UNIVERSIDADE ESTADUAL DE SANTA CRUZ
PRÓ-REITORIA DE PESQUISA E PÓS-GRADUAÇÃO
PÓS-GRADUAÇÃO EM ECOLOGIA E CONSERVAÇÃO DA BIODIVERSIDADE

MAYRA CAROLINY DE OLIVEIRA SANTOS

DESVENDANDO LACUNAS DE CONHECIMENTO SOBRE BIOACÚSTICA E GIRINOS DE ESPÉCIES DO GÊNERO *DENDROPSOPHUS* (AMPHIBIA: ANURA: HYLIDAE)

ILHÉUS – BAHIA
2024

MAYRA CAROLINY DE OLIVEIRA SANTOS

DESVENDANDO LACUNAS DE CONHECIMENTO SOBRE BIOACÚSTICA E GIRINOS DE ESPÉCIES DO GÊNERO *DENDROPSOPHUS* (AMPHIBIA: ANURA: HYLIDAE)

Tese apresentada à Universidade Estadual de Santa Cruz, como parte das exigências para obtenção do título de Doutor em Ecologia e Conservação da Biodiversidade.
Área de concentração: Ecologia e Conservação da Biodiversidade
Discente: Mayra Caroliny de Oliveira Santos
Orientador: Dr. Mirco Solé

ILHÉUS -BAHIA
2024

MAYRA CAROLINY DE OLIVEIRA SANTOS

DESVENDANDO LACUNAS DE CONHECIMENTO SOBRE BIOACÚSTICA E GIRINOS DE ESPÉCIES DO GÊNERO *DENDROPSOPHUS* (AMPHIBIA: ANURA: HYLIDAE)

Tese apresentada à Universidade Estadual de Santa Cruz, como parte das exigências para obtenção do título de Doutor em Ecologia e Conservação da Biodiversidade

Ilhéus, 28 de março de 2024.

Prof. Dra. Déborah Praciano de Castro
UECE

Prof. Dr. Mauro Sérgio Cruz Souza Lima
UFPI

Prof. Dr. Caio Vinícius de Mira-Mendes
UEMA

Prof. Dra. Karin Regina Seger
UNICAMP

Prof. Dr. Mirco Solé
(Orientador)
UESC

Dedico esta tese à minha mãe, meu pai e irmã, alicerces na minha caminhada. À memória de minha madrinha Maria Lucia dos Santos, que em vida sempre torceu por mim.

AGRADECIMENTOS

Não perca de vista seu ponto de partida (Santa Clara de Assis), essa frase sempre esteve presente na minha caminhada, fez fortalecer e lembrar de onde eu vim, do meu propósito, de minhas decisões, de todas as dificuldades que enfrentei e que foram superadas, com a família, amigos e colegas que me deram espaços em suas vidas. Clara é uma mulher de memória e ensinou que quando se olha para o passado se vê as origens, tudo que fundamenta e que leva ao que se é colocado adiante, apontando para o futuro.

Em primeiro lugar agradeço a Deus, por estar terminando o doutorado e ter tido a oportunidade de cursá-lo, através do meu esforço e políticas públicas que abriram espaço para uma menina do interior do Piauí expandir os conhecimentos. Por Ele ter concedido todo entusiasmo, alegria, sabedoria e por ter chegado até aqui com vida e saúde. A São Francisco de Assis e Santa Clara, pela intercessão junto ao Pai, e ensinamentos de vida.

Agradeço ao meus pais, Nira e Assis, que incentivaram, com brigas, conselhos e conversas me levaram ao caminho certo, sempre se esforçando para dar tudo que não tiveram em suas vidas. Obrigada por todas as ligações, por todo apoio e aguentarem minhas crises de risos, choros e chatices, e por me sustentarem com os pés no chão. Vocês me deram tudo quando não tinham nada, desde aquela casa de barro (pau a pique) até os tijolos do lar que temos hoje. Com vocês, eu tenho tudo.

À minha irmã Mayara Cristina, que sempre esteve ao meu lado, em todas as decisões me apoiou e aconselhou e sempre deixou de fazer suas próprias coisas para resolver as minhas. Por todas as alegrias e brigas que me fizeram amadurecer, irmã obrigada por seu amor. Todos os dias você me lembrou que eu conseguiria, todas nossas vitórias são compartilhadas e essa é também.

À Bruno de Almeida Barros, uma das pessoas que mais me incentivou todos os dias me lembrando que era capaz, que as atribulações me fortaleceriam. Obrigada por ser presença na minha vida segurando minha mão e me levantando nas quedas, eu amo você meu par. Ao meu cunhado, Marcus Vinícius pelas mais diversas ajudas com problemas no meu primeiro computador e até com o novo e pela disponibilidade de sempre.

A todos meus familiares por me apoiarem e entenderem quando não estava presente, por acreditarem no meu sucesso e me apoiarem quando necessário. Principalmente, aos meus Avós maternos, Francisco (meu Papê, *in Memoriam*) que se foi no início da minha jornada na Biologia, e Helena (minha voínha) que sempre entendeu minha ausência e sempre me espera com um sorriso no rosto (Eu te amo de uma maneira que não sei explicar), e minha avó paterna por todo amor, carinho e abraços (amo você também).

À minha madrinha Maria Lúcia (*In Memorian*), que se foi no meio dessa jornada em 2021. Obrigada pelos incentivos, você se foi, mas não teve um dia depois disso que não tive vontade de gritar pela janela e te ouvir responder da porta do seu ateliê ou esperar seu áudio dizendo que tem sopa para mim. Eu sempre terei você nas minhas memórias mais afetivas, onde estiver dedico a você.

À minha madrinha Divina (*In Memorian*), que se foi em 2018, sempre me amou incondicionalmente, sempre incentivou e lutou pela vida. Obrigada por me esperar para dizer adeus, sei que você sempre fez tudo por mim, te amo e desculpa ter demorado a chegar quando você se foi, a dissertação do mestrado foi para você e esse trabalho também é para a senhora Madrinha.

Ao meu orientador Mirco Solé, que desde o início acreditou em mim, obrigada pela confiança, todo apoio, dedicação. Em todas adversidades e problemas que tive nesses quatro anos, me incentivou a não desistir, lembrando que tudo daria certo (E deu certo!). Obrigada pela paciência e aprendizagem, suas contribuições foram importantes para o meu crescimento pessoal e profissional.

As minhas amigas de Floriano e Teresina, Brunna, Rutiely, Letícia, Jéssica, Layla, Ana Karina, Eduarda, Ana Clara, Iasmin, Vitoria, Vivi, Monica, Ana Lívia, Carol, Juliana, que entenderam minha ausência e sempre estiveram ao meu lado.

As minhas primas/irmãs Sayonara e Samantha que me acolheram nas correrias, me incentivando e contando histórias, sempre com um bom café. Obrigada, desde criança vocês estão comigo, me defendendo e me abrigando em seu lar. Amo vocês.

Aos amigos da Bravofit, todos vocês foram e são importantes na minha caminhada, me ensinarão a não desistir e que a cada a carga aumentada tudo ficaria leve (Grupinho do fuxico, vocês foram essenciais para passar por tudo com uma boa gaitada).

À minha "proposito" Jacqueline, rainha dos mapas, obrigada por se tornar mais que amiga para mim, uma irmã. A Yasmin que me incentivou desde a matrícula, o doutorado me deu uma amiga para vida toda, conte comigo sempre, mana.

Ao Movimento Laudato Si' e aos companheiros no ativismo e luta pelo cuidado da Casa Comum e cuidado com a biodiversidade, Igor, Letícia, Suzana, Eduardo, Cris, Anita, Ana Paula e Diego. À Mariana que sempre me recordou que sempre é melhor o feito.

À Gabriela Alves-Ferreira, que não só foi companheira no trabalho, mas incentivou e é uma inspiração. Ao Mario Herreira por toda ajuda e incentivo. Obrigada a vocês por compartilharem seus conhecimentos comigo.

Agradeço ao Conselho de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) pela bolsa de doutorado. À Universidade Estadual de Santa Cruz, a Pró-Reitora de Pesquisa e Pós-Graduação (PROPP UESC), ao Programa de Pós-graduação de Ecologia e Conservação da Biodiversidade (PPGECB) e ao Laboratório de Herpetologia Tropical por todo suporte e aprendizagem.

À Juventude Franciscana (JUFRA) e ao Frei Erivelton, por ter renovado meu espírito e me fazerem acreditar em um verdadeiro ideal, por me distraírem nos momentos de desespero, me fazerem rir, amar o irmão e seguir os passos de Jesus, amando a Deus acima de tudo. Muito obrigado! Amo todos vocês, Paz e Bem!

E por fim e não menos importante, aos Anuros por me deixarem mergulhar no mundo deles e me apaixonar por cada detalhe. ♥

Esses anos foram muito importantes na minha formação pessoal e profissional, passei por muitas atribulações, um computador roubado, crises de ansiedade, medo irracional, perdi minha tia/madrinha e desacreditei de mim, da minha capacidade. Mas as pequenas vitórias de cada dia e esse resultado, foram aos poucos me mostrando que eu sou aquela Mayrinha do início da vida profissional, lá da Biologia da UFPI, cheia de sonhos e tudo foi se recheando de alegria, risos, e muito aprendizado. E eu tenho certeza de que não chegaria até aqui se todos vocês não estivessem ao meu lado.

SUMÁRIO

RESUMO

Dendropsophus é considerado um dos gêneros com maior riqueza da família Hylidae. O gênero possui complexidade e taxonomia em nível de espécie bastante complicada, com variações intraespecíficas e interespecificas. Por essas razão, são necessários estudos e revisões para compreender as relações no gênero, reduzir as lacunas de informações e a falta de estudo sobre morfologia larval, acústica, molecular, padrões de atividades e reprodução, que juntas proporcionam uma melhor caracterização das espécies. Assim, o objetivo desta tese foi: reduzir a falta e desvendar lacunas de conhecimento do gênero *Dendropsophus*; recuperar, avaliar e reconhecer se erros de identificação nas descrições de cantos de anúncio e girinos das espécies de *Dendropsophus* aumentam com a distância da localidade-tipo; avaliar a fenologia reprodutiva de espécies, compreendendo o padrão de atividades por monitoramento da espécie *Dendropsophus branneri*. No primeiro capítulo, realizamos uma revisão sistemática da literatura para recuperar, avaliar e reconhecer possíveis erros taxonômicos nas descrições de girinos e cantos de espécies do gênero *Dendropsophus* relacionadas ou não à localidade-tipo, que podem ter resultado em descrições de outras espécies. Encontramos um total de 146 descrições de cantos de anúncio e 97 descrições de girinos e em nossa análise, considerando dados de girinos e cantos em conjunto, mostraram que há uma diferença significativa entre a distância da localidade tipo para espécies com identificação incorreta e para espécies sem identificação incorreta. No entanto, a análise considerando dados apenas para girinos e apenas para cantos não mostra diferença significativa. No segundo capítulo, avaliamos a fenologia reprodutiva de espécies através da atividade de vocalização de *Dendropsophus branneri* em três pontos de amostragem na Bahia, para isso foi realizado um Monitoramento Acústico Passivo durante o ano de 2020. Para analisar o padrão de atividades, cantos de referência da espécie foram utilizados para extrair e processar vocalizações das paisagens acústicas. Apresentamos em nossos resultados uma abordagem detalhada, isto é, período diário de atividade acústica e padrões da espécie, que teve atividade durante todo o ano e nos três pontos, constatando a estratégia de reprodução prolongada da espécie. Dessa forma, esta tese contribui para desvendar algumas das lacunas de informação do gênero *Dendropsophus*, para o entendimento dos desafios e potencialidades em estudos realizados com dados e descrições bioacústica e girinos de espécies, fornecendo novas evidência e conhecimento sobre o gênero. Por fim, ressaltamos que estudos de caracterização detalhada servem como uma ferramenta fundamental para a identificação das espécies, mitigando o risco de erros durante as atribuições taxonômicas.

Palavras-chave: Anuros, descrição de canto, descrição de girino, erros de identificação, fenologia.

ABSTRACT

Dendropsophus is considered one of the richest genera in the Hylidae family. The genus is complex and taxonomically complicated at the species level, with intraspecific and interspecific variations. For these reasons, studies and reviews are necessary to understand relationships in the genus and reduce information gaps and the lack of study on larval, acoustic, molecular morphology, activity, and reproduction patterns, providing a better characterization of the species. Thus, the objective of this thesis was: to reduce the lack and reveal gaps in knowledge of the genus *Dendropsophus*; recover, evaluate, and recognize whether identification errors in descriptions of advertisement calls and tadpoles of *Dendropsophus* species increase with distance from the type locality; evaluate the reproductive phenology of species, understanding the pattern of activities by monitoring the species *Dendropsophus branneri*. In the first chapter, we conducted a systematic review of the literature to recover, evaluate, and recognize possible taxonomic errors in the descriptions of tadpoles and calls of species of the genus *Dendropsophus* related or not to the type locality, which may have resulted in descriptions of other species. We found a total of 146 advertisement call descriptions and 97 tadpole descriptions and our analysis, considering tadpole and call data together, showed that there is a significant difference between the distance from the type locality for species with incorrect identification and species without incorrect identification. However, the analysis considering data only for tadpoles and only for calls shows no significant difference. In the second chapter, we evaluated the reproductive phenology of species through the vocalization activity of *Dendropsophus branneri* at three sampling points in Bahia, for which Passive Acoustic Monitoring was conducted during 2020. We analyzed the activity pattern using reference calls of the species to extract and process vocalizations from acoustic landscapes. In our results, we present a detailed approach, that is, the daily period of acoustic activity and patterns of the species, which had activity throughout the year and at all three points, confirming the species' prolonged reproduction strategy. In this way, this thesis contributes to unveiling some of the lack of information on the genus *Dendropsophus*, to understanding the challenges and potentialities in studies conducted with bioacoustic data and descriptions. In this way, this thesis contributes to unveiling some of the lack of information on the genus *Dendropsophus*, to understanding the challenges and potentialities in studies conducted with bioacoustic data and descriptions and tadpole descriptions, providing new evidence and knowledge about the genus. Finally, we emphasize that detailed characterization studies serve as a fundamental tool for species identification, mitigating the risk of errors during taxonomic assignments.

Keywords: Anurans, call description, tadpole description, misidentification, phenology.

INTRODUÇÃO GERAL

Dendropsophus Fitzinger, 1843 é um gênero específico de pequenos hilídeos que se distribuem do norte da Argentina e Uruguai ao norte através da América do Sul tropical e América Central até o sul tropical do México (FROST, 2024). O gênero *Dendropsophus* é considerado complexo, com uma taxonomia em nível de espécie bastante complicada, sendo um dos gêneros com maior riqueza em espécies da família Hylidae (ORRICO *et al*., 2014; ORRICO *et al*., 2020). O gênero é dividido em nove grupos: *Dendropsophus columbianus, D. garagoensis, D. labialis, D. marmoratus, D.microcephalus, D. minimus, D. minutus, D. parviceps,* e *D. leucophyllatus* (FAIVOVICH *et al.*, 2015).

As relações entre as espécies de *Dendropsophus* requerem uma revisão cuidadosa, pois ainda não são consideradas claras (MENIN *et al.*, 2020; ORRICO *et al.*, 2020). Por isso, muitos estudos têm contribuido para aumentar as informações disponíveis para o gênero (e.g. FAIVOVICH ET *et al.*, 2005; ORRICO *et al.*, 2020). Apesar disso, ainda existem lacunas no conhecimento das espécies, pois possuem variações intraespecíficas e interespecificas, principalmente com relação a morfologia, canto de anúncio, comportamento reprodutivo e girino (ORRICO *et al.*, 2013). Portanto, informações detalhadas sobre essas variações são importantes para o conhecimento das espécies desse gênero, uma vez que grupos do gênero, como por exemplo *D. minutus*, são frequentemente associados a dificuldades taxonômicas devido à falta de conjuntos de dados abrangentes (GEHARA *et al.*, 2014).

Desse modo, informações sobre morfologia larval, acústica, molecular, ecológica e comportamental juntas proporcionam uma melhor caracterização das espécies (RUAS *et al.*, 2018). Essas características tradicionais são importantes para estabelecer limites de espécies e para identificar espécies em campo e laboratório (CHÁVEZ *et al.*, 2021). Além disso, essas informações básicas são fundamentais para compreender a evolução de uma unidade taxonômica, bem como as relações filogenéticas estabelecidas entre os táxons (RUAS *et al.*, 2018). Assim, para espécies complexas, como as espécies do gênero *Dendropsophus,* abordagens que combinam dados moleculares e morfológicos são úteis e necessárias para identificar corretamente as espécies (SCHULZE *et al.*, 2015).

Concomitante a esses caracteres acústicos e morfológicos dos adultos e dos girinos, que continuam a fornecer um forte apoio para análises de diagnóstico adequado de espécies (CHÁVEZ *et al.*, 2021), os padrão de atividades e reprodução também são

importantes para reduzir a lacuna de informações no gênero *Dendropsphus*. Os modos e estratégias resprodutivas são comumente uma classificação que descreve como e onde os ovos são fertilizados e onde são depositados embriões e girinos (NUNES-DE-ALMEIDA *et al.*, 2021).

Para que os modos reprodutivos sejam observados é necessarios compreender a atividade de vocalização dos anuros, uma vez que os cantos de anúncio são essenciais para o sucesso reprodutivo e potencialmente transmitem diferentes tipos de informações sobre padrões de variação (GERHARDT & BEE, 2007). A fenologia da reprodução está diretamente ligada à estrutura da comunidade de anuros porque a sequência de eventos reprodutivos entre as espécies, combinada com o uso de locais de reprodução que variam no hidroperíodo, determina em grande parte a composição das comunidades de anuros em escalas locais (SAENZ et al., 2006).

Por fim, entende-se que todas essas lacunas de informações sobre girinos, cantos de anúncio e padrões de atividades contribuem para a imprecisão na definição e determinação de espécies que são muito semelhantes na morfologia e nas suas relações (SILVA-FILHO & JUNCÁ, 2006). E, consequentemente, carência dessas informações somadas a erros de identificação das espécies podem comprometer seriamente as interpretações dos resultados experimentais e também ter resultados negativos nas comunidades nas quais, por exemplo, experimentos são implantados, afetando a abundância relativa e a distribuição geográfica de organismos (BORTOLUS, 2008). Dessa forma, é necessário que através da colaboração possamos aumentar a eficiência da obtenção de dados, superando assim o problema de conjuntos de dados incompletos. (GEHARA *et al.*, 2014)

Diante do que foi exposto, o capítulo 1, intitulado "**Os erros de identificação nas descrições de cantos de anúncio e girinos de espécies do gênero *Dendropsophus* aumentam à medida que os dados são coletados da localidade-tipo?**" (*Do misidentifications in descriptions of advertisement calls and tadpoles of species of the genus Dendropsophus increase the farther the data is collected from the type locality?*), reuniu informações em uma revisão sistemática para recuperar estudos, avaliar e reconhecer possíveis erros taxonômicos a partir de descrições de girinos e cantos de espécies do gênero *Dendropsophus* relacionadas ou não à localidade-tipo, que podem ter resultado em descrições de outras espécies.

O capítulo 2, intitulado "**Fenologia e padrão de vocalização de *Dendropsophus branneri* em lagoas no Sul da Bahia**" *(Phenology and vocalization pattern of Dendropsophus branneri in southern Bahia lagoons*) avalia a fenologia reprodutiva de espécies através da atividade de vocalização de *Dendropsophus branneri* na Bahia.

REFERÊNCIAS

BORTOLUS, A. Error Cascades in the Biological Sciences: The Unwanted Consequences of Using Bad Taxonomy in Ecology. **AMBIO: A Journal of the Human Environment**, 37(2):114–118. 2008.

CHÁVEZ, G.; BARBOZA, A. C; THOMPSON, M. E. The distribution and calls of Vraem' Treefrog, *Dendropsophus vraemi* (Caminer, Milá, Jansen, Fouquet, Venegas, Chávez, Lougheed, and Ron 2017), with comments on its conservation status. **Amphibian & Reptile Conservation** 15(2): 311–317 (e295). 2021.

FAIVOVICH, J. *et al*. Systematic review of the frog family Hylidae, with special reference to Hylinae: phylogenetic analysis and taxonomic revision. **Bull. Am. Mus. Nat. Hist.** 294, 1–240. 2005.

FROST, DARREL R. **Amphibian Species of the World**: an Online Reference. 2024 Version 6.2. Electronic Database. American Museum of Natural History, New York, USA. doi.org/10.5531/db.vz.0001. Disponível em: https://amphibiansoftheworld.amnh.org/index.php. Acesso dia: 22 de fevereiro 2024.

GEHARA, M. *et al*. High Levels of Diversity Uncovered in a Widespread Nominal Taxon: Continental Phylogeography of the Neotropical Tree Frog Dendropsophus minutus. **PloS one** 9 (9): e103958. 2014.

GERHARDT, H. C.; BEE, M. A. **Recognition and localization of acoustic signals**. In: Hearing and sound communication in amphibians. Springer, New York, NY, p. 113-146. 2007.

MENIN, M. *et al*. Description of the tadpole of *Dendropsophus haraldschultzi* (Bokermann, 1962) (Anura: Hylidae), with comments on reproductive biology. **Zootaxa** 4780 (3): 594–600. 2020.

NUNES-DE-ALMEIDA, C. H. L.; HADDAD, C. F. B.; TOLEDO, L. F. A revised classification of the amphibian reproductive modes**. Salamandra 57**(3): 413–427. 2021.

ORRICO, V. G. D. *et al*. The Taxonomic Status of *Dendropsophus allenorum* and *Dendropsophus timbeba*. **Journal of Herpetology**, 47(4):615-618. 2013

ORRICO, V. G. D. *et al*. A new "Bat-Voiced" species of *Dendropsophus* Fitzinger, 1843 (Anura, Hylidae) from the Amazon Basin, Brazil. **Zootaxa** 3881 (4): 341–361. 2014.

ORRICO V. G. D. *et al*. The phylogeny of Dendropsophini (Anura: Hylidae: Hylinae). **Cladistics** 1–33. 2020.

RUAS D.S. *et al*. The tadpole of *Dendropsophus novaisi* (Bokermann, 1968) (Anura: Hylidae), with comments on natural history. **Zootaxa** 4375 (2): 296–300. 2018.

SAENZ, D. *et al.* Abiotic Correlates of Anuran Calling Phenology: The Importance of Rain, Temperature, and Season. **Herpetological Monographs**, 20, 64–82. 2006.

SCHULZE, A; JANSEN, M; KÖHLER, G. Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment. **Zootaxa** 4016 (1). 2015.

SILVA-FILHO, I. S. N.; JUNCÁ, F. A. Evidence of full species status of the neotropical leaf-frog *Phyllomedusa burmeisteri bahiana* (A. Lutz, 1925) (Amphibia, Anura, Hylidae). **Zootaxa** 1113: 51–64. 2006.

CAPÍTULO 1

Do misidentifications in descriptions of advertisement calls and tadpoles of species of the genus *Dendropsophus* increase the farther the data is collected from the type locality?

Do misidentifications in descriptions of advertisement calls and tadpoles of species of the genus *Dendropsophus* increase the farther the data is collected from the type locality?

Mayra Caroliny de Oliveira Santos[1,2] *, Gabriela Alves-Ferreira[1,2,3], Mirco Solé[1, 2]

[1]Programa de Pós-graduação em Ecologia e Conservação da Biodiversidade, Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil
[2]Tropical Herpetology Lab, Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil
[3]Laboratório de Ecologia Aplicada à Conservação, Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil

Corresponding Author:
Mayra Santos*
Rodovia Ilhéus-Itabuna, km 16, Salobrinho, 45662-000 Ilhéus, Bahia, Brazil
Email address: mayracarolinyoliveirasantos@yahoo.com.br

Abstract

Information such as data on advertisement calls and tadpoles are essential components for knowing and characterizing anurans, and it is recommended that such data be systematically collected at the type locality of these species and included in the original description. However, this information is absent for many species, especially for groups that have taxonomy considered difficult, such as species of the genus *Dendropsophus*. Therefore, in this study, we ask whether identification errors in descriptions of advertisement calls and tadpoles of *Dendropsophus*'s species increase with the distance from the type locality. To this end, we conducted a systematic review to retrieve studies, evaluate and recognize possible taxonomic errors from descriptions of tadpoles and calls of species of the genus *Dendropsophus* related to the type locality or not, which may have resulted in descriptions of other species. We carried out a Wilcoxon Test to evaluate whether there are differences between the distance from the type-locality for species with misidentifications in descriptions of advertisement calls and tadpoles and for species without misidentifications. We obtained a total of 146 descriptions of advertisement calls and 97 descriptions of tadpoles. The analysis considering data for tadpoles and calls together shows that there is a significant difference between the distance from type locality for species with misidentification and for species without misidentification. However, the analysis considering data only for tadpoles and only for calls do not show a significant difference. Our findings underscore the critical significance of accurately describing both the advertisement call and tadpole characteristics in the type locality. We highlight the need to describe the tadpole and the call as near as possible to the species' type locality, as the proximity ensures greater data fidelity.

Keywords: Anurans, original description, identification errors, systematic review

Introduction

Most anuran species still lack basic information, such as data on geographic distribution and natural history (*Ruas et al., 2018*). The detailed description of the larval stage and the advertisement call represent an essential component to describe anuran species. Therefore, it is recommended that such data be systematically collected at the type locality and included in the original description of the species (*Altig & McDiarmid, 1999*; *Kohler et al., 2017*). However, information on tadpoles and advertisement calls are notably absent for a considerable number of species (e.g. *Napoli & Caramaschi, 1998; Gomes & Peixoto, 1996; Motta et al., 2012; Peloso et al., 2016*), and are often published later from different populations that are usually distant from the species type locality (e.g. *Forti, Márquez & Bertoluci, 2015*; *Lourenço-de-Moraes, Campos & Toledo, 2012*; *Moura, Lacerda & Feio, 2012*; *Santana, Mesquita & Garda, 2011*).

The lack of such essential data contributes to imprecision in determining similar species (*Silva-Filho & Juncá, 2006*). Advertisement calls and tadpoles have species-specific characteristics and, because of this taxonomic importance, can be used to delimit and identify cryptic species that are morphologically difficult to distinguish (*Guerra et al., 2018*; *Heyer & Juncá, 2003*; *Silva-Filho & Juncá, 2006; Wogel, Abrunhosa & Pombal, 2000*). This data deficit is particularly notable in the Neotropics, a region harboring a high diversity of anuran's species, constituting approximately 49% of the amphibians of the world (*Bolaños et al, 2008*), with more than 89% of endemism in this area (*Bolaños et al, 2008*).

Formerly, species descriptions were based only on the external morphology of adult specimens, making it difficult to distinguish species with similar characteristics. This scenario has changed over the years and currently it is common to apply an integrative taxonomy approach, which combines various types of evidence to distinguish and describe new species, including the larval traits and calls (*Padial et al., 2009*). Thus, with the advance of molecular techniques and integrative taxonomic approaches, much data obtained outside the type locality have been assigned to other species (e.g. *Fouquet et al. 2007, 2015*).

The genus *Dendropsophus*, composed of 110 species (*Frost, 2022*), is the most speciose genus in the Hylidae family (*Orrico et al., 2020*). Species of the genus are extremely variable morphologically, and also present variations in their advertisement

call and reproductive behavior (*Orrico et al., 2020*). These intra and interspecific variations can help establish limits among species (*Orrico et al., 2009; Orrico et al., 2013*). The genus is widely distributed, extending from northern Argentina and Uruguay to southern Mexico (*Frost, 2022*). Furthermore, the phylogenetic relationships within the genus *Dendropsophus* are unclear and are still little explored (*Orrico et al., 2020*). For these reasons, species within the genus *Dendropsophus* are generally regarded as taxonomically challenging (*Duellman, 1982*; *Gehara et al., 2014; Orrico et al., 2020*).

Here, we ask whether identification errors in descriptions of advertisement calls and tadpoles of *Dendropsophus's* species increase with the distance from the type locality. To this end, we conducted a systematic review to retrieve studies, evaluate and recognize possible taxonomic errors from descriptions of tadpoles and calls of species of the genus *Dendropsophus* related to the type locality or not, which may have resulted in descriptions of other species. We expect that the chance of taxonomic error (i.e., the call or tadpole being from another species) will decrease along with the distance from the type locality.

Materials & Methods

The list of *Dendropsophus* species was obtained from Frost (2022) and a total of 110 species were considered. The search was conducted between September 2021 and March 2022. After obtaining the species list, the scientific literature regarding the advertisement call and tadpole description of each species were reviewed and compiled based on the "Amphibian Species of the World" (https://amphibiansoftheworld.amnh.org/) (*Frost, 2022*). Using this database, we identified changes in species taxonomy and conflicts in the descriptions of calls and tadpoles, to verify the possibility of misidentification. These articles were used to compose a database containing the geographic coordinates of the type locality, the geographic coordinates of the tadpole description location and/or vocalization description (See Supplementary Table 1). Articles with more than one species with a description of call and/or tadpole were duplicated in the database with the appropriate information for each of them. For articles with no coordinates available in the description, we used the centroid of the municipality or locality. We estimate the distance between the type locality and the description of vocalization and/or tadpole for each species that has such data available. For the review to be more in-depth, we searched for advertisement calls and tadpoles that were described in association with a species, but which later changed

taxonomy for that species, causing misidentification, such as two species with the same synonymy and/or which changed names and were separated.

The Shapiro-Wilk showed that our data is not normally distributed (W = 0.759, p-value < 2.2e-16). Thus, we carried out a Wilcoxon Test to evaluate whether there are differences between the distance from the type-locality for species with misidentifications in descriptions of advertisement calls and tadpoles and for species without misidentifications. We fitted three different models, the first one considering all data available (tadpole and call description), the second one considering only tadpole description, and the last one considering only call description. All analyses were conducted using R version 4.3.2 (R Core Team, 2024).

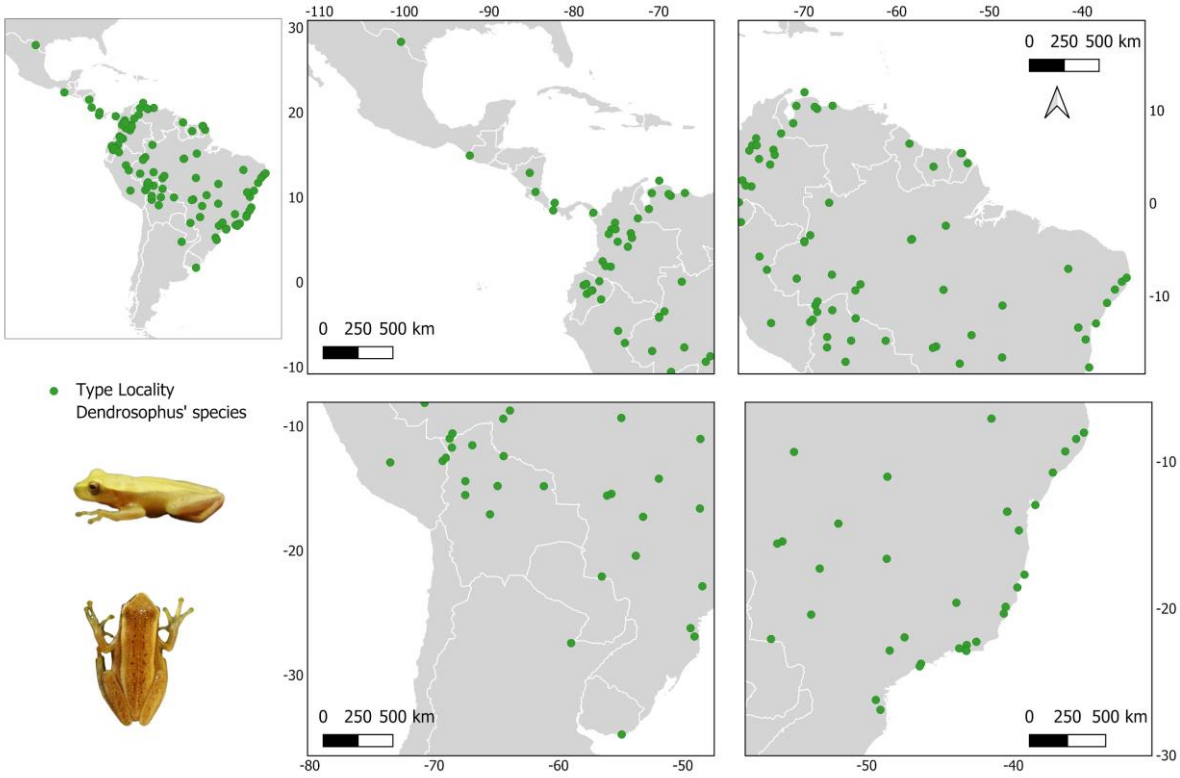

Fig. 1. Distribution of the type localities of the species of the genus *Dendropsophus*.

Results

We obtained data for 110 *Dendropsophus's* species, which presented a total of 146 descriptions of advertisement calls and 97 descriptions of tadpoles (Figure 2). Many descriptions are repeated for some species in different locations. Sixty-eight species do not have advertisement calls and tadpoles descriptions from the type locality. Of this total

number of species without descriptions from the type locality, only 44 species have descriptions outside the type locality. Despite the increase in the number of call and tadpole description publications over the years, the majority of descriptions are of vocalization, demonstrating a difficulty in describing tadpoles. Even with a total of 97 tadpole descriptions, many are repeated for the same species as updates or descriptions from different locations than the previous description. Only 33 species have descriptions for both the tadpole and the advertisement call.

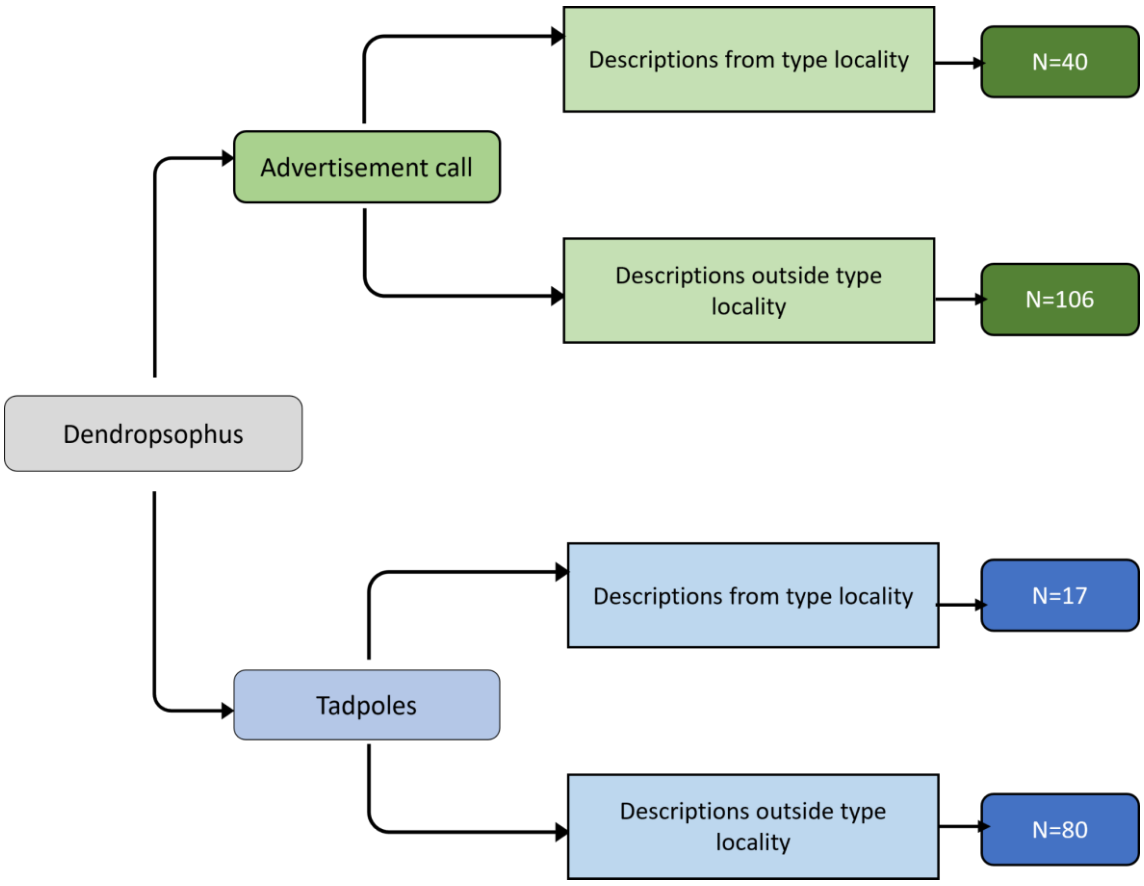

Fig. 2. Flowchart showing an overview of the compiled descriptions and their details for the genus *Dendropsophus*.

We observed that the majority of species have descriptions of advertisement calls and tadpoles from populations that are distant from the species' type locality. The number of species for which descriptions of vocalization and/or tadpoles are available solely from the type locality found in this review was n= 31. In the genus, six species have descriptions only from the type locality, recorded in other articles and not in the original description of the species. These are: *Dendropsophus anataliasiasi*, *D. bogerti*, *D.*

koechlini, *D. norandinus*, *D. sartori*, *D. robertmertensi* (Figure 9). Further, 25 species have vocalizations and/or tadpoles described only in the original publication. These are: both descriptions - *Dendropsophus counani*, *D. ruschii*; advertisement call only - *Dendropsophus aperomeus*, *D. arndti*, *D. bilobatus*, *D. bromeliaceus*, *D. coffea*, *D. delarivai*, *D. joannae*, *D. juliani*, *D. kamagarini*, *D. kubricki*, *D. luddeckei*, *D. nekronastes*, *D. ozzyi*, *D. praestans*, *D. reichlei*, *D. rozenmani*, *D. shiwiarum*, *D. xapuriensis*; tadpoles only - *Dendropsophus garagoensis*, *D. padreluna*, *D. stingi*, *D. tapacurensis*, *D. virolinensis*.

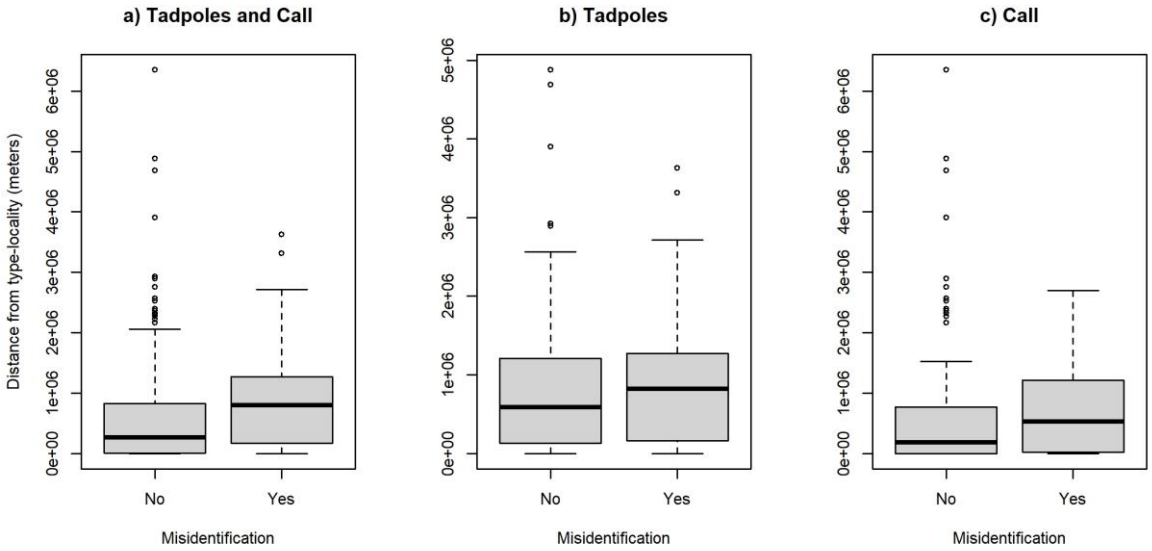

Fig. 3. The results of the analysis: 3a - considering all data available (tadpole and call description); 3b - considering only tadpole description; 3c – considering only call description.

The analysis considering data for tadpoles and calls together shows that there is a significant difference between the distance from type locality for species with misidentification and for species without misidentification (W = 2608.5, p-value = 0.020, Figure 3a). However, the analysis considering data only for tadpoles (W = 732.5, p-value = 0.692, Figure 3b) and only for calls (W = 1174.5, p-value = 0.077, Figure 3c) do not show a significant difference.

Discussion

We compiled 146 descriptions of advertisement calls and 97 descriptions of tadpoles for 110 species within the genus *Dendropsophus*. Our findings show that species

with misidentifications in tadpoles and call descriptions tend to be, in general, more geographically distant from their type locality compared to species without misidentifications.

Most species (n=68) have descriptions of advertisement calls and tadpoles outside the type locality (n=44) or no descriptions (n=24), which could result in the designation of other species. Our analysis shows that there is a significant difference between the distance from type locality for species with misidentification and for species without misidentification, as expected. Our study reveals that species with misidentifications are typically found far from their type localities. These findings underscore the challenges posed by morphological similarity and limited information, particularly in taxa like *Dendropsophus* (*Silva-Filho & Juncá, 2006*). Therefore, the documentation of advertisement calls and tadpoles becomes indispensable, as they serve as crucial tools for distinguishing, delimiting, and identifying anuran taxa (*Glaw et al., 2010; Guerra et al., 2018; Padial et al., 2008; Vieites et al., 2009)*, particularly in the context of the type locality. This approach helps prevent the misidentification of morphologically similar species, as highlighted by our results. Given the lack of consistent morphological characters for species differentiation, advertisement calls have proven to be of great help in species detection (*Padial et al, 2008*), while tadpoles from closely related species can exhibit surprisingly distinct characters (*Glaw et al., 2010*).

The importance of describing the advertisement call and tadpole was observed throughout the literature, and can be a way to solve misidentification issues for similar species, such as *Dendropsophus bogerti* and *Dendropsophus carnifex.* These species had their differences clarified with the description of the tadpole from the type locality by *Kaplan (1997)*, in which well-preserved tadpoles were used, revalidating the species *D. bogerti*. In addition, *De la Riva et al. (1997)* described the vocalization of *D. carnifex* from Las Palmeras, Pichincha Province, Ecuador, near the type locality of this species. The species *Dendropsophus counani* and *Dendropsophus brevifrons* were considered the same species and were distinguished by calls and tadpoles (REF). *Fouquet et al. (2007)* did the precursor work for this distinction and identified the existence of a species complex using molecular analyses. Later, *Fouquet et al. (2015)* separated the two species and published the description of the new species *D. counani*, describing the tadpole and vocalization of specimens from French Guiana. Another example is *Dendropsophus*

giesleri, which had its synonymy removed from *Dendropsophus microps* based on vocalizations described by *Heyer (1980)*.

Dendropsophus leali was initially considered synonymous with *Dendropsophus rossalleni*, a classification that was later challenged by *Heyer (1977)* based solely on morphology. Despite both species having descriptions of advertisement calls and tadpoles, *Schulze et al. (2015)* described the tadpole of *D. leali* noting similarities with tadpoles of *Dendropsophus nanus* in relation to body shape, potentially leading to field identification challenges. Other species that were confused are *Dendropsophus luddeckei* and *Dendropsophus molitor* (in the literature under the name *Dendropsophus labialis*), but were compared in the original publication to *D. luddeckei*, which has a description of the vocalization of the type locality (see *Guarnizo et al., 2012*). Confirming the confusion between these species, *Guarnizo et al. (2014)* pointed out the likelihood of misidentification in previous literature.

Based on the calls, *Dendropsophus meridianus* was removed from the synonymy with *Dendropsophus microcephalus*, and according to *Pombal & Bastos (1998)*, the two species have different vocalizations. Consequently, *Basso et al. (1985)* revalidated *Dendropsophus saborni*, previously considered synonymous with *Dendropsophus nanus*, by providing descriptions of their advertisement calls and comparing them. In addition, *Martins & Jim (2003)* described the vocalization of *D. nanus* and *D. saborni* and demonstrated acoustic segregation with differences in structure and timing.

The species *Dendropsophus reticulatus* was removed from the synonymy of *Dendropsophus triangulum* based on genetics and morphological data. *Caminer et al. (2017)*, analyzed acoustic data of the species that showed the difference between the advertisement calls. *D. triangulum* has as type locality only "Brazil", which makes it difficult to use nearby specimens, however for *D. reticulatus* it was possible to use specimens close to the type locality.

Some species, like *Dendropsophus cruzi*, exhibit geographic variations in their advertisement calls, as noted by *Tessarolo et al. (2016*). They investigated call variations across ten cities (the type locality, and nine others) in the State of Goiás/Brazil. By comparing the sonograms of calls from different regions, they highlighted differences between the original description of *D. cruzi* (*Pombal & Bastos, 1998*) in Silvânia, located in central-eastern Goiás, and specimens from Rio Verde in southern Goiás. Although

sonograms from other cities were not provided, the study revealed clear distinctions in calls between northern and southern regions of Goiás, with calls from closer locations showing greater similarity. Similarly, *Schulze et al. (2015)* observed variations in tadpole characteristics, identifying two morphologically distinct lineages of *Dendropsophus minutus* in Bolivia.

The scarcity of tadpole descriptions for the genus *Dendropsophus* compared to vocalizations underscores the challenge of characterizing and identifying species based on larval morphology. Unlike recording adult calls fordescribing vocalizations, describing tadpoles requires ensuring they belong to the correct species, which implies monitoring their development - a time consuming task. Thus, it is an enormous challenge, mostly due to the difficulty in recognizing and distinguishing morphological characteristics, being a major obstacle in species surveys (*Dubeux et al., 2020; Provete et al., 2012*). Consequently, there is a growing need for molecular species identification (*Schulze et al., 2015*) or to confirm species identification until the metamorphosis of an individual is complete (*Wogel, Abunhosa & Pombal, 2000*). According to *Andrade et al. (2007),* the difficulty in recognizing the morphological characteristics of tadpoles and phenotypic plasticity may make it difficult to distinguish tadpoles. Phenotypic plasticity is identified as the cause of a high variation in some larval characters due to environmental pressures (*Marques et al., 2018; Marques & Nomura, 2018*), which consequently can lead to errors in the taxonomic identification of tadpoles.These challenges likely contribute to the limited number of tadpole descriptions found in this study.

We identified a considerable number of species (67) lacking both advertisement call and tadpole descriptions from their type locality. Additionally, we found that 43 of these species had descriptions from other locations, which is also important and necessary information to understand variations in different populations, taking into account phenotypic plasticity for most tadpoles and call variations. While data from other locations are informative, emphasizing the importance of type locality descriptions is crucial for ensuring data accuracy and avoiding errors in subsequent research. Hutchings & *Lavesque (2020)* stress the need to review papers and highlight potential issues with using species names described in distant localities. Similarly, *Hutchings & Kupriyanova (2018),* advocate for collecting data as close as possible to the type locality when reviewing or obtaining information on already described species, citing the example of sequencing data. Misidentifications, as evidenced by *Bortolus (2008),* can trigger a

cascade of errors and compromise studies in various disciplines, particularly ecology. Misidentification errors not only affect the accuracy of experimental results but also have detrimental consequences on the communities involved, leading to erroneous population estimates, trends, geographic distributions, and relative abundance assessments (*Bortolus, 2008; Shea et al., 2011*). Therefore, efforts to reduce identification errors will prevent cascades of errors and should improve our ability to make effective management and conservation decisions (*Shea et al., 2011*).

Our findings underscore the critical significance of accurately describing both the advertisement call and tadpole characteristics in the type locality. This detailed characterization serves as a pivotal tool for species identification, mitigating the risk of errors during taxonomic assignments. We highlight the need to describe the tadpole and the call as near as possible to the species' type locality, as the proximity ensures greater data fidelity. Indeed, distant descriptions heighten the likelihood of misidentification, potentially confounding taxonomic assessments.

References

Altig R, McDiarmid RW. 1999. Body plan: Development and morphology. In: McDiarmid RW, Altig R, Eds: *Tadpoles: The Biology of Anuran Larvae*. The University of Chicago Press, Chicago and London, 24-51.

Andrade GV, Eterovick PC, Rossa-Feres DC, Schesari L. 2007. Estudos sobre girinos no Brasil: histórico, conhecimento atual e perspectivas. In: Luciana B. Nascimento; Ermelinda de Oliveira, eds. *Herpetologia no Brasil II*. 1ed. Belo Horizonte - PR: Sociedade Brasileira de Herpetologia v. 1:127-146.

Basso NG, Perí SI, Di Tada IE. 1985. Revalidación de *Hyla sanborni* Schmidt, 1944 (Anura: Hylidae). *Cuadernos de Herpetología* 1: 1–11.

Bolaños F, Castro F, Cortez C, De la Riva I, Hedges B, Heyer R., et al. 2008. "Amphibians of the neotropical realm," in Threatened amphibians of the world, eds S. N. Stuart, M. Hoffmann, J. S. Chanson, N. A. Cox, R. J. Berridge, P. Ramani, et al. (Barcelona: Lynx Edicions), 92–105.

Bortolus A. 2008. Error Cascades in the Biological Sciences: The Unwanted Consequences of Using Bad Taxonomy in Ecology. *AMBIO: A Journal of the Human Environment*, 37(2):114–118 DOI: 10.1579/0044-7447(2008)37[114:ECITBS]2.0.CO;2.

Caminer MA, Milá B, Jansen M, Fouquet A, Venegas PJ, Chávez G, Lougheed SC, Ron SR. 2017. Systematics of the *Dendropsophus leucophyllatus* species complex (Anura: Hylidae): Cryptic diversity and the description of two new species. PLoS (Public Library of Science) One 12(3: e0171785): 1–42 DOI:10.1371/journal.pone.0171785.

De la Riva I, Márquez R, Bosch J. 1997. Description of the advertisement calls of some South American Hylidae (Amphibia, Anura): Taxonomic and methodological consequences. *Bonner Zoologische Beiträge* 47: 175–185.

Dubeux MJM, Nascimento FAC, Lima LR, Magalhães FM, Silva IRS, Gonçalves U, Almeida JPF, Correia LL, Garda AA, Mesquita DO, Rossa-Feres DC, Mott R. 2020. Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest. *Biota Neotropica* 20(2): e20180718, 2020

Duellman WE. 1982. A new species of small yellow Hyla from Perú (Anura: Hylidae). *Amphibia-Reptilia* 3, 153 – 160.

Forti LR, Márquez R, Bertoluci J. 2015. Advertisement call of *Dendropsophus microps* (Anura: Hylidae) from two populations from southeastern Brazil. *Zoologia. Sociedade Brasileira de Zoologia* 32: 187–194 DOI: 10.1590/S1984-46702015000300002.

Fouquet A, Gilles A, Vences M, Marty C, Blanc M, Gemmell NJ. 2007. Underestimation of species richness in neotropical frogs revealed by mtDNA analyses. *PLoS (Public Library of Science) One* 10 (e1109): 1–10.

Fouquet, A, Orrico VGD, Ernst R, Blanc M, Martinez Q, Vacher J-P, Rodrigues MT, Ouboter P, Jairam R, Ron S. 2015. A new *Dendropsophus* Fitzinger, 1843 (Anura: Hylidae) of the parviceps group from the lowlands of the Guiana Shield. *Zootaxa* 4052: 39–64 DOI:10.11646/zootaxa.4052.1.2.

Frost, Darrel R. 2022. Amphibian Species of the World: an Online Reference. Version 6.1 (accessed 25 January 2022). Electronic Database accessible at https://amphibiansoftheworld.amnh.org/index.php. American Museum of Natural History, New York, USA. DOI: 10.5531/db.vz.0001.

Gehara M, Crawford AJ, Orrico VGD, Rodrígues A, Lötters S, Fouquet A., Barrientos LS, Brusquetti F, De la Riva I, Ernst R, Urrutia GG, Glaw F, Guayasamin JM, Hölting M, Jansen M, Kok PJR, Kwet A, Lingnau R, Lyra M, Moravec J, Pombal Jr JP, Rojas-

318 Runjaic FJM, Schulze A, Señaris JC, Solé M, Rodrigues MT, Twomey E, Haddad CFB,
319 Vences M, Köhler J. 2014. High Levels of Diversity Uncovered in a Widespread Nominal
320 Taxon: Continental Phylogeography of the Neotropical Tree Frog *Dendropsophus*
321 *minutus*. *PLoS ONE* 9(9): e103958. DOI:10.1371/journal.pone.0103958.

322 Glaw F, Köhler J, De La Riva I, Vieites DR, Vences M. 2010. Integrative taxonomy of
323 Malagasy treefrogs: combination of molecular genetics, bioacoustics and comparative
324 morphology reveals twelve additional species of *Boophis*. *Zootaxa* 2383: 1–82.

325 Gomes MR, Peixoto OL. 1996. Nova especie de *Hyla* do group *marmorata* de Sergipe,
326 nordeste do Brasil (Amphibia, Anura, Hylidae). Iheringia. Série Zoologia 80: 33–38.

327 Guarnizo CE, Escallón C, Cannatella D, Amézquita A. 2012. Congruence Between
328 Acoustic Traits and Genealogical History Reveals a New Species of *Dendropsophus*
329 (Anura: Hylidae) in the High Andes of Colombia. *Herpetologica* 68(4), 2012, 523–540.

330 Guarnizo CE, Armesto O, Acevado A. 2014. *Dendropsophus labialis* (Peters, 1863).
331 *Catálogo de Anfibios y Reptiles de Colombia* 2 (2): 56-61.

332 Guerra V, Llusia D, Gambale PG, Morais AR, Márquez R, Bastos RP. 2018. The
333 advertisement calls of Brazilian anurans: Historical review, current knowledge and future
334 directions. *PLoS ONE* 13(1): e0191691 DOI: 10.1371/journal.pone.0191691.

335 Heyer WR. 1977. Taxonomic notes on frogs from the Madeira and Purus rivers, Brasil.
336 *Papéis Avulsos de Zologia*. São Paulo 31: 141–162.

337 Heyer WR. 1980.The calls and taxonomic positions of Hyla giesleri and Ololygon opalina
338 (Amphibia: Anura: Hylidae). *Proceedings of the Biological Society of Washington* 93(3):
339 655–661.

340 Heyer WR, Juncá FA. 2003. Leptodactylus caatingae, a new species of frog from eastern
341 Brazil (Ampliibia: Anura: Leptodactyjidae). Proceedings Of The Biological Society Of
342 Washington 116(2):317-329. 2003.

343 Hutchings P, Kupriyanova E. 2018. Cosmopolitan polychaetes – fact or fiction? Personal
344 and historical perspectives. *Invertebrate Systematics*, 2018, **32**, 1–9
345 http://dx.doi.org/10.1071/IS17035.

Hutchings P, Lavesque N. 2020. I know who you are, but do others know? Why correct scientific names are so important for the biological sciences. *Zoosymposia* 19: 151–163. https://doi.org/10.11646/zoosymposia.19.1.16.

Kaplan M. 1997. On the Status of Hyla bogerti Cochran and Goin. Journal of Herpetology, Vol.3 1, No. 4, 536-54.

Kohler J, Jansen M, Rodríguez A, Kok PJR, Toledo LF, Emmrich M, Glaw F, Haddad, Célio F.B, Rodel M, Vences M. 2017. The use of bioacoustics in anuran taxonomy: theory, terminology, methods and recommendations for best practice. *Zootaxa* 4251 (1): 001–124 DOI: 10.11646/zootaxa.4251.1.1.

Lourenço-De-Moraes R, Campo FS, Toledo LF. 2012. The tadpole of Dendropsophus haddadi (Bastos & Pombal 1996) (Hylidae: Hylinae). *Zootaxa* 3476: 86–88.

Marques NCS, Nomura F. 2018. Environmental and spatial factors affect the composition and morphology of tadpole assemblages. Canadian Journal of Zoology. https://doi.org/10.1139/cjz-2017-0313.

Marques NCS, Rattis L, Nomura F. 2018. Local environmental conditions affecting anuran tadpoles' microhabitat choice and morphological adaptation. *Marine and Freshwater Research.* https://doi.org/10.1071/MF18106

Martins IA, Jim J. 2003. Bioacoustic analysis of advertisement call in *Hyla nana* and *Hyla sanborni* (Anura, Hylidae) in Botucatu, São Paulo, Brazil. *Brazilian Journal of Biology 63*(3): 507–516.

Motta AP, Castroviejo-Fisher S, Venegas PJ, Orrico VGD, Padial JM. 2012. A new species of the *Dendropsophus parviceps* group from the western Amazon Basin (Amphibia: Anura: Hylidae). Zootaxa 3249: 18–30.

Moura MR, Lacerda JVA, Feio RN. 2012. Advertisement call and distribution of *Dendropsophus berthalutzae* (Anura: Hylidae). *Salamandra* 48(2) 177–180.

Napoli MF, Caramaschi U. 1998. Duas novas espécies de *Hyla* Laurenti, 1768 do Brasil central afins de *H. tritaeniata* Bokermann, 1965. Boletim do Museu Nacional. Nova Serie, Zoologia. Rio de Janeiro 391: 1–12.

Orrico VGC, Lingnau R, Giasson LOM. 2009. The advertisement call of *Dendropsophus nahdereri* (Anura, Hylidae, Dendropsophini). *South American Journal of Herpetology,* 4(3), 2009, 295-299.

Orrico VGC, Duellman WE, Souza MB, Haddad CFB. 2013 The Taxonomic Status of *Dendropsophus allenorum* and *Dendropsophus timbeba***.** *Journal of Herpetology,* 47(4):615-618, DOI: 10.1670/12-208.

Orrico VGC, Grant T, Faivovich J, Rivera-Correa M, Rada MA, Lyra ML, Cassine CS, Valdujo, PH, Schargel WE, Machado DJ, Wheller WC, Barrio-Amorós C, Loebmann D, Moravec J, Zina J, Solé M, Staru MJ, Peloso PLV, Suarez P, Haddad CFB. 2020. The phylogeny of Dendropsophini (Anura: Hylidae: Hylinae). *Cladistics* 1–33 DOI: 10.1111/cla.12429.

Padial JM, Köhler J, Muñoz A, De La Riva I. 2008. Assessing the taxonomic status of tropical frogs through bioacoustics: geographical variation in the advertisement calls in the *Eleutherodactylus discoidalis* species group (Anura). *Zoological Journal of the Linnean Society*, 152, 353–365.

Padial JM, Castroviejo-Fisher S, Köhler J, Vilá C, Chaparro JC, De La Riva I. 2009. Deciphering the products of evolution at the species level: the need for an integrative taxonomy. *Zoologica Scripta* DOI:10.1111/j.1463-6409.2008.00381.x

Peloso PLV, Orrico VGD, Haddad CFB, Lima-Filho GR, Sturaro MJ. 2016. A new species of Clown Tree Frog, *Dendropsophus leucophyllatus* species group, from Amazonia (Anura, Hylidae). South American Journal of Herpetology 11: 66–80.

Pombal Jr JP, Bastos RP. 1998. Nova espécie de *Hyla* Laurenti, 1768 do centro-oeste brasileiro e a posição taxonômica de *H. microcephala werneri* Cochran, 1952 e *H. microcephala meridiana* B. Lutz, 1952 (Anura, Hylidae). *Boletim do Museu Nacional. Nova Serie, Zoologia* 390: 1–13.

Provete DB, Garey MV, Da Silva FR, Jordani MX. 2012. Knowledge gaps and bibliographical revision about descriptions of free-swimming anuran larvae from Brazil. *North-Western Journal of Zoology* 8 (2): 283-286.

R Core Team (2024). R: A language and environment for statistical computing. R Found ation for Statistical Computing, Vienna, Austria. URLhttps://www.R-project.org/.

Ruas DS, Mira-Mendes CV, Del-Grande ML, Zina J, Solé M. 2018. The tadpole of *Dendropsophus novaisi* (Bokermann, 1968) (Anura: Hylidae), with comments on natural history. *Zootaxa* 4375 (2): 296–300 DOI: 10.11646/zootaxa.4375.2.10.

Santana DJ, Mesquita DO, Garda AA. 2011. Advertisement call of *Dendropsophus oliveirai* (Anura, Hylidae). *Zootaxa* 2997: 67–68.

Schulze A, Jansen M, Köhler G. 2015. Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment. *Zootaxa* 4016 (1): 001–111 DOI:10.11646/zootaxa.4016.1.1.

Shea CP, Peterson JT, Wisniewski JM, Johnson NA. 2011. Misidentification of freshwater mussel species (Bivalvia:Unionidae): contributing factors, management implications, and potential solutions. J. N. Am. Benthol. Soc., 30(2):446–458 DOI: 10.1899/10-073.1

Silva-Filho ISN, Juncá FA. 2006. Evidence of full species status of the neotropical leaf-frog *Phyllomedusa burmeisteri bahiana* (A. Lutz, 1925) (Amphibia, Anura, Hylidae). *Zootaxa* 1113: 51–64.

Tessorolo G, Maciel NM, Morais AR, Bastos RP. 2016. Geographic variation in advertisement calls among populations of *Dendropsophus cruzi* (Anura: Hylidae). *Herpetological Journal* 26: 219–224.

Vieites DR, Wollenberg KC, Andreone F, Köhler J, Glaw F, Vences M. 2009. Vast underestimation of Madagascar’s biodiversity evidenced by an integrative amphibian inventory. *PNAS* vol. 106 no. 20.

Wogel H, Abrunhosa PA, Pombal Jr. JP.2000. Girinos de cinco espécies de anuros do sudeste do Brasil (Amphibia: Hyidae, Leptodactylidae, Microhylidae). *Boletim do Museu Nacional* 427.

Supplementary data

Table 1: Database with article information.

Authrs	Year	Published in	Title	Specie	Coordinate	Description
Márquez, De la Riva, Bosch	1993	Biotropica	Advertisement calls of Bolivian species of *Hyla* (Amphibia, Anura, Hylidae)	*Dendropsophus acreanus*	15 ° 46'S 62 ° 15'W	Advertisement call
Teixeira, Giaretta	2015	Salamandra	Setting a fundament for taxonomy: advertisement calls from the type localities of three species of the *Dendropsophus rubicundulus* group (Anura: Hylidae)	*Dendropsophus anataliasiasi*	11 ° 02’34 ’’ S 48 ° 35’24 ’’ W	Advertisement call
Jansen, Santana, Teixeira, Köhler	2019	Vertebrate Zoology	A new striped species of *Dendropsophus* (Anura: Hylidae) with a composite advertisement call and comments on the *D. rubicundulus* group	*Dendropsophu anataliasiasi*	11 ° 02’34 ’’ S 48 ° 35’24 ’’	Advertisement call
Gomes, Martins	2006	Check List	Amphibia, Anura, Hylidae, *Dendropsophus anceps* (Lutz, 1929): filling gap, geographic distribution map and vocalization	*Dendropsophus anceps*	23º06’10’’ S 45º43’05’’ W	Advertisement call
Conte, Nomura, Machado, Kwet, Lingnau, Rossa-Feres	2010	Biotaneotropica	Novos registros na distribuição geográfica de anuros na Floresta com Araucária e considerações sobre suas vocalizações	*Dendropsophus anceps*	23.1984° S 49.7573° W**	Advertisement call
Conte, Nomura, Machado, Kwet, Lingnau, Rossa-Feres	2010	Biotaneotropica	Novos registros na distribuição geográfica de anuros na Floresta com Araucária e considerações sobre suas vocalizações	*Dendropsophus anceps*	24.3335° S, 50.6250° W**	Advertisement call
Duellman, WE	1982	Amphibia-Reptilia	A new species of small yellow *Hyla* from Peru (Anura: Hylidae)	*Dendropsophus aperomeus*	05° 46′ S 74° 47′ W	Advertisement call
Caminer, Milá, Jansen, Fouquet, Venegas,	2017	PLoS One	Systematics of the *Dendropsophus leucophyllatus* species complex (Anura: Hylidae): Cryptic diversity and the description of two new species	*Dendropsophus reticulatus*	16.3596° S, 62.0000° W	Advertisement call

Chávez, Lougheed, Ron.						
Moura, Lacerda, Feio	2012	Salamandra	Advertisement call and distribution of *Dendropsophus berthalutzae* (Anura: Hylidae)	*Dendropsophus berthalutzae*	20 ° 44'05"S 42 ° 20'50"W	Advertisement call
Forti, Martins, Bertoluci	2012	Zootaxa	Advertisement call and geographical variation in call features of *Dendropsophus berthalutzae* (Anura: Hylidae) from the Atlantic Rainforest of southeastern Brazil	*Dendropsophus berthalutzae*	24 ° 01 ′ S 47 ° 48 W	Advertisement call
Forti, Martins, Bertoluci	2012	Zootaxa	Advertisement call and geographical variation in call features of *Dendropsophus berthalutzae* (Anura: Hylidae) from the Atlantic Rainforest of southeastern Brazil	*Dendropsophus berthalutzae*	23 ° 46 ′ S 46 ° 22 ′ W	Advertisement call
Forti, Martins, Bertoluci	2012	Zootaxa	Advertisement call and geographical variation in call features of *Dendropsophus berthalutzae* (Anura: Hylidae) from the Atlantic Rainforest of southeastern Brazil	*Dendropsophus berthalutzae*	24 ° 24 ′ S 47 ° 05 ′ W	Advertisement call
Forti, Martins, Bertoluci	2012	Zootaxa	Advertisement call and geographical variation in call features of *Dendropsophus berthalutzae* (Anura: Hylidae) from the Atlantic Rainforest of southeastern Brazil	*Dendropsophus berthalutzae*	25 ° 04 ′ S 47 ° 55 ′ W	Advertisement call
Forti, Martins, Bertoluci	2012	Zootaxa	Advertisement call and geographical variation in call features of *Dendropsophus berthalutzae* (Anura: Hylidae) from the Atlantic Rainforest of southeastern Brazil	*Dendropsophus berthalutzae*	23 ° 21 ′ S 44 ° 51 ′ W	Advertisement call
Márquez, De la Riva, Bosch	1993	Biotropica	Advertisement calls of Bolivian species of *Hyla* (Amphibia, Anura, Hylidae)	*Dendropsophus bifurcus*	18 ° 07'S 63 ° 38'W	Advertisement call
Duellman, W. E.	1978	Miscellaneous Publication.	The biology of an equatorial herpetofauna in Amazonian Ecuador	*Dendropsophus bifurcus*	7° 44' 31" S 35° 52' 34" W**	Advertisement call and tadpole
Ferrão, Moravec, Hanken, Lima	2020	ZooKeys	A new species of *Dendropsophus* (Anura, Hylidae) from southwestern Amazonia with a green bilobate vocal sac	*Dendropsophus bilobatus*	09 ° 24′45 ″ S 64 ° 26′33 ″ W	Advertisement call

Abrunhosa, Wogel, Pombal, Jr	2001	Boletim do Museu Nacional do Rio de Janeiro	Vocalização de quatro espécies de anuros do Estado do Rio de Janeiro, Sudeste do Brasil (Amphibia, Hylidae, Leptodactylidae)	*Dendropsophus bipuctatus*	22°50'48"S 42°27'16"W	Advertisement call
Kaplan, M	1997	Journal of Herpetology	On the status of *Hyla bogerti* Cochran and Goin	*Dendropsophus bogerti (E separção de D. carnifex)*	6° 13′ 1″ N 75° 34′ 1″ W**	Tadpole
Duellman, WE	1978	Miscellaneous Publication.	The biology of an equatorial herpetofauna in Amazonian Ecuador	*Dendropsophus bokermanni*	7°44' 31" S 35° 52' 34" W**	Advertisement call and tadpole
Duellman, WE	2005	Comstock Publishing Associates	Cusco Amazonico, The lives of amphibians and reptiles in an Amazonian rainforest	*Dendropsophus bokermanni*	13°31′21″ S 71°58′02″ W**	Advertisement call and tapole
Nunes, Santiago, Juncá	2007	South American Journal of Herpetology	Advertisment calls of four hylid frogs from the state of Bahia, northeastern Brazil (Amphibia, Anura, Hylidae)	*Dendropsophus branneri*	12°16’00”S 38°58’00”W	Advertisement call
Nunes, Santiago, Juncá	2007	South American Journal of Herpetology	Advertisment calls of four hylid frogs from the state of Bahia, northeastern Brazil (Amphibia, Anura, Hylidae)	*Dendropsophus branneri*	12°31’49”S 38°17’57”W	Advertisement call
Abreu, Juncá, Souza, Napoli	2015	Zootaxa	The tadpole of *Dendropsophus branneri* (Cochran, 1948) (Amphibia, Anura, Hylidae)	*Dendropsophus branneri*	7° 50′ 4″ S 34° 54′ 23″ W**	Tadpole
Abreu, Juncá, Souza, Napoli	2015	Zootaxa	The tadpole of *Dendropsophus branneri* (Cochran, 1948) (Amphibia, Anura, Hylidae)	*Dendropsophus branneri*	11° 46' 0.120"S 37° 47' 60.000"W**	Tadpole
Abreu, Juncá, Souza, Napoli	2015	Zootaxa	The tadpole of *Dendropsophus branneri* (Cochran, 1948) (Amphibia, Anura, Hylidae)	*Dendropsophus branneri*	12° 21′ 11″S 38° 22′ 48″ W**	Tadpole
Abreu, Juncá, Souza, Napoli	2015	Zootaxa	The tadpole of *Dendropsophus branneri* (Cochran, 1948) (Amphibia, Anura, Hylidae)	*Dendropsophus branneri*	11° 48' 49"S 37° 36' 38"W**	Tadpole
Abreu, Juncá, Souza, Napoli	2015	Zootaxa	The tadpole of *Dendropsophus branneri* (Cochran, 1948) (Amphibia, Anura, Hylidae)	*Dendropsophus branneri*	13° 49′ 31″ S 39° 7′ 50″ W**	Tadpole
Abreu, Juncá, Souza, Napoli	2015	Zootaxa	The tadpole of *Dendropsophus branneri* (Cochran, 1948) (Amphibia, Anura, Hylidae)	*Dendropsophus branneri*	12° 31′ 50″ S 38° 17′ 59″ W**	Tadpole

Dubeux, Silva, Nascimento, Gonçalves, Mott	2019	Revista Nordestina de Zoologia	Síntese histórica e avanços no conhecimento de girinos (Amphibia: Anura) no estado do Alagoas, nordeste do Brasil	*Dendropsophus branneri*	9°39′56″ S 35°44′07″ W**	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus branneri*	9°39′56″ S 35°44′07″ W**	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus branneri*	5° 51' 36" S 35° 20' 59" W**	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus branneri*	7°06′54″ S 34°51′47″ W**	Tadpole
Duellman, Crump	1974	Occasional Papers of the Museum of Natural History, University of Kansas	Speciation in frogs of the *Hyla parviceps* group in the upper Amazon Basin	*Dendropsophus brevifrons*	00° 50' 06" N 76° 59' 33" W**	Advertisement call and tadpole
Duellman, WE	1978	Miscellaneous Publication.	The biology of an equatorial herpetofauna in Amazonian Ecuador	*Dendropsophus brevifrons*	7° 44' 31" S 35° 52' 34" W**	Advertisement call and tadpole
Duellman, WE	2005	Comstock Publishing Associates.	Cusco Amazonico, The lives of amphibians and reptiles in an Amazonian rainforest	*Dendropsophus brevifrons*	13°31′21″ S 71°58′02″ W**	Advertisement call and tadpole
Hero, J-M	1990	Amazoniana	An illustrated key to tadpoles occurring in the Central Amazon rainforest, Manaus, Amazonas, Brasil	*Dendropsophus cf. brevifrons*	2°57'42"S 59°55'40"W**	Tadpole
Ferreira, Faivovich, Beard, Pombal Jr	2015	PLoS One	The first bromeligenous species of *Dendropsophus* (Anura: Hylidae) from Brazil's Atlantic Forest	*Dendropsophus bromeliaceus*	19°54’S 40°32’W	Advertisement call
Teixeira, Giaretta	2015	Salamandra	Setting a fundament for taxonomy: advertisement calls from the type localities of three species of the *Dendropsophus rubicundulus* group (Anura: Hylidae)	*Dendropsophus cachimbo*	9°21’32’’ S 54°43’26’’ W	Advertisement call
Duellman, WE	1969	Herpetologica	A new species of frog in the *Hyla parviceps* group from Ecuador	*Dendropsophus carnifex*	0 °24′ S 78° 51′ W	Tadpole
De la Riva, Márquez, Bosch	1997	Bonner Zoologische Beiträge	Description of the advertisement calls of some South American Hylidae) Amphibia, Anura): Taxonomic and methodological consequences	*Dendropsophus carnifex*	00°17' S 78° 45' W	Advertisement call

Köhler, Jungfer, Reichle	2005	Journal of Herpetology	Another new species of small *Hyla* (Anura, Hylidae) from Amazonian sub-Andean forest of western Bolivia	*Dendropsophus coffea*	15° 33′ S 67° 30′ W	Advertisement call
Fouquet, Orrico, Ernst, Blanc, Martinez, Vacher, Rodrigues, Ouboter, Jairam, Ron	2015	Zootaxa	A new *Dendropsophus* Fitzinger, 1843 (Anura: Hylidae) of the parviceps group from the lowlands of the Guiana Shield	*Dendropsophus counani*	4.292663, -52.349539	Advertisement call and tadpole
Tessarolo, Maciel, Morais, Bastos	2016	Herpetological Journal	Geographic variation in advertisement calls among populations of *Dendropsophus cruzi* (Anura: Hylidae)	*Dendropsophus cruzi*	16° 19′ 43″ S 48° 57′ 12″ W**	Advertisement call
Tessarolo, Maciel, Morais, Bastos	2016	Herpetological Journal	Geographic variation in advertisement calls among populations of *Dendropsophus cruzi* (Anura: Hylidae)	*Dendropsophus cruzi*	16° 27' 40" S 49° 57' 42" W**	Advertisement call
Tessarolo, Maciel, Morais, Bastos	2016	Herpetological Journal	Geographic variation in advertisement calls among populations of *Dendropsophus cruzi* (Anura: Hylidae)	*Dendropsophus cruzi*	16° 40′ 48″ S 49° 15′ 18″ W**	Advertisement call
Tessarolo, Maciel, Morais, Bastos	2016	Herpetological Journal	Geographic variation in advertisement calls among populations of *Dendropsophus cruzi* (Anura: Hylidae)	*Dendropsophus cruzi*	17° 52′ 33″S 51° 43′ 17″ W**	Advertisement call
Tessarolo, Maciel, Morais, Bastos	2016	Herpetological Journal	Geographic variation in advertisement calls among populations of *Dendropsophus cruzi* (Anura: Hylidae)	*Dendropsophus cruzi*	14° 28' 26" S 48° 27' 35" W**	Advertisement call
Tessarolo, Maciel, Morais, Bastos	2016	Herpetological Journal	Geographic variation in advertisement calls among populations of *Dendropsophus cruzi* (Anura: Hylidae)	*Dendropsophus cruzi*	27° 34′ 46″ S 50° 9′ 37″ W**	Advertisement call
Tessarolo, Maciel, Morais, Bastos	2016	Herpetological Journal	Geographic variation in advertisement calls among populations of *Dendropsophus cruzi* (Anura: Hylidae)	*Dendropsophus cruzi*	15° 51′ 14″ S 48° 57′ 31″ W**	Advertisement call
Tessarolo, Maciel, Morais, Bastos	2016	Herpetological Journal	Geographic variation in advertisement calls among populations of *Dendropsophus cruzi* (Anura: Hylidae)	*Dendropsophus cruzi*	13° 25′ 52″ S 49° 8′ 34″ W**	Advertisement call
Tessarolo, Maciel, Morais, Bastos	2016	Herpetological Journal	Geographic variation in advertisement calls among populations of *Dendropsophus cruzi* (Anura: Hylidae)	*Dendropsophus cruzi*	17° 47′ 50″ S 50° 54′ 0″ W**	Advertisement call

Tessarolo, Maciel, Morais, Bastos	2016	Herpetological Journal	Geographic variation in advertisement calls among populations of *Dendropsophus cruzi* (Anura: Hylidae)	*Dendropsophus cruzi*	16° 39' 32" S 48° 36' 29" W**	Advertisement call
Pombal Jr, Bastos	1998	Boletim do Museu Nacional. Nova Serie, Zoologia	Nova espécie de *Hyla* Laurenti, 1768 do centro-oeste brasileiro e a posição taxonômica de *H. microcephala werneri* Cochran, 1952 e *H. microcephala meridiana* B. Lutz, 1952 (Anura, Hylidae)	*Dendropsophus cruzi*	16° 38′ S 48° 38′ W	Advertisement call
Abrunhosa, Wogel, Pombal Jr	2001	Boletim do Museu Nacional do Rio de Janeiro	Vocalização de quatro espécies de anuros do Estado do Rio de Janeiro, Sudeste do Brasil (Amphibia, Hylidae, Leptodactylidae)	*Dendropsophus decipiens*	22°50'48"S 42°27'16"W	Advertisement call
Dias, Araujo-Vieira, Carvalho-e-Silva, Orrico	2019	Plos One	Larval anatomy of *Dendropsophus decipiens* (A. Lutz 1925) (Anura: Hylidae: Dendropsophini) with considerations to larvae of this genus	*Dendropsophus decipiens*	22˚ 59'19"S 44˚06'13"W	Tadpole
Köhler, Lötters	2001	Salamandra	Description of a small tree frog, genus *Hyla* (Anura: Hylidae), from humid Andean slopes of Bolivia	*Dendropsophus delarivai*	17° 06′ 06″ S 65° 30′ 36″ W	Advertisement call
Ohmer, Robertson, Zamudio	2009	Biological Journal of the Linnean Society	Discordance in body size, colour pattern, and advertisement call across genetically distinct populations in a Neotropical anuran (*Dendropsophus ebraccatus*)	*Dendropsophus ebraccatus*	9°55′59″ N 84°04′59″ W**	Advertisement call
Ohmer, Robertson, Zamudio	2009	Biological Journal of the Linnean Society	Discordance in body size, colour pattern, and advertisement call across genetically distinct populations in a Neotropical anuran (*Dendropsophus ebraccatus*)	*Dendropsophus ebraccatus*	8°59′36″ N 79°31′11″ W**	Advertisement call
Muniz, Moura, Moraes, Galindo, Chaves, Kokubum, Moura	2016	Herpetology Notes	Acoustic characteristics of the advertisement call of *Dendropsophus elegans* (Anura: Hylidae)	*Dendropsophus elegans*	07° 60'S 34° 50'W	Advertisement call
Dubeux, Silva, Nascimento, Gonçalves, Mott	2019	Revista Nordestina de Zoologia	Síntese histórica e avanços no conhecimento de girinos (Amphibia: Anura) no estado do Alagoas, nordeste do Brasil	*Dendropsophus elegans*	9°39′56″ S 35°44′07″ W**	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus elegans*	8° 58' 33"S 35° 55' 48"W**	Tadpole
Martins, Jim	2004	Brazilian Journal of Biology	Advertisement call of *Hyla jimi and Hyla elianeae* (Anura, Hylidae) in the Botucatu Region, São Paulo, Brazil	*Dendropsophus elianeae*	22° 53'08 "S 48° 29'24" W	Advertisement call
Martins, Jim	2004	Brazilian Journal of Biology	Advertisement call of *Hyla jimi and Hyla elianeae* (Anura, Hylidae) in the Botucatu Region, São Paulo, Brazil	*Dendropsophus elianeae*	22° 57'03 "S 48° 27'36" W	Advertisement call

Kaplan, M	1991	Journal of Herpetology	A new species of *Hyla* from the eastern slope of the Cordillera Oriental in northern Colombia	*Dendropsophus garagoensis*	5° 11' 49" N 73° 8' 47" W	Tadpole
Heyer, WR	1980	Proceedings of the Biological Society of Washington	The calls and taxonomic positions of *Hyla giesleri* and *Ololygon opalina* (Amphibia: Anura: Hylidae)	*Dendropsophus giesleri*	19° 55′ 53″ S 40° 35′ 43″ W**	Advertisement call
Ruas, Mira-Mendes, Dias, Solé	2012	Zootaxa	Description of the advertisement call of *Dendropsophus haddadi* (Bastos and Pombal 1996) (Anura: Hylidae) from southern Bahia, Brazil	*Dendropsophus haddadi*	13° 49’35’’S 39° 08’32’’ W	Advertisement call
Ruas, Mira-Mendes, Dias, Solé	2012	Zootaxa	Description of the advertisement call of *Dendropsophus haddadi* (Bastos and Pombal 1996) (Anura: Hylidae) from southern Bahia, Brazil	*Dendropsophus haddadi*	15° 25’5 ’’ S 39° 32’45 ’’ W	Advertisement call
Lourenço-de-Moraes, Campos, Toledo	2012	Zootaxa	The tadpole of *Dendropsophus haddadi* (Bastos & Pombal 1996) (Hylidae: Hylinae)	*Dendropsophus haddadi*	14° 19 ’S 39° 04’ W	Tadpole
Dubeux, Silva, Nasciment, Gonçalves, Mott	2019	Revista Nordestina de Zoologia	Síntese histórica e avanços no conhecimento de girinos (Amphibia: Anura) no estado do Alagoas, nordeste do Brasil	*Dendropsophus haddadi*	9°39′56″ S 35°44′07″ W**	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus haddadi*	9°39′56″ S 35°44′07″ W**	Tadpole
Zimmerman, BL	1983	Herpetologica	A comparison of structural features of calls of open and forest habitat frog species in the central Amazon	*Dendropsophus haraldschultzi*	3° 6′ 26″ S 60° 1′ 34″ W**	Advertisement call
Menin, Almeida, Pedroso-Santos, Sanches, Costa-Campos	2020	Zootaxa	Description of the tadpole of *Dendropsophus haraldschultzi* (Bokermann, 1962) (Anura: Hylidae), with comments on reproductive biology	*Dendropsophus haraldschultzi*	0.0363°N 51.1625°W	Tadpole
Martins, Jim	2004	Brazilian Journal of Biology	Advertisement call of *Hyla jimi and Hyla elianeae* (Anura, Hylidae) in the Botucatu Region, São Paulo, Brazil	*Dendropsophus jimi*	22° 53'08 ”S 48° 29'24” W 57'03 "S 48 ° 27'36" W	Advertisement call
Köhler, Lötters	2001	Studies on Neotropical Fauna and Environment.	A new species of minute *Hyla* from the southwestern Amazon Basin (Amphibia, Anura, Hylidae)	*Dendropsophus joannae*	11° 00′ 45″ S 68° 45′ 27″ W	Advertisement call
Moravec, Aparicio, Köhler	2006	Zootaxa	A new species of tree frog, genus *Dendropsophus* (Anura: Hylidae), from the Amazon of northern Bolivia	*Dendropsophus juliani*	11° 33 ′ S 66° 56 ′ W	Advertisement call

Rivadeneira, Venegas, Ron	2018	ZooKeys	Species limits within the widespread Amazonian treefrog *Dendropsophus parviceps* with descriptions of two new species (Anura, Hylidae)	*Dendropsophus kamagarini*	12.8092°S 69.3182°W	Advertisement call
Duellman, WE	2005	Comstock Publishing Associates, Cornell University	Cusco Amazonico, The lives of amphibians and reptiles in an Amazonian rainforest	*Dendropsophus koechlini*	13°31′21″ S 71°58′02″ W**	Advertisement call and tadpole
Rivadeneira, Venegas, Ron	2018	ZooKeys	Species limits within the widespread Amazonian treefrog *Dendropsophus parviceps* with descriptions of two new species (Anura, Hylidae)	*Dendropsophus kubricki*	7.1914°S 73.9781°W	Advertisement call
Márquez, De la Riva, Bosch	1993	Biotropica	Advertisement calls of Bolivian species of *Hyla* (Amphibia, Anura, Hylidae)	*Dendropsophus leali*	15°46'S 62°15'W	Advertisement call
Duellman, WE	2005	Comstock Publishing Associates, Cornell University	Cusco Amazonico, The lives of amphibians and reptiles in an Amazonian rainforest	*Dendropsophus leali*	13°31′21″ S 71°58′02″ W**	Advertisement call and tadpole
Schulze, Jansen, Köhler	2015	Zootaxa	Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment	*Dendropsophus leali*	16°21.749'S 62°01.317'W	Tadpole
Duellman, WE	1978	Museum of Natural History, University of Kansas	The biology of an equatorial herpetofauna in Amazonian Ecuador. Miscellaneous Publication	*Dendropsophus leucophyllatus*	0°13′47″ S 78°31′29″ W**	Advertisement call and tadpole
Schulze, Jansen, Köhler	2015	Zootaxa	Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment	*Dendropsophus leucophyllatus*	S 17°31.032' W 63°17.399'	Tadpole
Zimmerman, BL	1983	Herpetologica	A comparison of structural features of calls of open and forest habitat frog species in the central Amazon	*Dendropsophus leucophyllatus*	3° 6′ 26″ S 60° 1′ 34″ W**	Advertisement call
Caminer, Milá, Jansen, Fouquet, Venegas, Chávez, Lougheed, Ron	2017	PLoS One	Systematics of the *Dendropsophus leucophyllatus* species complex (Anura: Hylidae): Cryptic diversity and the description of two new species	*Dendropsophus reticulatus*	2.5333°S 54.9666°W	Advertisement call
Guarnizo, Escallón, Cannatella, Amézquita	2012	Herpetologica	Congruence between acoustic traits and genealogical history reveals a new species of *Dendropsophus* (Anura: Hylidae) in the high Andes of Colombia	*Dendropsophus luddeckei*	05°45′02.8″N 73°16′39.7″W	Advertisement call

Duellman, WE	1978	Miscellaneous Publication.	The biology of an equatorial herpetofauna in Amazonian Ecuador	*Dendropsophus marmoratus*	0.085 N -76.9925 W**	Advertisement call and tadpole
Zimmerman, BL	1983	Herpetologica	A comparison of structural features of calls of open and forest habitat frog species in the central Amazon	*Dendropsophus marmoratus*	3°31'01"S 55°04'23"W**	Advertisement call
Zimmerman, BL, Bogart	1984	Acta Amazonica	Vocalizations of primary forest frog species in the Central Amazon	*Dendropsophus marmoratus*	3°31'01"S 55°04'23"W**	Advertisement call
Duellman, WE	2005	Comstock Publishing Associates	Cusco Amazonico, The lives of amphibians and reptiles in an Amazonian rainforest	*Dendropsophus marmoratus*	13°31′21″ S 71°58′02″ W**	Advertisement call and tadpole
Márquez, De la Riva, Bosch	1993	Biotropica	Advertisement calls of Bolivian species of *Hyla* (Amphibia, Anura, Hylidae)	*Dendropsophus melanargyreus*	15°46'S 62°15'W	Advertisement call
Schulze, Jansen, Köhler	2015	Zootaxa	Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment	*Dendropsophus melanargyreus*	16°21.749'S 62°01.317'W	Tadpole
Schulze, Jansen, Köhler	2015	Zootaxa	Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment	*Dendropsophus melanargyreus*	14°48.795'S 61°09.602'W	Tadpole
Pombal Jr., Bastos	1998	Boletim do Museu Nacional. Nova Serie, Zoologia	Nova espécie de *Hyla* Laurenti, 1768 do centro-oeste brasileiro e a posição taxonômica de *H. microcephala werneri* Cochran, 1952 e *H. microcephala meridiana* B. Lutz, 1952 (Anura, Hylidae)	*Dendropsophus meridianus*	16° 38′ S 48° 38′ W	Advertisement call
Vera Candioti, MF	2007	Zootaxa	Anatomy of anuran tadpoles from lentic water bodies: systematic relevance and correlation with feeding habits	*Dendropsophus microcephalus*	8°59′36″ N 79°31′11″ W**	Tadpole
Forti, Márquez, Bertoluci	2015	Zoologia	Advertisement call of *Dendropsophus microps* (Anura: Hylidae) from two populations from southeastern Brazil	*Dendropsophus microps*	23°37'S 45°52'W	Advertisement call
Forti, Márquez, Bertoluci	2015	Zoologia	Advertisement call of *Dendropsophus microps* (Anura: Hylidae) from two populations from southeastern Brazil	*Dendropsophus microps*	24°15'S 48°24'W	Advertisement call
Heyer, Rand, Cruz, Peixoto, Nelson	1990	Arquivos de Zoologia	Frogs of Boracéia	*Dendropsophus microps*	23°38'S 45°52'W	Advertisement call and tapole
Duellman, WE	1978	Miscellaneous Publication. Museum of Natural History	The biology of an equatorial herpetofauna in Amazonian Ecuador	*Dendropsophus minutus*	0.085 N -76.9925 W**	Advertisement call and tadpole
Donnelly, Myers	1991	American Museum Novitates	Herpetological results of the 1990 Venezuelan expedition to the summit of Cerro Guaiquinima, with new tepui reptiles	*Dendropsophus minutus*	5°46'N 63°36'W	Advertisement call and tadpole

Heyer, Rand, Cruz, Peixoto, Nelson	1990	Arquivos de Zoologia	Frogs of Boracéia	*Dendropsophus minutus*	23°38'S 45°52'W	Advertisement call and tadpole
Márquez, De la Riva, Bosch	1993	Biotropica	Advertisement calls of Bolivian species of *Hyla* (Amphibia, Anura, Hylidae)	*Dendropsophus minutus*	15°46'S 62°15'W	Advertisement call
Schulze, Jansen, Köhler	2015	Zootaxa	Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment	*Dendropsophus minutus*	17°31.032’S 63°17.399’W	Tadpole
Schulze, Jansen, Köhler	2015	Zootaxa	Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment	*Dendropsophus minutus*	16°21.749'S 62°01.317'W	Tadpole
Zimmerman, BL	1983	Herpetologica	A comparison of structural features of calls of open and forest habitat frog species in the central Amazon.	*Dendropsophus minutus*	3°31’01”S 55°04’23”W**	Advertisement call
Hero, J-M	1990	Amazoniana	An illustrated key to tadpoles occurring in the Central Amazon rainforest, Manaus, Amazonas, Brasil.	*Dendropsophus minutus*	02°55'S 59°59'W	Tadpole
Dubeux, Silva, Nascimento, Gonçalves, Mott	2019	Revista Nordestina de Zoologia	Síntese histórica e avanços no conhecimento de girinos (Amphibia: Anura) no estado do Alagoas, nordeste do Brasil	*Dendropsophus minutus*	9°39′56″ S 35°44′07″ W**	Tadpole
Rossa-Feres, Nomura	2006 "2005 ".	Biota Neotropica	Characterization and taxonomic key for tadpoles (Amphibia: Anura) from the northwestern region of São Paulo State, Brazil	*Dendropsophus minutus*	21°04’40’’S 49°32’23’’W	Tadpole
Rossa-Feres, Nomura	2006 "2005 ".	Biota Neotropica	Characterization and taxonomic key for tadpoles (Amphibia: Anura) from the northwestern region of São Paulo State, Brazil	*Dendropsophus minutus*	20°34’59" S 49°30’00’’W	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus minutus*	09°44’27,6’’ S 36°30’10,8’’ W**	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus minutus*	5° 51' 36" S 35° 20' 59" W**	Tadpole
Alves-Ferreira, Paixão, Nomura	2021	Biota Neotropica	Morphological characterization and diversity of tadpoles (Amphibia: Anura) at Emas National Park and its surrounding, Goiás State, Brazil	*Dendropsophus minutus*	17°49',18°28'S e 52°39',53°10'W	Tadpole
Guarnizo, Armesto	2014	Catálogo de Anfibios y Reptiles de Colombia.	*Dendropsophus labialis* (Peters, 1863)	*Dendropsophus molitor*	6° 30' 36" N 72° 18' 25" W**	Advertisement call

Sanguino, Acevedo-Rincón						
Orrico, Lingnau, Giasson	2009	South American Journal of Herpetology	The advertisement call of *Dendropsophus nahdereri* (Anura, Hylidae, Dendropsophini)	*Dendropsophus nahdereri*	26°51'13" S 50°40'00" W	Advertisement call
Conte, Nomura, Machado, Kwet, Lingnau, Rossa-Feres	2010	Biota Neotropical	Novos registros na distribuição geográfica de anuros na Floresta com Araucária e considerações sobre suas vocalizações	*Dendropsophus nahdereri*	25° 32' 05”S 49° 12' 23”W**	Advertisement call
Lavilla, EO	1990	Journal of Herpetology	The tadpole of *Hyla nana* (Anura: Hylidae)	*Dendropsophus nanus*	26°47′00″S 60°27′00″W**	Tadpole
Márquez, De la Riva, Bosch	1993	Biotropica	Advertisement calls of Bolivian species of *Hyla* (Amphibia, Anura, Hylidae)	*Dendropsophus nanus*	15°46'S 62°15'W	Advertisement call
Martins, Jim	2003	Brazilian Journal of Biology	Bioacoustic analysis of advertisement call in *Hyla nana* and *Hyla sanborni* (Anura, Hylidae) in Botucatu, São Paulo, Brazil	*Dendropsophus nanus*	22°53’08”S 48°29’24”W	Advertisement call
Martins, Jim	2003	Brazilian Journal of Biology	Bioacoustic analysis of advertisement call in *Hyla nana* and *Hyla sanborni* (Anura, Hylidae) in Botucatu, São Paulo, Brazil	*Dendropsophus nanus*	22°57’03”S 48°27’36”W	Advertisement call
Vera Candioti, MF	2007	Zootaxa	Anatomy of anuran tadpoles from lentic water bodies: systematic relevance and correlation with feeding habits	*Dendropsophus nanus*	31° 38′ 26″ S 60° 41′ 30″ W**	Tadpole
Schulze, Jansen, Köhler	2015	Zootaxa	Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment	*Dendropsophus nanus*	16°21.749'S 62°01.317'W	Tadpole
Teixeira, Zaracho, Giaretta	2016	Biota Neotropical	Advertisement and courtship calls of *Dendropsophus nanus* (Boulenger, 1889) (Anura: Hylidae) from its type locality (Resistencia, Argentina)	*Dendropsophus nanus*	27°27′38″ S 58°59′02″W	Advertisement call
Zimmerman, BL	1983	Herpetologica	A comparison of structural features of calls of open and forest habitat frog species in the central Amazon	*Dendropsophus nanus*	3° 6′ 26″ S 60° 1′ 34″ W**	Advertisement call
Hero, J-M	1990	Amazoniana	An illustrated key to tadpoles occurring in the Central Amazon rainforest, Manaus, Amazonas, Brasil	*Dendropsophus nanus*	02°55'S 59°59'W	Tadpole

Dubeux, Silva, Nascimento, Gonçalves, Mott	2019	Revista Nordestina de Zoologia	Síntese histórica e avanços no conhecimento de girinos (Amphibia: Anura) no estado do Alagoas, nordeste do Brasil	*Dendropsophus nanus*	9°39′56″ S 35°44′07″ W**	Tadpole
Rossa-Feres, Nomura	2006 "2005 ".	Biota Neotropica	Characterization and taxonomic key for tadpoles (Amphibia: Anura) from the northwestern region of São Paulo State, Brazil	*Dendropsophus nanus*	21°04’40’’S 49°32’23’’W	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus nanus*	5° 51' 36" S 35° 20' 59" W**	Tadpole
Alves-Ferreira, Paixão, Nomura	2021	Biota Neotropica	Alves-Ferreira, G., I B. F. da Paixão, and F. Nomura. 2021. Morphological characterization and diversity of tadpoles (Amphibia: Anura) at Emas National Park and its surrounding, Goiás State, Brazil	*Dendropsophus nanus*	17°49',18°28'S e 52°39',53°10'W	Tadpole
Basso, Perí, Di Tada.	1985	Cuadernos de Herpetología	Revalidación de *Hyla sanborni* Schmidt, 1944 (Anura: Hylidae)	*Dendropsophus nanus*	-34.6653 S -58.7275 W**	Advertisement call
Dias, I. R., C. F. B. Haddad, A. J. S. Argôlo, and V. G. D. Orrico	2017	PloS One	The 100th: An appealing new species of *Dendropsophus* (Amphibia: Anura: Hylidae) from northeastern Brazil.	*Dendropsophus nekronastes*	14° 42′ 0,51″ S 39° 37′ 48″ W	Advertisement call
Rivera-Correa, Gutiérrez-Cárdenas.	2012	Zootaxa	A new highland species of treefrog of the *Dendropsophus columbianus* group (Anura: Hylidae) from the Andes of Colombia	*Dendropsophus norandinus*	06°58’50’’N 75°08’07’’W	Tadpole
Rivera-Correa, Gutiérrez-Cárdenas	2013	Medellín	*Dendropsophus norandinus*. Catálogo de Anfibios y Reptiles de Colombia	*Dendropsophus norandinus*	06°58’50’’N 75°08’07’’W	Advertisement call and tadpole
Protázio, Protázio, Conceição, Braga, Santos, Ribeiro, Souza	2017	Zootaxa	The advertisement call of *Dendropsophus novaisi* (Bokermann, 1968) (Anura: Hylidae: Dendropsophinae)	*Dendropsophus novaisi*	12°39’29” S 39°04’48” W	Advertisement call
Ruas, Mira-Mendes, Del Grande	2018	Zootaxa	The tadpole of *Dendropsophus novaisi* (Bokermann, 1968) (Anura: Hylidae), with comments on natural history	*Dendropsophus novaisi*	13° 49' 26.674"S 39° 11' 5.248" W	Tadpole

Santana, Mesquita, Garda	2011	Zootaxa	Advertisement call of *Dendropsophus oliveirai* (Anura, Hylidae)	*Dendropsophus oliveirai*	6° 43' 17"S 35° 10' 49"W**	Advertisement call
Dubeux, Silva, Nascimento, Gonçalves, Mott	2019	Revista Nordestina de Zoologia	Síntese histórica e avanços no conhecimento de girinos (Amphibia: Anura) no estado do Alagoas, nordeste do Brasil	*Dendropsophus oliveirai*	9°39′56″ S 35°44′07″ W**	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus oliveirai*	10° 8′ 1″ S 36° 10′ 34″ W**	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus oliveirai*	5° 51' 36" S 35° 20' 59" W**	Tadpole
Orrico, Peloso, Sturaro, Silva, Filho, Neckel-Oliveira, Gordo, Faivovich, Haddad	2014	Zootaxa	A new "Bat-Voiced" species of *Dendropsophus* Fitzinger, 1843 (Anura, Hylidae) from the Amazon Basin, Brazil	*Dendropsophus ozzyi*	03°56'50"S 58°26'36"W	Advertisement call
Kaplan, Ruiz-Carranza	1997	Journal of Herpetology	Two new species of *Hyla* from the Andes of central Colombia and their relationships to other small Andean *Hyla*	*Dendropsophus padreluna*	4° 45′ N 74° 50′ W	Tadpole
Duellman, Crump	1974	Occasional Papers of the Museum of Natural History, University of Kansas	Speciation in frogs of the *Hyla parviceps* group in the upper Amazon Basin	*Dendropsophus parviceps*	0.085 N -76.9925 W**	Advertisement call and tadpole
Duellman, WE	1978	Miscellaneous Publication. Museum of Natural History	The biology of an equatorial herpetofauna in Amazonian Ecuador	*Dendropsophus parviceps*	0.085 N -76.9925 W**	Advertisement call and tadpole
Duellman, WE	2005	Comstock Publishing Associates	Cusco Amazonico, The lives of amphibians and reptiles in an Amazonian rainforest	*Dendropsophus parviceps*	13°31′21″ S 71°58′02″ W**	Advertisement call and tadpole
Hero, J-M	1990	Amazoniana	An illustrated key to tadpoles occurring in the Central Amazon rainforest, Manaus, Amazonas, Brasil	*Dendropsophus parviceps*	02°55'S 59°59'W	Tadpole
Márquez, De la Riva, Bosch	1993	Biotropica	Advertisement calls of Bolivian species of *Hyla* (Amphibia, Anura, Hylidae)	*Dendropsophus parviceps*	15°46'S 62°15'W	Advertisement call

Mijares-Urrutia, A	1998	Revista de Biología Tropical	Los renacuajos de los anuros (Amphibia) altoandinos de Venezuela: Morfología externa y claves	*Dendropsophus pelidnus*	7° 14′ 49″ N 70° 43′ 1″ W	Tadpole
Duellman, Trueb	1983	Cambridge, Massachusetts, Museum of Comparative Zoology	Frogs of the Hyla columbiana group: taxonomy and phylogenetic relationships. (Capítulo de livro)	*Dendropsophus praestans*	1° 53′ N 76° 16′ W	Advertisement call
Cruz, Caramaschi, Dias	2000	Boletim do Museu Nacional. Nova Serie, Zoologia	Espécie nova de *Hyla* Laurenti, 1768 do Estado do Rio de Janeiro, Brasil (Amphibia, Anura, Hylidae)	*Dendropsophus pseudomeridianus*	22° 44′ S 43° 42′ W	Tadpole
Caram, Luna-Dias, Neto, Hepp, Carvalho-e-Silva	2014	Zootaxa	The advertisement call of *Dendropsophus pseudomeridianus* (Cruz, Caramaschi & Dias) (Anura: Hylidae)	*Dendropsophus pseudomeridianus*	22° 34’ 37” S 43° 01’ 50” W	Advertisement call
Rosado, Assis, Dias, Guedes, Feio	2019	Herpetology Notes	New records of *Dendropsophus pseudomeridianus* (Cruz, Caramaschi & Dias 2000) (Anura: Hylidae) from southeastern Brazil	*Dendropsophus pseudomeridianus*	21.241111°S 42.696667°W	Advertisement call
Rosado, Assis, Dias, Guedes, Feio	2019	Herpetology Notes	New records of *Dendropsophus pseudomeridianus* (Cruz, Caramaschi & Dias 2000) (Anura: Hylidae) from southeastern Brazil	*Dendropsophus pseudomeridianus*	21.516028°S 42.962944°W	Advertisement call
Rosado, Assis, Dias, Guedes, Feio	2019	Herpetology Notes	New records of *Dendropsophus pseudomeridianus* (Cruz, Caramaschi & Dias 2000) (Anura: Hylidae) from southeastern Brazil	*Dendropsophus pseudomeridianus*	21.719917°S 42.676778° W	Advertisement call
Rosado, Assis, Dias, Guedes, Feio	2019	Herpetology Notes	New records of *Dendropsophus pseudomeridianus* (Cruz, Caramaschi & Dias 2000) (Anura: Hylidae) from southeastern Brazil	*Dendropsophus pseudomeridianus*	21.459528°S 42.323611°W	Advertisement call
Moravec, Aparicio, Guerrero-Reinhard, Calderón, Köhler	2008	Zootaxa	Diversity of small Amazonian *Dendropsophus* (Anura: Hylidae): another new species from northern Bolivia	*Dendropsophus reichlei*	11° 44′ S 68° 34′ W	Advertisement call
Caminer, Milá, Jansen, Fouquet, Venegas, Chávez, Lougheed, Ron	2017	PLoS One	Systematics of the *Dendropsophus leucophyllatus* species complex (Anura: Hylidae): Cryptic diversity and the description of two new species	*Dendropsophus reticulatus*	1.0343°S 77.6685°W	Advertisement call

Caminer, Milá, Jansen, Fouquet, Venegas, Chávez, Lougheed, Ron	2017	PLoS One	Systematics of the *Dendropsophus leucophyllatus* species complex (Anura: Hylidae): Cryptic diversity and the description of two new species	*Dendropsophus reticulatus*	0.7554°S 76.3461°W	Advertisement call
Duellman, WE	1972	Herpetologica	The systematic status and life history of *Hyla rhodopepla* Günther	*Dendropsophus rhodopeplus*	0.085 N -76.9925 W**	Advertisement call and tadpole
Duellman, WE	1978	Miscellaneous Publication. Museum of Natural History	The biology of an equatorial herpetofauna in Amazonian Ecuador	*Dendropsophus rhodopeplus*	0.085 N -76.9925 W**	Advertisement call and tadpole
Márquez, De la Riva, Bosch	1993	Biotropica	Advertisement calls of Bolivian species of *Hyla* (Amphibia, Anura, Hylidae)	*Dendropsophus rhodopeplus*	17°00'S 64°50'W	Advertisement call
Duellman, WE	2005	Comstock Publishing Associates	Cusco Amazonico, The lives of amphibians and reptiles in an Amazonian rainforest	*Dendropsophus rhodopeplus*	13°31′21″ S 71°58′02″ W**	Advertisement call and tadpole
Márquez, De la Riva, Bosch	1993	Biotropica	Advertisement calls of Bolivian species of *Hyla* (Amphibia, Anura, Hylidae)	*Dendropsophus riveroi*	15°46'S 62°15'W	Advertisement call
Duellman, WE	1970	Museum of Natural History.	The hylid frogs of Middle America	*Dendropsophus robertmertensi*	14° 54′ 0″ N 92° 16′ 0″ W**	Advertisement call
Duellman, WE	1978	Miscellaneous Publication. Museum of Natural History	The biology of an equatorial herpetofauna in Amazonian Ecuador	*Dendropsophus rossalleni*	0.085 N -76.9925 W**	Tadpole
Zimmerman, BL	1983	Herpetologica	A comparison of structural features of calls of open and forest habitat frog species in the central Amazon	*Dendropsophus rossalleni*	3° 6′ 26″ S 60° 1′ 34″ W**	Advertisement call
Jansen, Santana, Teixeira, Köhler	2019	Vertebrate Zoology	A new striped species of *Dendropsophus* (Anura: Hylidae) with a composite advertisement call and comments on the *D. rubicundulus* group	*Dendropsophus rozenmani*	14.836217°S, 61.177783°W	Advertisement call
Napoli, Caramaschi	1999	ALYTES	Geographic variation of *Hyla rubicundula* and *Hyla anataliasiasi*, with the description of a new species (Anura, Hylidae)	*Dendropsophus rubicundulus*	16.643°S 48.6041°W**	Advertisement call
Teixeira, Giaretta	2015	Salamandra	Setting a fundament for taxonomy: advertisement calls from the type localities of three species of the *Dendropsophus rubicundulus* group (Anura: Hylidae)	*Dendropsophus rubicundulus*	19°37’53’’ S 43°53’17’’ W	Advertisement call
Weygoldt, Peixoto	1987	Studies on Neotropical Fauna and Environment	*Hyla ruschii* n. sp., a new frog from the Atlantic Forest domain in the state of Espirito Santo, Brazil (Amphibia, Hylidae)	*Dendropsophus ruschii*	20.3639°S 40.6598°W**	Vocalização e girino

Jungfer, Reichle, Piskurek	2010	Salamandra	Description of a new cryptic southwestern Amazonian species of leaf-gluing treefrog, genus *Dendropsophus* (Amphibia: Anura: Hylidae)	*Dendropsophus salli*	14° 26′ 11″ S 67° 29′ 35″ W	Advertisement call
Schulze, Jansen, Köhler	2015	Zootaxa	Tadpole diversity of Bolivia's lowland anuran communities: molecular identification, morphological characterisation, and ecological assignment	*Dendropsophus salli*	16°21.749'S 62°01.317'W	Tadpole
Basso, Perí, Di Tada	1985	Cuadernos de Herpetología	Revalidación de *Hyla sanborni* Schmidt, 1944 (Anura: Hylidae)	*Dendropsophus sanborni*	34.6653°S; 58.7275°W**	Advertisement call
Martins, Jim	2003	Brazilian Journal of Biology	Bioacoustic analysis of advertisement call in *Hyla nana* and *Hyla sanborni* (Anura, Hylidae) in Botucatu, São Paulo, Brazil	*Dendropsophus sanborni*	22°53'08"S 48°29'24"W	Advertisement call
Martins, Jim	2003	Brazilian Journal of Biology	Bioacoustic analysis of advertisement call in *Hyla nana* and *Hyla sanborni* (Anura, Hylidae) in Botucatu, São Paulo, Brazil	*Dendropsophus sanborni*	22°57'03"S 48°27'36"W	Advertisement call
Duellman, WE	1978	Miscellaneous Publication. Museum of Natural History	The biology of an equatorial herpetofauna in Amazonian Ecuador.	*Dendropsophus sarayacuensis*	0.085 N -76.9925 W**	Advertisement call and tadpole
Duellman, WE	1970	Museum of Natural History	The hylid frogs of Middle America	*Dendropsophus sartori*		Advertisement call
Duellman, WE	2005	Comstock Publishing Associates, Cornell University	Cusco Amazonico, The lives of amphibians and reptiles in an Amazonian rainforest	*Dendropsophus schubarti*	13°31′21″ S 71°58′02″ W**	Advertisement call and tadpole
Hepp, Luna-Dias, Neto, Gonzaga, Carvalho-e-Silva	2012	South American Journal of Herpetology	Redescription of the advertisement call of *Dendropsophus seniculus* (Cope, 1868) and the consequences for the acoustic traits of the *Dendropsophus marmoratus* species group (Amphibia: Anura: Dendropsophini)	*Dendropsophus seniculus*	22°27'10,20"S 42°18'6,28"W	Advertisement call
Ortega-Andrade, Ron	2013	Zootaxa	A new species of small tree frog, genus *Dendropsophus* (Anura: Hylidae) from the eastern Amazon lowlands of Ecuador	*Dendropsophus shiwiarum*	2.060° S 76.780° W	Advertisement call
Guimarães, Lima, Juliano, Bastos	2001	Boletim do Museu Nacional. Nova Serie, Zoologia	Vocalizações de espécies de anuros (Amphibia) no Brasil central	*Dendropsophus soaresi*	14° 20' 16"S 46°06'47" W	Advertisement call
Dubeux, Silva, Nascimento, Gonçalves, Mott	2019	Revista Nordestina de Zoologia	Síntese histórica e avanços no conhecimento de girinos (Amphibia: Anura) no estado do Alagoas, nordeste do Brasil	*Dendropsophus soaresi*	9°39′56″ S 35°44′07″ W**	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus soaresi*	10° 8′ 1″ S 36° 10′ 34″ W**	Tadpole

Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus soaresi*	5° 51' 36" S 35° 20' 59" W**	Tadpole
Kaplan, M.	1994	Journal of Herpetology	A new species of frog of the genus *Hyla* from the Cordillera Oriental in northern Colombia with comments on the taxonomy of *Hyla minuta*	*Dendropsophus stingi*	5.19695 N -73.1463 W**	Tadpole
Carvalho-e-Silva, Carvalho-e-Silva, Izecksohn	2003	Revista Brasileira de Zoologia	Nova especie de *Hyla* Laurenti do grupo de *H. microcephala* Cope (Amphibia, Anura, Hylidae) do nordeste do Brasil	*Dendropsophus studerae*	09° 19′ 08″ S 36° 28′ 16″W	Tadpole
Napoli, M.F., Abreu, R.O., Cruz, D., Herrera, J.B., Petersen, E. & Klein, W.	2014	Zootaxa	Advertisement call of *Dendropsophus studerae* (Carvalho-e-Silva, Carvalho-e-Silva and Izecksohn, 2003) (Anura: Hylidae), with new record and geographic distribution extension	*Dendropsophus studerae*	12°27'03,6"S 38°24'23,3"W	Advertisement call
Dubeux, Silva, Nascimento, Gonçalves, Mott	2019	Revista Nordestina de Zoologia	Síntese histórica e avanços no conhecimento de girinos (Amphibia: Anura) no estado do Alagoas, nordeste do Brasil	*Dendropsophus studerae*	9°39′56″ S 35°44′07″ W**	Tadpole
Dubeux et al	2020	Biota Neotropica	Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest	*Dendropsophus studerae*	09° 19′ 08″ S 36° 28′ 16″W	Tadpole
Duellman, WE	1970	Museum of Natural History	The hylid frogs of Middle America	*Dendropsophus subocularis*	8.15081 N -77.69521 W**	Advertisement call and tadpole
Duellman, Crump	1974	Occasional Papers of the Museum of Natural History	Speciation in frogs of the *Hyla parviceps* group in the upper Amazon Basin	*Dendropsophus subocularis*	8.15081 N -77.69521 W**	Advertisement call and tadpole
Duellman, Crump	1974	Occasional Papers of the Museum of Natural History	Speciation in frogs of the *Hyla parviceps* group in the upper Amazon Basin	*Dendropsophus subocularis*	8.15081 N -77.69521 W**	Tadpole
Oliveira, Magalhães, Teixeira, Moura, Porto,	2021	PloS ONE	A new species of the *Dendropsophus decipiens* group (Anura: Hylidae) from northeastern Brazil	*Dendropsophus tapacurensis*	8˚2’26.13"S 35˚12’0.43"W	Advertisement call

Guimarães, Giaretta, Tinôco						
Martins, Cardoso	1987	Revista Brasileira de Biologia	Novas especies de hilideos do Estado do Acre (Amphibia: Anura)	*Dendropsophus timbeba*	10° 36′ S 68° 32′ W	Advertisement call
Duellman, WE	2005	Comstock Publishing Associates	Cusco Amazonico, The lives of amphibians and reptiles in an Amazonian rainforest	*Dendropsophus timbeba*	13°31′21″ S 71°58′02″ W**	Advertisement call and tadpole
Teixeira, Giaretta	2017	Phyllomedusa	Rediscovery of *Dendropsophus tintinnabulum* (Anura: Hylidae) in the upper Rio Negro drainage (Amazonas, Brazil), with a description of its advertisement call and external morphology	*Dendropsophus tintinnabulum*	0° 09' 43"S 66° 50' 32" W	Advertisement call
Duellman, WE	1978	Miscellaneous Publication. Museum of Natural History	The biology of an equatorial herpetofauna in Amazonian Ecuador	*Dendropsophus triangulum*	0.085 N -76.9925 W**	Advertisement call and tadpole
Duellman, WE	2005	Comstock Publishing Associates, Cornell University	Cusco Amazonico, The lives of amphibians and reptiles in an Amazonian rainforest	*Dendropsophus triangulum (como Hyla leucophyllatus)*	13°31′21″ S 71°58′02″ W**	Advertisement call and tadpole
Caminer, Milá, Jansen, Fouquet, Venegas, Chávez, Lougheed, Ron	2017	PLoS One	Systematics of the *Dendropsophus leucophyllatus* species complex (Anura: Hylidae): Cryptic diversity and the description of two new species	*Dendropsophus triangulum*	0.5756°S 75.8998°W	Advertisement call
Zimmerman, BL	1983	Herpetologica	A comparison of structural features of calls of open and forest habitat frog species in the central Amazon	*Dendropsophus triangulum*	3° 6′ 26″ S 60° 1′ 34″ W**	Advertisement call
Teixeira, Giaretta, Pansonato.	2013	Zootaxa	The advertisement call of *Dendropsophus tritaeniatus* (Bokermann, 1965) (Anura: Hylidae)	*Dendropsophus tritaeniatus*	15°36´50´´S 55°28´14´´W	Advertisement call
Jansen, Santana, Teixeira, Köhler	2019	Vertebrate Zoology	A new striped species of *Dendropsophus* (Anura: Hylidae) with a composite advertisement call and comments on the *D. rubicundulus* group	*Dendropsophus tritaeniatus*	15°36´50´´S 55°28´14´´W	Advertisement call
Kaplan, Ruiz-Carranza	1997	Journal of Herpetology	Two new species of *Hyla* from the Andes of central Colombia and their relationships to other small Andean *Hyla*.	*Dendropsophus virolinensis*	6° 13′ N 75° 05′ W	Tadpole
Chávez, Barboza, Thompson	2021	Amphibian & Reptile Conservation	The distribution and calls of Vraem' Treefrog, *Dendropsophus vraemi* (Caminer, Milá, Jansen, Fouquet, Venegas, Chávez, Lougheed, and Ron 2017), with comments on its conservation status	*Dendropsophus vraemi*	12° 55'46,8"S 73°32'3,3"W	Advertisement call

Chávez, Barboza, Thompson	2021	Amphibian & Reptile Conservation	The distribution and calls of Vraem' Treefrog, *Dendropsophus vraemi* (Caminer, Milá, Jansen, Fouquet, Venegas, Chávez, Lougheed, and Ron 2017), with comments on its conservation status	*Dendropsophus vraemi*	11°31'38,9"S 74°24'40,2 "W	Advertisement call
De la Riva, Márquez, Bosch	1997	Bonner Zoologische Beiträge	Description of the advertisement calls of some South American Hylidae) Amphibia, Anura): Taxonomic and methodological consequences	*Dendropsophus walfordi*	13°33'S 6°00' W	Advertisement call
Lingnau, Guimarães, Bastos	2004	Phyllomedusa.	Vocalizations of *Hyla werneri* (Anura, Hylidae) in southern Brazil	*Dendropsophus werneri*	25°26'59'' S 48°52'09'' W	Advertisement call
Martins, Cardoso	1987	Revista Brasileira de Biologia	Novas especies de hilideos do Estado do Acre (Amphibia: Anura)	*Dendropsophus xapuriensis*	10° 36′ S 68° 32′ W	Advertisement call

**Articles that indicated only the municipality or when the coordinates were not available in the description were inserted as general coordinates of the municipality or locality

CAPÍTULO 2

Phenology and vocalization pattern of *Dendropsophus branneri* in southern Bahia lagoons

Phenology and vocalization pattern of *Dendropsophus branneri* in southern Bahia lagoons

Mayra Caroliny de Oliveira Santos[1,2] *, Jorge Mario Herrera-Lopera[1,2], Mirco Solé[1,2]

[1]Programa de Pós-graduação em Ecologia e Conservação da Biodiversidade, Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil
[2]Tropical Herpetology Lab, Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil

Corresponding Author:
Mayra Santos*
Rodovia Ilhéus-Itabuna, km 16, Salobrinho, 45662-000 Ilhéus, Bahia, Brazil
Email address: mayracarolinyoliveirasantos@yahoo.com.br

Abstract

Anurans are diverse in the number of species and reproductive modes, which are adapted to specific environmental conditions. During reproductive periods, advertisement calls are important as signal species identity, sexual receptivity, position, size, and, in some cases, the identity of males in a chorus. Therefore, understanding these daily vocalization patterns is crucial for species with taxonomic complexity, such as those in the genus *Dendropsophus*. The species *Dendropsophus branneri Dendropsophus branneri* has its advertisement call description and tadpole known; however, there is still no information regarding the daily vocalization pattern. Thus, the objective of this study was to assess the reproductive phenology of the species through its vocalization activity in southern Bahia. In this way, we employed the Passive Acoustic Monitoring (PAM) technique. We analyzed the activity pattern using reference calls of the species to extract and process vocalizations from acoustic landscapes. In our results, we present a detailed approach, that is, the daily period of acoustic activity and patterns of the species, which had activity throughout the year and at all three points, confirming the species' prolonged reproduction strategy. In visits where a higher number of simultaneous advertisement calls (choruses) were recorded at all sampling points, we observed that this peak of activity occurred mostly during the night or early morning. Therefore, monitoring the same species in different environments was crucial for understanding its behavior throughout the year, thereby reducing the information gap for both the species and such a diverse group.

Keywords: Anurans, advertisement call, acoustic monitoring, acoustic landscapes

Introduction

Anurans comprise a diverse group, with a global species count of 7,687 (*Frost, 2024*), and exhibit a wide array of reproductive modes, totaling 71 known strategies (*Nunes-de-Almeida et al., 2021*). These reproductive strategies in anurans encompass a set of traits describing how and where eggs are fertilized and where embryos and larvae

are found (*Nunes-de-Almeida et al., 2021*), which are adapted to specific environmental conditions (*Pombal Jr & Haddad, 2005*).

Generally, the reproductive period is linked to the rainy season. In tropical regions with higher humidity, anurans typically reproduce more or less continuously during the rainy season, although some species time their reproduction to coincide with particularly heavy rains (*Wells, 2007*). In drier tropical habitats such as savannas, reproductive seasons are shorter or divided into brief episodes of reproduction (*Wells, 2007*).

During these reproductive periods, advertisement calls are crucial for partner recognition in anurans, thus contributing to pre-mating isolation among sympatric species (*Padial et al., 2008*). Advertisement calls are considered species-specific and signal species identity, sexual receptivity, position, size, and, in some cases, male identity within a chorus (*Wells & Schwartz, 2007; Köhler et al., 2017*). Acoustic signals are sounds that mediate intra- or interspecific communication (*Köhler et al., 2017*). Therefore, such acoustic signals can be a prominent feature in community ecology studies (*Guerra et al., 2018*).

Anuran species exhibit different daily vocalization patterns. In most cases, aside from rainfall quantity, suitable temperature conditions and photoperiod are important for vocalization activity in all anuran species (*Schalk & Saenz, 2016*). Understanding these daily vocalization patterns is crucial for species with taxonomic complexity, such as those in the genus *Dendropsophus*, as acoustic characteristics can aid in species delimitation and resolving phylogenetic relationships among species (*Nunes et al., 2007; Orrico et al., 2009; Orrico et al., 2013*).

Traditionally, amphibian calls were recorded using an analogue or digital recorder coupled with a unidirectional microphone. This allowed recordings of a single pre-located and identified individual. However, recording had a time limitation, as the researcher needed to manipulate the recorder, and the recording could only accommodate the time the researcher spent on-site. The arrival of automatic recorders enabled recordings of extended periods, without the disturbance caused by the presence of a researcher, with subsequent analysis of recordings outside of nature. Only recently have these recorders begun to be used to understand the acoustic temporal patterns of different amphibian

species, and with the use of dataloggers, it has become possible to associate these acoustic data with abiotic data such as rainfall and temperature (*Güell & Warkentin, 2023*).

The species *Dendropsophus branneri* (Cochran, 1948) is a small hylid anuran belonging to the *Dendropsophus microcephalus* group (*Orrico et al., 2020*), distributed in Pernambuco, Rio Grande do Norte, Alagoas, Bahia, and Rio de Janeiro in Brazil (*Frost, 2024*). It can be found in large numbers in temporary and permanent lagoons (*Arzabe et al., 1998; Castro et al., 2016*). *Dendropsophus branneri* has its advertisement call description (*Nunes et al., 2007*) and tadpole (*Abreu et al., 2015*) known; however, there is still no information regarding the daily vocalization pattern. Thus, the objective of this study was to assess the reproductive phenology of the species through its vocalization activity in southern Bahia.

Materials & Methods

The study was conducted in three locations in the state of Bahia, northeastern Brazil (Fig. 1): Poça Cabruca, a cocoa plantation located behind the campus of the State University of Santa Cruz (UESC), Municipality of Ilhéus, Bahia, Brazil (14°47'42.84"S 39°10'28.28"W); pond in the Serra Bonita Reserve, Santa Bárbara Farm, municipality of Camacan – Bahia (15°24'29.25"S 39°32'06.70"W); Mata Boa Pond, Pacange, Michelin Ecological Reserve (REM), Igrapiúna – Bahia (13°50'S, 39°10'W).

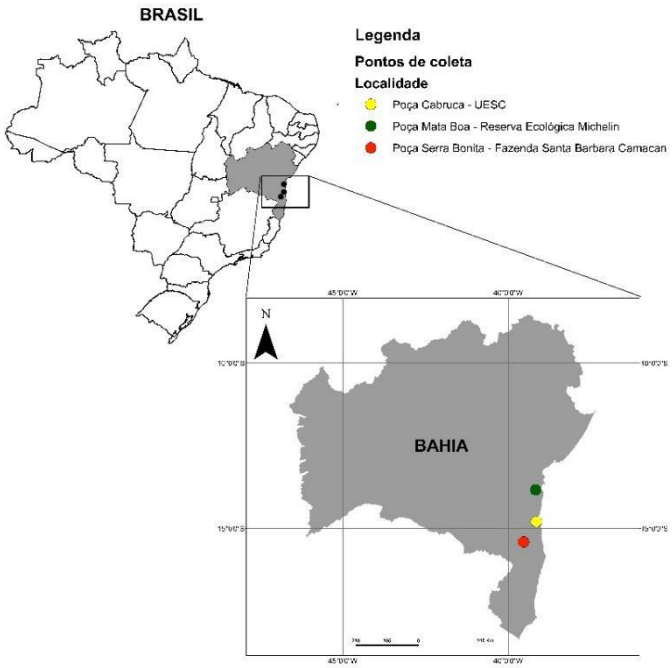

Fig. 1. Map with sampling locations: yellow: Cabruca – UESC, green: Michelin Ecological Reserve, red: Serra Bonita Reserve.

To record the acoustic activity of *D. branneri*, we employed the Passive Acoustic Monitoring (PAM) technique, a method used for abundance and richness estimation studies through sound metrics. Several studies on anuran behavior and activity patterns are conducted using this monitoring approach (*Sugai et al., 2018*). Thus, in the three lagoons, automated recorders (SM4, Wildlife Acoustics, Inc., Concord, MA, USA) were installed, generating audio files in WAV format, with a sampling rate of 22050 kHz. The recorders were installed at approximately 1 m above the ground and less than a meter from the edge of the lagoons (Fig. 2). To monitor the daily vocalization pattern, the recorders were programmed to record one minute every 15 minutes throughout the day, totaling four minutes of recording per hour and 96 minutes of recording every 24 hours. Visits to the sites were made every two or three months in the year 2020, totaling four visits. During each visit, the two 64 GB memory cards were collected and replaced.

Fig. 3. Recorder used to register the acoustic landscapes

To extract and process *D. branneri* vocalizations from the acoustic landscapes, reference calls of the species were used. Their spectrograms were analysed, and individual notes were isolated, serving as templates to identify the species' calls within

the acoustic environment. Once isolated, the sampling rates were adjusted to match those of the recordings from the recorders. Random days from each visit were selected to search for the species' advertisement calls, and subsequent activities were delineated. Subsequently, detection times were extracted for detailed analysis, namely, the daily period of acoustic activity and patterns of *D. branneri*. For all these processes, the *monitoR*, *seewave*, *bioacoustics*, *stringr*, *magrittr*, *dplyr*, *tidyr*, *ggplot2*, and *ggsci* packages of the R program were utilized and analysed within the same program (*R Development Core Team 2024*).

Results

Dendropsophus branneri exhibited acoustic activity throughout the year at all three points, indicating the species' prolonged reproductive strategy. The intensity of activities during the rainy season, both in terms of the number of simultaneous advertisement calls (chorus) and the number of hours the species was detected, was notable. During this period, calls were observed at various times, including during the daytime.

In the Cabruca pond, located on the campus of the State University of Santa Cruz (UESC), a pattern of activity was found throughout the day, with peak intensity from 12:00 to 20:00 during the first visit in the rainy season, corresponding to the months between January and March, with up to 20 simultaneous vocalizations per day (Fig. 3a). During the second visit, corresponding to the months between April and June, an intermediate period, a peak in activity was observed only during the night-time between 22:00 and 02:00, with up to 12 advertisement calls from active individuals at the same time during this period (Fig. 3b). The results of the third visit showed a pattern of activity from 20:00 to 22:00. However, despite fewer hours of species activity, it was observed that the number of simultaneous advertisement calls (n=30) was higher than in the second visit (Fig. 3c). In the fourth visit, activity was recorded at various times from November to December, with peak intensity occurring at three times of the day: 08:00 to 10:00, 11:00 to 14:00, and 20:00 to 00:00, with the number of advertisement calls distributed throughout the day ranging from 5 to 15 calls during these hours (Fig. 3d).

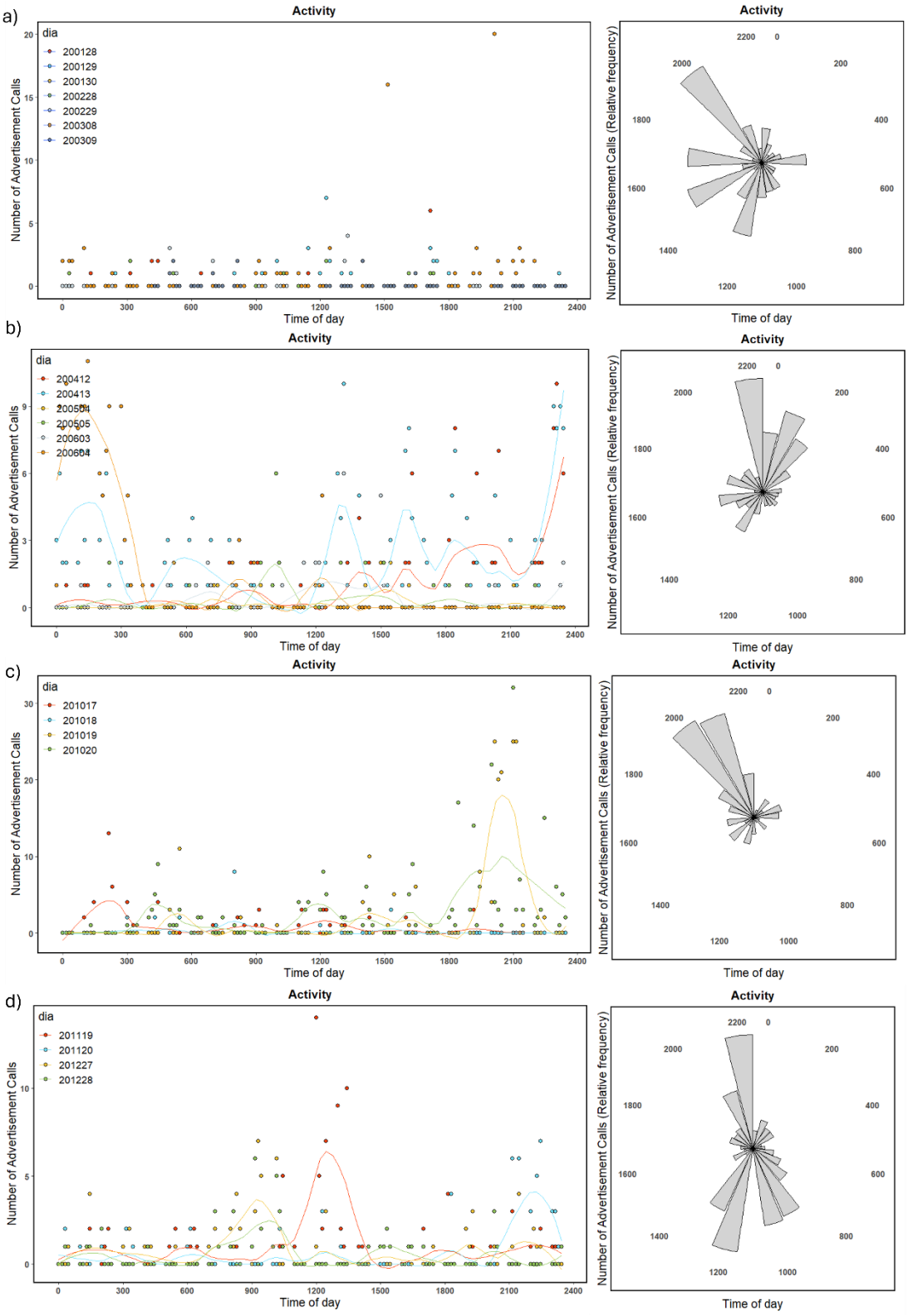

Fig. 3. Phenology of *D. branneri* in Cabruca Pond - UESC. a) Visit 1 - between January and March, b) Visit 2 - between April and June, c) Visit 3 - between September and October, and d) Visit 4 - between November and December.

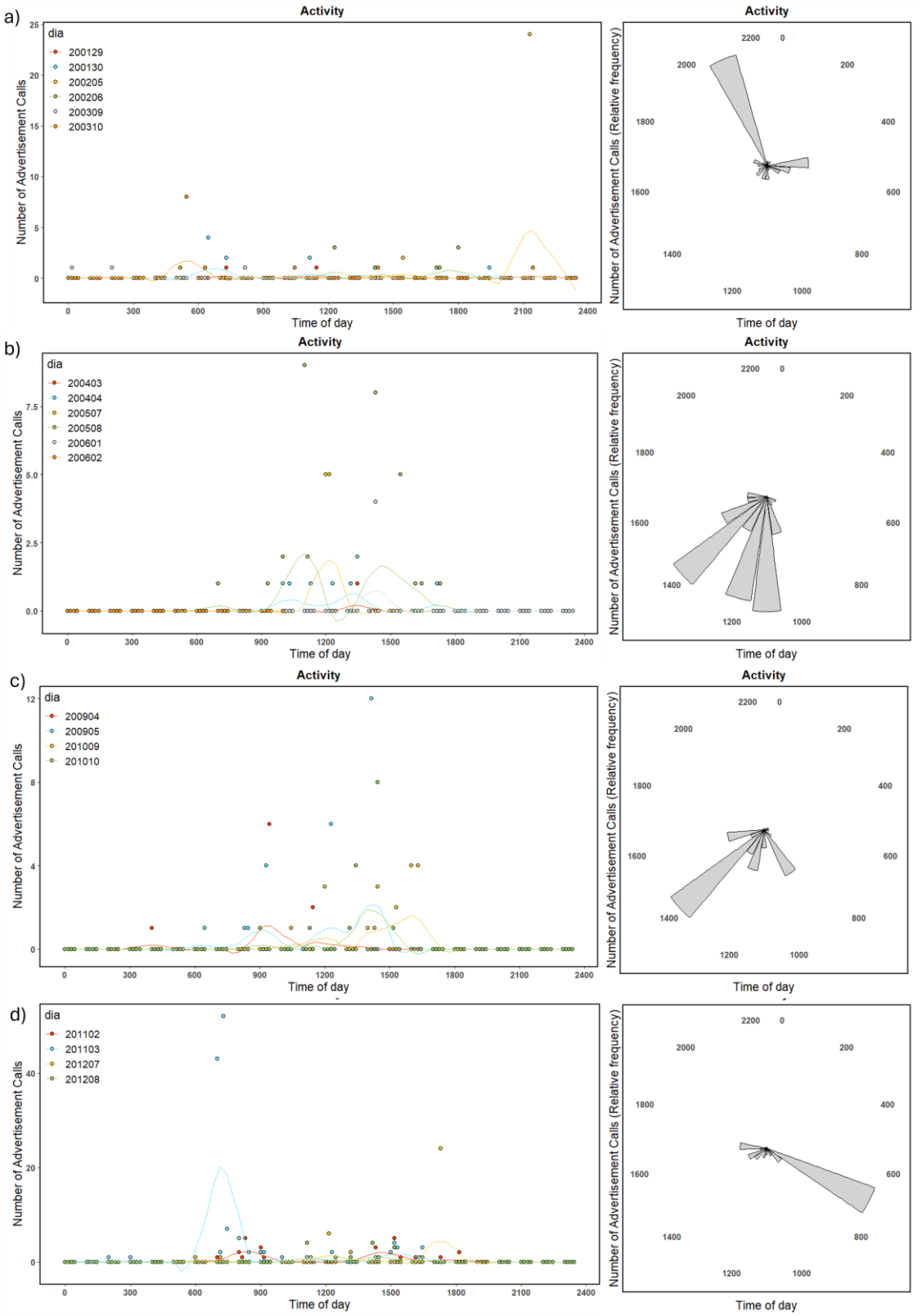

Fig. 4. Phenology of *D. branneri* in the Pond of Serra Bonita Reserve. a) Visit 1 - between January and March, b) Visit 2 - between April and June, c) Visit 3 - between September and October, and d) Visit 4 - between November and December.

In the pond located in the Serra Bonita Reserve, during the first visit, between January and March, activity was concentrated during the night-time (20:00 to 22:00), with

up to twenty-five advertisement calls recorded (Fig. 4a). During the second visit, corresponding to April to June, calls were only recorded during the daytime, between eight and eighteen hours, with intensity observed in two periods, from 10:00 to 12:00 and between 14:00 and 15:00, detecting up to 10 advertisement calls at the same time/day (Fig. 4b). Still, during the intermediate period from September to October, corresponding to visit 3, activity was observed between 09:00 and 17:00, but intense activity was only noted between 14:00 and 15:00, with a maximum of 12 advertisement calls at the same time (Fig. 4c). During the last visit, there was no nocturnal activity from the species, and as observed in visits 2 and 3, the intensity during visit four was observed in the morning period between 07:00 and 9:00 hours; however, the number of simultaneous advertisement calls (n=50) was higher than in all other visits to the Reserve (Fig. 4d).

During the first visit to Mata Boa Pond in the Michelin Ecological Reserve, there was a recording of up to 15 simultaneous calls during the period between 06:00 and 8:00. Throughout the day until 21:00, activity and the number of calls were reduced, fluctuating between 1 and 5 calls (Fig. 5a). During the second visit, corresponding to April and June, the highest number of simultaneous advertisements calls in the locality was recorded (n=50), which were concentrated between 18:00 to 20:00 and 21:00 to 23:00, besides, there was a small activity in the morning and none during the afternoon period (Fig. 5b). The third visit showed a pattern of lower intensity compared to all visits, with a number of calls up to 6 at the same time, and a higher concentration between 08:00 and 10:00 in the morning (Fig. 5c). During the last visit, higher intensity was recorded during the night-time, with a greater concentration of advertisement calls (n=30) between 18:00 and 20:00 (Fig. 5d).

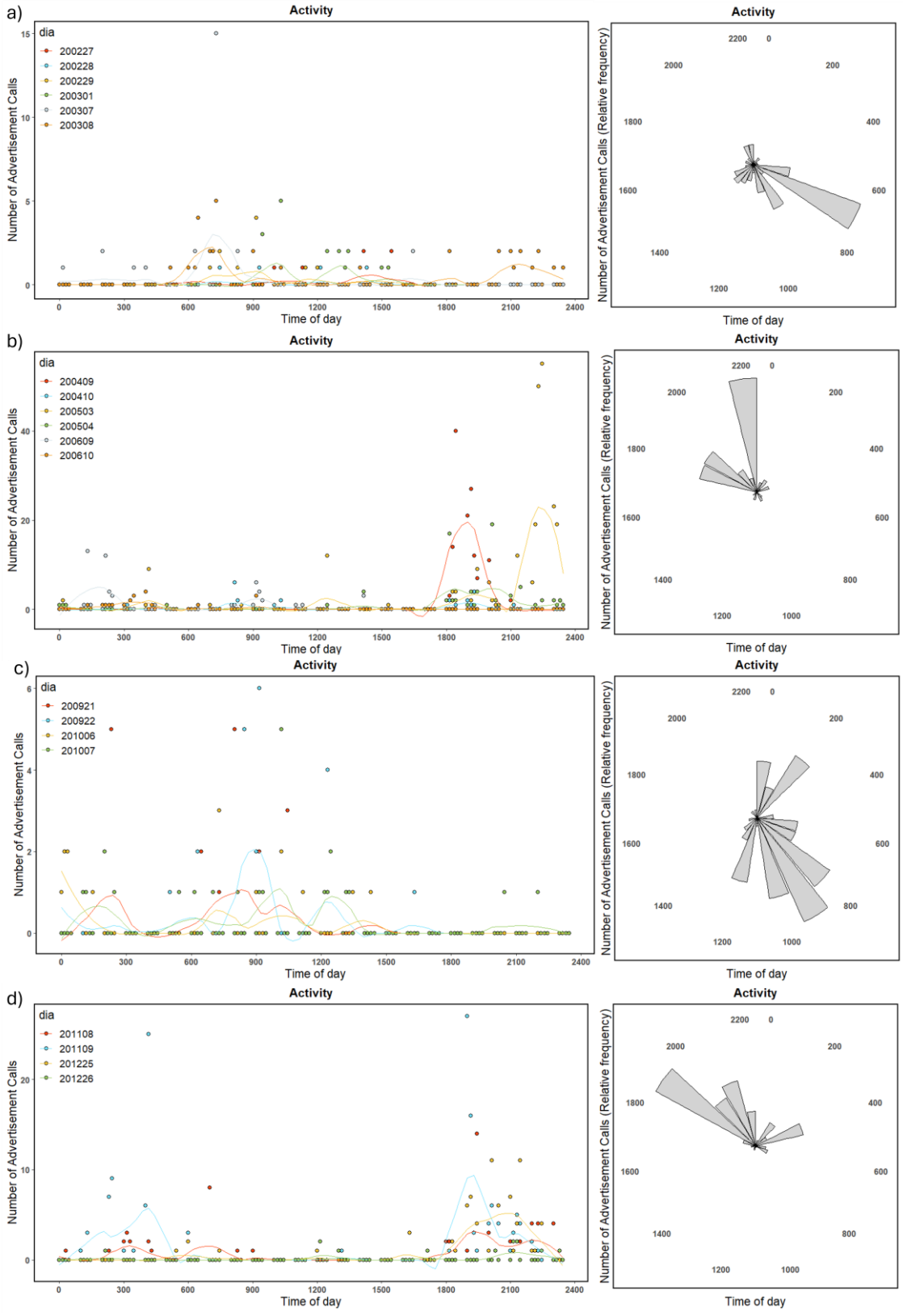

Fig. 5. Phenology of *D. branneri* in the Pond of the Michelin Ecological Reserve. a) Visit 1 - between January and March, b) Visit 2 - between April and June, c) Visit 3 - between September and October, and d) Visit 4 - between November and December.

Discussion

We described the phenology pattern of *Dendropsophus branneri*'s calling and the potential influence of life history strategy, in this case, the prolonged reproductive strategy, on the observed pattern responses. Corroborating with *Arzabe et al.* (*1998*), who found prolonged reproduction for the species, following an active search method in a permanent pond, and suggested that the annual pattern of vocal activity observed likely resulted from the interplay between water supply in the pond and the potential of the arboreal environment to mitigate the severe effects of the wet-dry climate.

In the initial period of the studied year, corresponding to the first sampling point visit, there was a preference for the species to sing intensively at night until early morning. This was also observed in the fourth visit, corresponding to the end of the year, with the exception of the Cabruca Pond - UESC, which, despite having a lot of activity during this period, had a higher peak of activity in the morning until early afternoon (10:00 to 14:00). Overall, it is noted that the species had a constant presence in all three locations. Of the three bodies of water, the Cabruca pond has the largest shaded area, which may explain a higher incidence of individuals vocalizing during the day.

According to *Duarte et al.* (*2019*), the constant predominance of the species in ponds may indicate the likelihood of a dominance in the calling site, which influences the species' vocalization activity pattern. Furthermore, *Duarte et al.* (*2019*) suggest that differences in vocalization activity represent a strategy to reduce competition for oviposition sites, which may explain these variations in activity patterns of *D. branneri* among the studied locations.

In visits where a higher number of simultaneous advertisement calls (choruses) were recorded at all sampling points, we observed that this peak of activity occurred mostly during the night or early morning. According to *Farina* (*2014*), choruses result from the contemporary vocalization of several individuals and species, and in general, vocal animals are active at dawn and dusk. In anurans, during the chorus, individuals need strategies to reduce overlap, so males have the ability to group calls into acoustic intervals, choosing the time and space to sing (*Farina, 2014*). The preference for vocalizing during specific periods is an example of temporal acoustic partitioning that can serve to reduce acoustic interference between species in the same area (*Luther, 2008*).

In the work of *Duarte et al.* (*2019*), the preference for initiating chorus calling regulated by sunset time during the rainy season was observed and detected as more favourable for anurans. *Schalk & Saenz* (*2016*) found that while species were similar in their seasonal activity patterns, there were differences in their daily vocalization patterns, particularly in their response to rainfall. Furthermore, congeners with the same reproductive modes exhibited different responses to abiotic factors in their daily vocalization activity (*Schalk & Saenz, 2016*).

The Passive Acoustic Monitoring (PAM) technique used in this study proved to be an efficient method for understanding the real activity pattern of *D. branneri*. Traditional methods of active search and manual recording with the presence of a researcher may inhibit the emission of calls, thus leading to underestimation of the number of calls of the species and their calling rate (*Duarte et al., 2019*). By recording data continuously over several days and consequently collecting a large amount of information from the acoustic environment, it can be used to study acoustic communication, including the acoustic partitioning of anurans, allowing the assessment of chorus dynamics from the beginning and its sequence (*Duarte et al., 2015; Duarte et al., 2019*). Therefore, PAM is an efficient tool for biodiversity monitoring and conservation research and has increased in use over the past few years, consolidating its position and achieving the highest publication rates in recent years (*Duarte et al., 2019; Sugai et al., 2019*).

In the present study, PAM was important for increasing our understanding of *D. branneri*, with its activity observed at various times and higher reproductive activity during the rainy season, evidenced by an increase in the number of advertisement calls and the detection of the onset and progression of chorusing individuals of the species. Monitoring the same species in three different environments was crucial for understanding its behavior throughout the year, thereby reducing the information gap for both the species and such a diverse group.

References

Abreu RO, Juncá FA, Souza ICA, Napoli MF. 2015. The tadpole of Dendropsophus branneri (Cochran, 1948) (Amphibia, Anura, Hylidae). Zootaxa 3946 (2): 296–300.

Arzabe C, Carvalho CXC, Costa MAG. 1998. Anuran assemblages in Crasto Forest Ponds (Sergipe State, Brazil): Comparative structure and Calling activity patterns. *Herpetological Journal*, Vol. 8.

Castro IM, Rebouças R, Solé M. 2016. Diet of *Dendropsophus branneri* (Cochran, 1948) (Anura: Hylidae) from a cocoa plantation in southern Bahia, Brazil. *North-Western Journal of Zoology* 12 (1): 159-165.

Duarte MHL, Caliari EP, Viana YP, Nascimento LB. 2019. A natural orchestra: how are anuran choruses formed in artificial ponds in southeast Brazil? *Amphibia-Reptilia* 40 (2019): 373-382.

Duarte MHL, Sousa-Lima RS, Young RJ, Farina A, Vasconcelos M, Rodrigues M, Pieretti N. 2015. The impact of noise from open-cast mining on Atlantic forest biophony. Biological Conservation 191, 623–631. http://dx.doi.org/10.1016/j.biocon.2015.08.006.

Farina, A. (2014): Soundscape Ecology: Principles, Patterns, Methods and Applications, 1st Edition. Springer, New York.

Frost, Darrel R. 2024. Amphibian Species of the World: an Online Reference. Version 6.2 (accessed 14 January 2024). Electronic Database accessible at https://amphibiansoftheworld.amnh.org/index.php. American Museum of Natural History, New York, USA. DOI: 10.5531/db.vz.0001.

Güell BA, Warkentin KM. 2023. Phenology and environmental determinants of explosive breeding in gliding treefrogs: diel timing of rainfall matters. *Behavioral Ecology*, Volume 34 (6). https://doi.org/10.1093/beheco/arad072.

Guerra V, Llusia D, Gambale PG, Morais AR, Márquez R, Bastos RP. 2018. The advertisement calls of Brazilian anurans: Historical review, current knowledge and future directions. *PLoS ONE* 13(1): e0191691 DOI: 10.1371/journal.pone.0191691.

Kohler J, Jansen M, Rodríguez A, Kok PJR, Toledo LF, Emmrich M, Glaw F, Haddad, Célio F.B, Rödel M, Vences M. 2017. The use of bioacoustics in anuran taxonomy: theory, terminology, methods and recommendations for best practice. *Zootaxa* 4251 (1): 001–124 DOI: 10.11646/zootaxa.4251.1.1.

Luther DA, 2008. Signaller: receiver coordination and the timing of communication in Amazonian Birds. Biology Letters. (2008) 4, 651–654. doi:10.1098/rsbl.2008.0406.

Nunes I, Santiago RS, Junca FA. 2007. Advertisement Calls of four Hylid Frogs from the state of Bahia, Northeastern Brazil (Amphibia, Anura, Hylidae). *South American Journal of Herpetology,* 2(2), 2007, 89-96.

Nunes-de-almeida, CHL, Haddad, CFB, Toledo, lF. 2021. A revised classification of the amphibian reproductive modes. *Salamandra* 57(3): 413–427.

Orrico VGC, Lingnau R, Giasson LOM. 2009. The advertisement call of *Dendropsophus nahdereri* (Anura, Hylidae, Dendropsophini). *South American Journal of Herpetology,* 4(3), 2009, 295-299.

Orrico VGC, Duellman WE, Souza MB, Haddad CFB. 2013 The Taxonomic Status of *Dendropsophus allenorum* and *Dendropsophus timbeba***.** *Journal of Herpetology,* 47(4):615-618, DOI: 10.1670/12-208.

Orrico VGC, Grant T, Faivovich J, Rivera-Correa M, Rada MA, Lyra ML, Cassine CS, Valdujo, PH, Schargel WE, Machado DJ, Wheller WC, Barrio-Amorós C, Loebmann D, Moravec J, Zina J, Solé M, Staru MJ, Peloso PLV, Suarez P, Haddad CFB. 2020. The phylogeny of Dendropsophini (Anura: Hylidae: Hylinae). *Cladistics* 1–33 DOI: 10.1111/cla.12429.

Padial JM, Köhler J, Muñoz A, De La Riva I. 2008. Assessing the taxonomic status of tropical frogs through bioacoustics: geographical variation in the advertisement calls in the *Eleutherodactylus discoidalis* species group (Anura). *Zoological Journal of the Linnean Society*, 152, 353–365.

Pombal Jr JP, Haddad CFB. 2005. Estratégias e Modos Reprodutivos De Anuros (Amphibia) em uma Poça Permanente na Serra De Paranapiacaba, Sudeste do Brasil. *Papéis Avulsos de Zoologia.* Volume 45(15):201-213.

R Core Team (2024). R: A language and environment for statistical computing. R Found ation for Statistical Computing, Vienna, Austria. URLhttps://www.R-project.org/.

291 Schalk CM, Saenz D. 2016. Environmental drivers of anuran calling phenology in a
292 seasonal Neotropical ecosystem. *Austral Ecology* (2016) **41**, 16–27.
293 doi:10.1111/aec.12281.

294 Sugai LSM, Silva TSF, Ribeiro Jr JW, Llusia D. 2019. Terrestrial Passive Acoustic
295 Monitoring: Review and Perspectives. *BioScience* 69: 15–25. doi:10.1093/biosci/biy147

296 Wells, K.D. 2007: The ecology and behavior of amphibians. University of Chicago Press,
297 Chicago

298 Wells, K.D., Schwartz, J.J. 2007. The Behavioral Ecology of Anuran Communication. In:
299 Narins, P.M., Feng, A.S., Fay, R.R., Popper, A.N. (eds) Hearing and Sound
300 Communication in Amphibians. Springer Handbook of Auditory Research, vol 28.
301 Springer, New York, NY . https://doi.org/10.1007/978-0-387-47796-1_3

CONSIDERAÇÕES FINAIS

Os resultados deste estudo apresentam uma contribuição significativa para reduzir a lacuna de conhecimento sobre as espécies do gênero *Dendropsophus*, colaborando para o entendimento dos desafios e a necessidade de reduzir erros de identificação. Bem como enfatizamos a importância das descrições de canto de anúncio e girinos na localidade-tipo ou mais próximo possível, para garantir a precisão dos dados e informações, evitando cascatas de erros.

Além disso, destacamos que conhecer padrões diários de vocalização são essenciais para ajudar a delimitar e resolver as relações entre as espécies do gênero *Dendropsophus*. Através do monitoramento de *D. branneri* conseguimos evidenciar e compreender o seu comportamento ao longo do ano, reduzindo, assim, a falta de conhecimento tanto para as espécies como para um grupo tão diverso.

Assim, a caracterização detalhada, desde a descrição do canto, girino e o entendimento do padrão de atividades das espécies serve como uma ferramenta para a identificação das espécies, diminuindo o risco de atribuições taxonômicas errôneas.