginning and a downward trend at the end, thus forming a series of inverted “V”s in the sonogram (Fig. 1), which are not common in amphibian calls. Six harmonic

Table 1. Acoustic parameters of the song of *Paracycloptera grandifolia* from two localities (Uruçuca and Serra da Jibóia) both in Bahia state, Brazil. Recordings are available on Orthoptera Species File Online (Eades et al. 2016). Mean \pm standard-deviation and range in parentheses.

Call parameters	Serra da Jibóia (n=20)	Uruçuca (n=20)
Duration (s)	1.11 \pm 0.14 (0.84–1.29)	0.56 \pm 0.03 (0.497–0.622)
Dominant frequency (kHz)	3.2 \pm 0.1 (2.7–3.2)	2.9 \pm 0.1 (2.6–3.0)
Group of pulses	15.75 \pm 2.1 (12–18)	8.25 \pm 0.6 (7–10)
Date and temperature	2 March 2015, 21.9 °C	26 March 2009, 24.3 °C



Fig. 2. Two individuals of *Paracycloptera grandifolia* found at night in a shrub just in front of a research station in Serra da Jibóia. a. Lateral view and b. dorsal view.

bands could be discerned. However, these structures only became evident in recordings made nearer the individuals. This was only possible in Serra da Jibóia and Santa Terezinha. At the other locations the individuals only called at the canopy and this interfered negatively in the quality of the recordings.

Finally, after roughly a decade of frustrated attempts and much speculation, during fieldwork at the Serra da Jibóia at the municipalities of Santa Teresinha and Elísio Medrado in Bahia, we found an insect emitting the same sound in a shrub just in front of a research station. The individual (Fig. 2) measured about seven centimeter, and belongs to Pterochrozinae, an exclusively Neotropical subfamily of Tettigoniidae (Orthoptera) in which are grouped leaf-like katydids. Pterochrozines are very diverse in the Brazilian Atlantic Forest and inhabit well preserved forest fragments, but unfortunately this group of katydids is understudied (JCH personal observations). The specimen was identified as *Paracycloptera grandifolia* (Brunner von Wattenwyl) based on a photo that was sent to the specialist in Tettigoniidae JCH. JCH had been collecting in Bahia in January of 2012 and also captured and photographed specimens of the same species. One specimen was housed at the Zoological Museum of Universidade Estadual de Santa Cruz (voucher CMSK-0001). At the same locality we registered a large abundance of these katydids and several other individuals were located in other shrubs. Males of this family attract females through sound they produce by rubbing specialized regions of the forewings (Montealegre-Z & Manson 2005). Most bioacoustics studies on species

of Tettigoniidae revealed that they produce mainly ultra-sonic sounds (66 %) and that the frequency used by the different species varies between 5 kHz and 150 kHz (Montealegre-Z 2009, Sarrias et al. 2014).

As acoustic transect sampling is a well established amphibian monitoring protocol (Rödel & Ernst 2004) our findings may aid researchers undertaking amphibian inventories in Northeastern Brazil as we provide data that may aid herpetologists to identify this species of katydid during fieldwork. Furthermore we hope to stimulate specialists of katydid bioacoustics to continue studying this species which has revealed very different characteristics compared to those reported in the literature for the group. Maybe this species could reveal insights concerning the mechanisms and evolution of acoustic communication of those insects.

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References

- Caramaschi, U., Peixoto, O. L. & Rodrigues, M. T. 2004. Revalidation and redescription of *Phyllodytes wuchereri* (Peters, 1873) (Amphibia, Anura, Hylidae). *Arquivos do Museu Nacional* 62: 185-191.
- Chamorro-Rengifo, J., Montealegre-Z, F. & González-O, R. 2007. Determinants of male spacing behaviour in *Panacanthus pallicornis* (Orthoptera: Tettigoniidae). *Ethology* 113: 1158-1172.
- Dias, I. R., Mira-Mendes, C. V. & Solé, M. 2014a. Rapid inventory of herpetofauna at the APA (Environmental Protection Area) of the Lagoa Encantada and Rio Almada, Southern Bahia, Brazil. *Herpetology Notes* 7: 627-637.
- , Medeiros, T., Nova, M. V. & Solé, M. 2014b. Amphibians of Serra Bonita, southern Bahia: a new hotspot within Brazil's Atlantic Forest hotspot. *ZooKeys* 449: 105-130.
- Eades, D. C., Otte, D., Cigliano, M. M. & Braun, H. 2016. Orthoptera Species File Online. Version 5.0/5.0. World Wide Web electronic publication. <http://Orthoptera.SpeciesFile.org> [accessed 05-June-2016].
- Frost, D. 2016. Amphibian Species of the World: an Online Reference. Version 6.0. World Wide Web electronic publication. <http://research.amnh.org/herpetology/amphibia/index.html> [accessed 26-February-2016].
- Isler, M. L., Isler, P. R. & Whitney, B. M. 1998. Use of vocalizations to establish species limits in Antbirds (Passeriformes: Thamnophilidae). *The Auk* 115: 577-590.
- Köhler, J., Glaw, F., Pabijan, M. & Vences, M. 2015. Integrative taxonomic revision of mantellid frogs of the genus *Aglyptodactylus* (Anura: Mantellidae). *Zootaxa* 4006: 401-438.
- Mankin, R. W., Hagstrum, D. W., Smith, M. T., Roda, A. L. & Kairo, M. T. K. 2011. Perspective and promise: a century of insect acoustic detection and monitoring. *American Entomologist* 57: 30-44.
- Montealegre-Z, F. 2009. Scale effects and constraints for sound production in katydids (Orthoptera: Tettigoniidae): generator morphology constrains signal parameters. *Journal of Evolutionary Biology* 22: 355-366.
- & Manson, C. A. 2005. The mechanics of sound production in *Panacanthus pallicornis* (Orthoptera: Tettigoniidae: Conocephalinae): the stridulatory motor patterns. *The Journal of Experimental Biology* 208: 1219-1237.
- Obrist, M. K., Pavan, G., Sueur, J., Riede, K., Llusia, D. & Márquez, R. 2010. Bioacoustic approaches in biodiversity inventories. Pp. 68-99 in: Eymann, J., Degreef, J., Häuser, C., Monje, J. C., Samyn, Y. & VandenSpiegel, D. (eds). *Manual on field recording techniques and protocols for all taxa biodiversity inventories*. Abc Taxa 8.
- Payne, R. B. 1986. Bird songs and avian systematics. Pp. 87-126 in: Johnston, R. J. (ed.). *Current Ornithology* 3, New York (Plenum Publishing Corporation).
- Peixoto, O. L. 1995. Associação de anuros a bromeliáceas na Mata Atlântica. *Revista da Universidade Rural do Rio de Janeiro, Série Ciências da Vida* 17: 75-83.
- Portillo, F. & Greenbaum, E. 2014. At the edge of a species boundary: a new and relatively young species of *Leptopelis* (Anura: Arthroleptidae) from the Itombwe Plateau, Democratic Republic of the Congo. *Herpetologica* 70: 100-119.
- Rödel, M.-O. & Ernst, R. 2004. Measuring and monitoring amphibian diversity in tropical forests. I. An Evaluation of methods with recommendations for standardizations. *Ecotropica* 10: 1-14.
- Sarrias, F. A., Morris, G. K., Windmill, J. F. C., Jackson, J. & Montealegre-Z, F. 2014. Shrinking wings for ultrasonic pitch production: hyperintense ultrashort-wavelength calls in a new genus of Neotropical katydids (Orthoptera: Tettigoniidae). *PLoS ONE* 9: e98708.