

Occurrence of *Echinococcus vogeli* in *Cuniculus paca* from the Western Amazon and its implications for the health of local traditional communities

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ABSTRACT

Consumption of wild animals, especially the paca (*Cuniculus paca*), is a common practice among traditional communities. This rodent represents the main intermediate host for *Echinococcus vogeli*, the etiological agent of human polycystic echinococcosis, which is a zoonosis of growing public health concern in the region. This study aimed to investigate the occurrence of *E. vogeli* in livers of pacas slaughtered and consumed by resident traditional communities in the Western Brazilian Amazon. The research was observational and descriptive, conducted between May 2022 and December 2023 in traditional communities of Sena Madureira and Rio Branco (State of Acre, Brazil). Household interviews were performed to characterize hunting practices and dog management, along with the collection of paca livers for parasitological and molecular analysis (amplification and sequencing of a fragment of the *cox1* mtDNA). Of the 78 families interviewed, 78% reported the practice of subsistence hunting. A total of 194 dogs were recorded, 83% of which actively participated in hunting activities, and 80% often consumed raw viscera, mostly from pacas. Among the 23 livers analyzed, 48% contained hydatid cysts (ranging from 1 to 13 cysts per liver), with *E. vogeli* infection confirmed based on morphology and PCR. The findings suggest that feeding dogs with raw viscera may facilitate the establishment of the domestic transmission cycle of *E. vogeli*, thereby increasing the risk of zoonotic infection. The close contact between humans, dogs, and infected paca livers highlight the urgent need for epidemiological surveillance and educational strategies aiming at the prevention of echinococcosis in endemic areas.

KEYWORDS: zoonotic transmission, sociocultural factors, epidemiological surveillance, emerging parasitoses

Ocorrência de *Echinococcus vogeli* em *Cuniculus paca* da Amazônia Ocidental e suas implicações para a saúde de comunidades tradicionais locais

RESUMO

O consumo de animais silvestres, especialmente a paca (*Cuniculus paca*), é uma prática comum entre comunidades tradicionais. Este roedor representa o principal hospedeiro intermediário do *Echinococcus vogeli*, agente etiológico da equinococose policística humana, uma zoonose de crescente preocupação para a saúde pública na região. Este estudo teve como objetivo investigar a ocorrência de *E. vogeli* em fígados de pacas abatidas e consumidas por moradores de comunidades tradicionais da Amazônia Ocidental Brasileira. A pesquisa, de caráter observacional e descritivo, foi realizada entre maio de 2022 e dezembro de 2023, em comunidades tradicionais de Sena Madureira e Rio Branco (Estado do Acre, Brasil). Foram conduzidas entrevistas domiciliares para caracterizar práticas de caça e manejo de cães, bem como coletas de fígados de pacas para análises parasitológicas e moleculares (amplificação e sequenciamento de um fragmento do mtDNA *cox1*). Das 78 famílias entrevistadas, 78% relataram praticar caça de subsistência. Foram contabilizados 194 cães, dos quais 83% participavam de caçadas e 80% consumiam vísceras cruas, especialmente de pacas. Dos 23 fígados analisados, 48% apresentaram cistos hidáticos (1 a 13 por fígado), com confirmação de *E. vogeli* por morfologia e PCR. Os resultados sugerem que alimentar cães com vísceras cruas pode facilitar o estabelecimento do ciclo de transmissão doméstico de *E. vogeli*, aumentando assim o risco de infecção zoonótica. O contato próximo entre humanos, cães e fígados de pacas infectados ressalta a necessidade urgente de vigilância epidemiológica e estratégias educacionais visando à prevenção da equinococose em áreas endêmicas.

PALAVRAS-CHAVE: transmissão zoonótica, fatores socioculturais, vigilância epidemiológica, parasitoses emergentes

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INTRODUCTION

Neotropical polycystic echinococcosis (NPE) is a zoonotic disease caused by *Echinococcus vogeli*, a cestode belonging to the family Taeniidae, which was described in 1972 (Rausch and Bernstein 1972). This species is endemic to the Neotropical Region, and has been reported in Brazil, Colombia, Bolivia, Peru, and Argentina (D'Alessandro and Rausch 2008). It is associated with severe infections in humans, particularly among residents of traditional communities composed of rubber tappers, riverside dwellers, farmers and indigenous populations (D'Alessandro and Rausch 2008; Soares et al. 2004; Siqueira et al. 2013). In Brazil, human cases are predominant in the northern region, especially in the states of Acre and Pará (Pastore et al. 2003; Soares et al. 2004; Siqueira et al. 2013).

The sylvatic cycle of *E. vogeli* includes the canid *Speothos venaticus* (bush dog) as definitive host and the paca (*Cuniculus paca*), a rodent widely distributed throughout the Amazon, as intermediate host that has an essential role for the maintenance of the parasite (Rausch and Bernstein 1972; Almeida et al. 2013; Soares et al. 2014; Souza et al. 2023). In domestic environments, domestic dogs that are common in traditional communities serve as definitive hosts by consuming raw viscera from infected pacas, a practice that supports the domestic transmission of the parasite (Neves et al. 2017; Souza et al. 2023).

In traditional Amazonian communities, subsistence hunting is a common and essential practice for household nutrition and survival, as families rely on forest resources to supplement their diets and sustain their way of life (Chaves et al. 2018; Guimarães et al. 2019; Souza et al. 2021; Sampaio et al. 2022). The paca is among the most frequently consumed wild animals by these populations, and domestic dogs are often fed with its viscera. Such a practice facilitates the introduction of *E. vogeli* into domestic environments and, consequently, increases the risk of human transmission (Neves et al. 2017; Souza et al. 2023).

The close relation between dogs and humans contributes to the dissemination of *E. vogeli* eggs, which may result in an increase of human infections by accidental ingestion of these parasite forms in contaminated soil or food (Neves et al. 2017). Understanding the life cycle of *E. vogeli* and its transition from sylvatic to the domestic environment is crucial for the control of NPE, as well as for improving the diagnostic methods and epidemiological surveillance strategies. The present study aimed to investigate the occurrence of *E. vogeli* in livers of pacas slaughtered and consumed by residents of traditional communities in the Western Brazilian Amazon.

MATERIALS AND METHODS

Study area

The study was conducted in the municipalities of Rio Branco and Sena Madureira, State of Acre, located at the Western Amazon, Brazil. Collection sites were selected based on the historical occurrence of human NPE cases and

accessibility to traditional communities. In Sena Madureira, sample collections were carried out in four traditional communities: i) Cazumbá-Iracema (9°30'51"S, 69°28'20"W), a federal protected area that is part of the Western Amazon Corridor; ii) Novo Amparo (9°04'16.0"S, 68°27'02.0"W), a land settlement project and managed by the INCRA and located along the Purus River; iii) Joaquim José de Matos (9°23'35.6"S, 68°35'37.8"W), located along the BR-364 Highway at kilometer 104; and iv) São José (9°22'28.6"S, 68°43'29.0"W), situated along the Yaco River. In Rio Branco, the capital of the state of Acre, sample collection was carried out in the Vila Verde community (9°56'05"S, 68°18'15"W), located along the Transacrea Highway, a key agricultural expansion corridor connecting urban and rural areas.

Data and biological sample collection

Data on hunting practices and the biological samples were collected from 2022 to 2023. In Sena Madureira, one field expedition was conducted in each of the selected community, with support from the local health surveillance team. During household visits, a semi-structured questionnaire was administered to the head of the household to gather information on the presence of domestic dogs, hunting practices, consumption of wildlife species, and methods for disposing of viscera from hunted animals. In Rio Branco, no household visits were conducted. Samples were donated by Community Health Agents (CHAs) working in the region.

All participants received guidance on NPE and instructions on the proper preservation of *Cuniculus paca* livers for research purposes. After hunting and processing the animals, local residents identified and froze the livers, which were later collected by the CHAs. Samples were then transported to the Laboratory of Pathology and Parasitic Biology at the *Universidade Federal do Acre*, following protocols established in collaboration with the municipal health surveillance teams.

Macroscopic evaluation of livers

Livers were thawed, rinsed in 0.9% saline, and macroscopically inspected for suggestive lesions of hydatid cysts. Samples with lesions were subjected to hydatid fluid aspiration using a 1 mL syringe, and the fluid was transferred to 15 mL Falcon tubes. Fragments of the germinal membrane were collected, stored in 1.5 mL microtubes containing 70% ethanol, and kept at -20 °C for molecular analyses.

Other part of the hydatid fluid was centrifuged at 3,500 rpm for 15 minutes; the supernatant was separated and stored at -20 °C for subsequent antigen preparation. The sediment was resuspended in PBS buffer (10-fold the volume of the suspension), with 90% of the suspension fixed in an equal volume of 96% ethanol and stored at -20 °C for molecular analysis. The remaining 10% was fixed in 10% formalin (5-fold the volume of the suspension) for morphometric and morphological analysis.

Parasitological diagnosis

Hydatid fluid obtained from each liver was used for direct parasitological diagnosis and morphometry of the rostellar hooks as described by Mayuri *et al.* (2017). Briefly, glass slides were prepared with one drop of the sample and one drop of lactophenol and incubated for 15 minutes at room temperature. Circular movements were applied to the coverslip with a rubber pencil to facilitate the detachment of hooks from protoscoleces.

Morphological and morphometric analyses were conducted using a binocular optical microscope (Leica DM750) at magnifications of 100×, 400×, and 1,000×. Hook measurements included total length and width of the blade (Mayuri *et al.* 2017). Images were captured with an attached digital camera (Leica ICC50 HD) and analyzed using Leica LAS EZ software.

Molecular analyses

Genomic DNA isolation was performed from germinal membranes preserved in 70% ethanol and hydatid fluid preserved in 96% ethanol. Both samples were digested using 180 µL of PureLink® Genomic Lysis/Binding Buffer supplemented with 20 µL of proteinase K, at 55 °C for 4 hours. Subsequently, the samples were centrifuged at 12,000 x *g* for 3 minutes, and the resulting supernatant was stored at -20 °C. DNA was later isolated using an automated system (EXTRACTA® 32) with the Extracta® DNA and RNA Kit of Pathogens (MPTA-B01K), following the manufacturer's instructions.

Molecular detection of *Echinococcus* was performed by conventional polymerase chain reaction (PCR) targeting a mitochondrial cytochrome c oxidase subunit 1 (cox1 mtDNA) gene partial region with 396 bp, using the primers cox1F (5'-TTTTTTGGGCATCCTGAGGTTTAT-3') and cox1R (5'-TAAAGAAAGAACATAATGAAAATG-3') (Bowles *et al.* 1992). *Echinococcus vogeli* DNA from human samples was used as a positive control and ultrapure water as a negative control.

PCR reactions (final volume of 47 µL) consisted of: 26.2 µL ultrapure water, 5.0 µL 10× buffer, 2.5 µL 50 mM MgCl₂, 5.0 µL 2 mM dNTPs, 2.5 µL of each primer (10 pmol), 0.3 µL of Taq DNA polymerase (5 U/µL), and 3.0 µL of extracted DNA, according to a protocol adapted from Sánchez *et al.* (2010).

Amplifications were performed in a thermal cycler (CFX96 Touch Real-Time PCR Detection System) with the following cycling conditions: initial denaturation at 95 °C for 3 minutes; 35 cycles of 95 °C for 1 minute, 56 °C for 1 minute, and 72 °C for 1 minute and 30 seconds; followed by a final extension at 72 °C for 3 minutes. Amplified products were visualized by electrophoresis on 2% agarose gel.

Sequencing and genetic diversity

Positive amplicons were purified using the PureLink™ PCR Purification Kit (Invitrogen™), following the manufacturer's instructions and Sanger sequenced at the *Fundação Oswaldo*

Cruz (Fiocruz) platform P01 001A RPT/FIOCRUZ. Genetic sequences contigs were assembled and edited using Geneious software v.2023.0.3 (Kearse *et al.* 2012). The resulting consensus sequences were compared with data available in the GenBank using the Basic Local Alignment Search Tool (BLAST) and subsequently deposited in this same database (accession numbers PX229574 - PX229580). The genetic diversity of the present sequences was calculated in terms of the number of haplotypes (H), number of polymorphic sites (S), haplotype diversity (Hd), and nucleotide diversity (π) using DNAsp, version 5.10.1 (Librado and Rozas 2009). The PopART program, version 1.7, using the median-joining method, was employed to infer the haplotype network based on cox1 mtDNA sequences of *E. vogeli* obtained in this study, together with additional sequences deposited in GenBank, generated from the same gene (Table S1).

Ethical considerations

This study was conducted with approval from the *Sistema de Autorização e Informação em Biodiversidade* (SISBIO/ICMBio) under protocol number 68547-1, the *Comitê de Ética no Uso de Animais da Universidade Federal do Acre* (CEUA/UFAC), protocol number 15/2022, process number 23107.015181/2022-08, and the interview data as part of the project activities approved by the *Comitê de Ética em Pesquisa Envolvendo Seres Humanos do Instituto Oswaldo Cruz – CEP Fiocruz/IOC* (CAAE: 57573822.2.0000.5248; approval number: 3,544,996).

RESULTS

Seventy-eight families were interviewed, of which 78% (n = 61) reported engagement in subsistence hunting of wild animals during different parts of the year. All families owned dogs that were used in hunting, fishing, and extractive activities, living freely in domestic and peridomestic environments. The number of dogs per family ranged from one to eight, resulting in a sample of 194 dogs in the present study, of which 64% were males (n = 124). Most animals (83%; n = 161) used to accompany their owners in hunting, and 80% (n = 155) consumed raw viscera from hunted animals, especially paca (Table 1).

Table 1. Biological and behavioral characteristics of domestic dogs from traditional communities in the municipality of Sena Madureira, State of Acre, Brazil.

	Number of Animals	Frequency (%)
Sex		
Female	70	36.1
Male	124	63.9
Participation in hunting activities		
Yes	161	83.0
No	33	17.0
Consumption of raw viscera		
Yes	155	79.9
No	39	20.1

Thirty livers were analyzed, of which 77% (n = 23) from the Sena Madureira and 23% (n = 7) from Rio Branco. Hydatid cysts were identified in 37% (n = 11) livers, all from Sena Madureira, with eight from the Cazumbá-Iracema community and three from the Joaquim de Matos community. The number of cysts per liver ranged from 1 to 13, with a mean of 5 cysts, totaling 57 cysts, and diameters between 0.1 and 2.0 cm.

Morphological analysis revealed protoscolexes with crowns of large and small hooks (Figure 1). The larger hooks had a mean length of $42.3 \pm 0.81 \mu\text{m}$ and mean width of $14.14 \pm 0.48 \mu\text{m}$, while the smaller hooks had $31.49 \pm 1.54 \mu\text{m}$ of mean length and $11.53 \pm 0.10 \mu\text{m}$ of mean width, measurements similar to those previously reported in the literature for *E. vogeli* (Table 2).

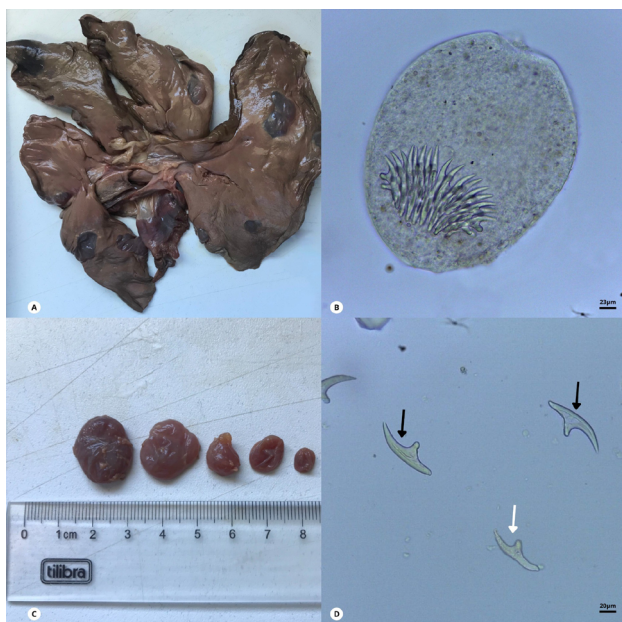


Figure 1. A - Livers of *Cuniculus paca* with *Echinococcus vogeli* hydatid cysts, collected from traditional communities in the municipality of Sena Madureira, State of Acre, Brazil. B - Protoscolex displaying two rows of rostellar hooks; C - Hydatid cysts measuring up to 2.0 cm in diameter; e D - Large hooks (black arrow) and small hooks (white arrow).

Table 2. Morphometry of large and small rostellar hooks (μm) of *Echinococcus vogeli* metacestodes in the liver of *Cuniculus paca* from the municipality of Sena Madureira, State of Acre, Brazil. Values are means and standard deviations.

Study	N	Large hook length (μm)	Small hook length (μm)
D'Alessandro et al. 1979.	197	41.4 ± 3.8	–
Meneghelli et al. 1992.	197	41.4 ± 3.8	–
Somocurcio et al. 2004.	300	40 – 45	28 – 35
Abdul-Hadi et al. 2007.	100	41	33
Knapp et al. 2009.	500	39.9 ± 0.8	31.8 ± 0.4
Almeida et al. 2014	1000	40.6 ± 1.4	32.7 ± 0.7
Present study	40	42.3 ± 0.81	31.49 ± 1.54

N - Number of measured hooks.

After sequencing and comparison with GenBank sequences, high similarity and identity with *E. vogeli* (>98% in *cox1* mtDNA gene) were revealed. This confirmed the morphometric analyses and the circulation of this species in the region. The haplotype network placed the two haplotypes observed in our study with other similar haplotypes already reported in the State of Acre (Figure 2). It should be noted that in the State of Acre 10 haplotypes have been recorded, and the two haplotypes of the present study represented Hap_1 and Hap_2 (Figure 2).

DISCUSSION

This study indicates a high risk of Neotropical echinococcosis transmission in traditional communities of Sena Madureira, associated with local subsistence practices and the occurrence of *E. vogeli* in *Cuniculus paca* (paca) livers. We observed a high involvement of domestic dogs in hunting activities as well as high consumption of raw viscera of paca by them. These results clearly highlight the zoonotic risk of *E. vogeli* in these communities. Other results also reinforce this risk in traditional Amazonian communities (Pastore et al. 2003; Almeida et al. 2013; Neves et al. 2017; Souza et al. 2023). In this sense, health education regarding the transmission of echinococcosis and its prophylaxis is urgent in these communities.

Our findings reinforce the endemicity of *E. vogeli* in the municipality of Sena Madureira, State of Acre, strengthening the evidence of its active circulation in the region. These results have significant implications for local public and veterinary health, highlighting the need for surveillance and control strategies in traditional communities within the Amazon region. The presence of *E. vogeli* in pacas has been documented in other studies in Brazil (Meneghelli et al. 1990; Almeida et al. 2013; Souza et al. 2023; Bittencourt-Oliveira et al. 2018), yet data remain scarce, highlighting the relevance of the present study to broaden knowledge about the distribution and infection dynamics in Western Amazonia.

Detection of *E. vogeli* DNA using PCR represents a significant advancement for the epidemiological surveillance of NPE in the Amazon region because this method provides good sensibility and specificity. The use of mitochondrial markers, such as the *cox1* mtDNA gene, has proven effective both for species identification within the genus *Echinococcus* and for analyzing intraspecific genetic diversity (Santos et al. 2012; Daipert-Garcia et al. 2019). The haplotypes (Hap_1 and Hap_2) found in our study were shared with *E. vogeli* samples previously studied from different locations in the state of Acre, and are the most frequent in the population, as demonstrated by Daipert-Garcia et al. (2019). Those haplotypes that were less frequent in Acre were not observed in our *E. vogeli* samples. Furthermore, we observed a lower haplotypic diversity among our sequences than what was described by Daipert-Garcia et al. (2019) in most of the localities studied. The lower genetic diversity observed in

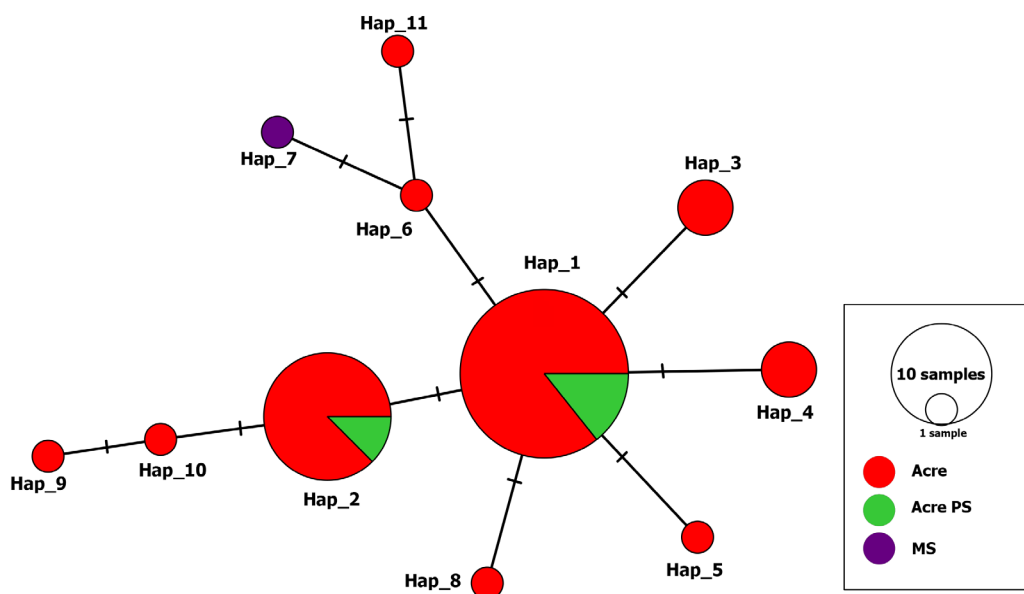


Figure 2. Median-joining network of partial *cox1* mitochondrial gene haplotypes of *Echinococcus vogeli*, based on 56 sequences from this study and GenBank. Circle sizes indicate haplotype frequencies, colors represent their geographical origins, and hash marks along the branches denote single-step mutations separating the haplotypes: Acre (red) – sequences deposited in GenBank; Acre PS (green) – sequences obtained in the present study; MS (purple) – sequence from the state of Mato Grosso do Sul (Brazil) deposited in GenBank.

our data may be due to a more restricted number of clinical samples and locations when compared to the previous study.

The morphological characteristics of the rostellar hooks observed in the protoscoleces, combined with the molecular analysis of hydatid cysts, confirmed the presence of *E. vogeli* in all 11 samples with hepatic lesions from Sena Madureira. The high similarity between the sequences obtained in this study and those deposited in GenBank (98–100% identity) strengthens the species diagnosis, corroborating previous findings in the Amazon (Santos *et al.* 2012; Oliveira *et al.* 2016; Daipert-Garcia *et al.* 2019). The integration of molecular and morphological approaches allows for a more accurate epidemiological delineation of echinococcosis, especially in endemic areas (Daipert-Garcia *et al.* 2019). This study represents the first application of these methodologies in the State of Acre, contributing valuable knowledge regarding the occurrence and distribution of *E. vogeli* in the region.

This study reinforces the need for integrated surveillance and control strategies for echinococcosis in the Amazon region, taking into account the local sociocultural and ecological specificities. Actions, such as canine population control, the implementation of regular deworming programs, and educational actions aimed at raising the awareness about the risks associated with the consumption of raw viscera by dogs are fundamental. Furthermore, strengthening healthcare infrastructure and training professionals in rural and remote areas of the Amazon are essential to enhance the early

identification of human cases of NPE and interruption of the parasite's transmission cycle.

CONCLUSIONS

This study provides evidence of the active circulation of *E. vogeli* in traditional communities in Western Amazonia, demonstrating the potential for a domestic transmission cycle due to residents' habits of feeding raw viscera to dogs. The high frequency of dogs involved in hunting activities, combined with the frequent consumption of raw viscera of *paca* by these domestic animals, characteristic of traditional Amazonian communities, elevates the zoonotic risk for echinococcosis in the local population. These findings highlight the need for further studies in the region as well as the urgent implementation of integrated surveillance, control, and health education strategies that are culturally and socially tailored, aiming to reduce the transmission risks of the *E. vogeli* to both human and canine populations.

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SUPPLEMENTARY MATERIAL

Anadão *et al.* Occurrence of *Echinococcus vogeli* in *Cuniculus paca* from the Western Amazon and its implications for the health of local traditional communities

Table S1. Genbank accession number, locality and state, or just state, and reference of the sequences used in this study.

Accession number	Locality/State	Reference	Accession number	Locality/State	Reference
KX257618	Corguinho/Mato Grosso do Sul	Bittencurt Oliveira <i>et al.</i> (2018)	MK791180	Acre	Daipert-Garcia <i>et al.</i> (2019)
KX527916	Sena Madureira/Acre	Neves <i>et al.</i> (2017)	MK791181	Acre	Daipert-Garcia <i>et al.</i> (2019)
MK791154	Acre	Daipert-Garcia <i>et al.</i> (2019)	MK791182	Acre	Daipert-Garcia <i>et al.</i> (2019)
MK791155	Acre	Daipert-Garcia <i>et al.</i> (2019)	MK791183	Acre	Daipert-Garcia <i>et al.</i> (2019)
MK791156	Acre	Daipert-Garcia <i>et al.</i> (2019)	MK791184	Acre	Daipert-Garcia <i>et al.</i> (2019)
MK791157	Acre	Daipert-Garcia <i>et al.</i> (2019)	MK791185	Acre	Daipert-Garcia <i>et al.</i> (2019)
MK791158	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969813	Acre	Bittencurt-Oliveira (2021)
MK791159	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969814	Acre	Bittencurt-Oliveira (2021)
MK791160	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969815	Acre	Bittencurt-Oliveira (2021)
MK791161	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969816	Acre	Bittencurt-Oliveira (2021)
MK791162	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969817	Acre	Bittencurt-Oliveira (2021)
MK791163	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969819	Acre	Bittencurt-Oliveira (2021)
MK791164	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969820	Acre	Bittencurt-Oliveira (2021)
MK791165	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969821	Acre	Bittencurt-Oliveira (2021)
MK791166	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969822	Acre	Bittencurt-Oliveira (2021)
MK791167	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969823	Acre	Bittencurt-Oliveira (2021)
MK791169	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969824	Acre	Bittencurt-Oliveira (2021)
MK791170	Acre	Daipert-Garcia <i>et al.</i> (2019)	MZ969825	Acre	Bittencurt-Oliveira (2021)
MK791171	Acre	Daipert-Garcia <i>et al.</i> (2019)	OK157435	Acre	Bittencurt-Oliveira (2021)
MK791172	Acre	Daipert-Garcia <i>et al.</i> (2019)	OK157436	Acre	Bittencurt-Oliveira (2021)
MK791173	Acre	Daipert-Garcia <i>et al.</i> (2019)	OK157437	Acre	Bittencurt-Oliveira (2021)
MK791174	Acre	Daipert-Garcia <i>et al.</i> (2019)	PX229574	Sena Madureira /Acre	Present study
MK791175	Acre	Daipert-Garcia <i>et al.</i> (2019)	PX229575	Sena Madureira /Acre	Present study
MK791176	Acre	Daipert-Garcia <i>et al.</i> (2019)	PX229576	Sena Madureira /Acre	Present study
MK791177	Acre	Daipert-Garcia <i>et al.</i> (2019)	PX229577	Sena Madureira /Acre	Present study
MK791178	Acre	Daipert-Garcia <i>et al.</i> (2019)	PX229578	Sena Madureira /Acre	Present study
MK791179	Acre	Daipert-Garcia <i>et al.</i> (2019)	PX229579	Sena Madureira /Acre	Present study
			PX229580	Sena Madureira /Acre	Present study