

# Subsistence hunting and the introduction of Neotropical echinococcosis into the domestic environment in the Brazilian Amazon\*

## Caça de subsistência e a introdução da equinococose neotropical no ambiente doméstico na Amazônia brasileira

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### Resumo

O presente estudo registrou o consumo de carne de paca e cutia e revelou a presença de cistos hidáticos nos fígados desses roedores em comunidades extrativistas da Amazônia brasileira. Foram entrevistadas 42 famílias (mediana quatro membros/família), destas 98% (n=41) informaram o consumo de paca e 86% (n=36) o consumo de cutia. Estruturas compatíveis com cistos hidáticos foram relatadas com maior frequência em fígados de pacas 74% (31/42) do que em cutias 26% (11/42). A análise parasitológica de um fígado de paca confirmou a presença de *E. vogeli*. O consumo da carne desses roedores e a confirmação da infecção por *E. vogeli* representam fatores de risco preocupantes para os moradores dessas comunidades florestais, uma vez que as vísceras cruas de ambos os roedores são utilizadas na alimentação de cães domésticos.

**Palavras-chaves:** Equinococose, caça, população rural, animais selvagens.

### Abstract

The present study recorded the consumption of paca and agouti meat and revealed the presence of hydatid cysts in the livers of these rodents in extractivist communities in Brazilian Amazonia. A total of 42 families (with a median four of members per household) were interviewed, of which 98% (n=41) reported the consumption of paca and 86% (n=36) the consumption of agouti. Structures consistent with hydatid cysts were detected more frequently in the liver tissue of the pacas (74% – 31 of 42 samples) than the agoutis (26% – 11/42). The parasitological analysis of a paca liver confirmed the presence of *E. vogeli*. The consumption of the meat of these rodents and the confirmation of infection by *E. vogeli* represent preoccupying risk factors for the inhabitants of these forest communities, given that the uncooked viscera of both rodents are often fed to domestic dogs.

**Keywords:** Echinococcosis, hunting, rural population, wild animals.

### Introduction

Neotropical echinococcosis is a zoonotic disease endemic to the tropical regions of South and Central America. It is manifested in two forms: the polycystic form caused by *Echinococcus vogeli* Rausch & Bernstein, 1972, and the unicystic form caused by *Echinococcus oligarthra* Diesing, 1863 (Vuitton et al., 2020). The Neotropical echinococcosis caused by *E. vogeli* was first described by Rausch and Bernstein (1972), who observed the eggs during the examination of fecal samples of a bush dog (*Speothos venaticus*) kept in a zoo in Ecuador.

In Brazil, the first human case of Neotropical echinococcosis caused by *E. vogeli* was documented in 1983 in the state of Pará, but the first clinical case was published only in 1985 (Meneghelli, 1985). Most cases now recorded in Brazil are from rural communities in the Amazon region, mainly in the states of Acre and Pará, where the malady is known as “Paca Disease” (Oliveira et al., 2018; Garcia et al., 2019).

The consumption of wild game meat is a common practice in the rural and indigenous communities that inhabit tropical forests, such as those of the Amazon region, where wild rodents are

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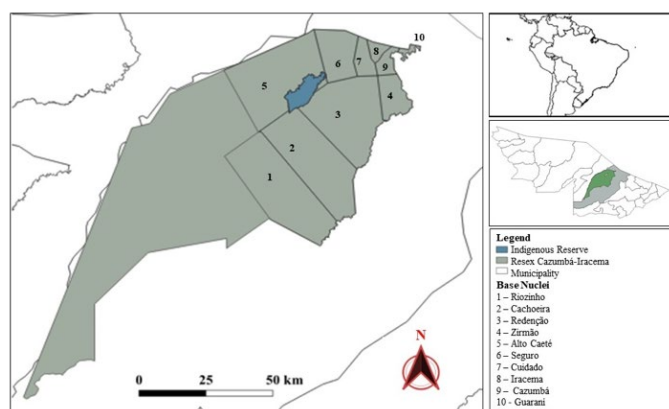
among the most important sources of protein (Chaves et al., 2018; Guimarães et al., 2019). The two game animals most consumed in many regions of Latin America are the paca (*Cuniculus paca* Linnaeus, 1766) and the agouti (*Dasyprocta* spp.). While both species are found in the same types of habitat, have similar behavior, and diet, the paca is active at night, and the agouti, during the day (Ferregueti et al., 2018). Both species are intermediate hosts of *E. vogeli* (Almeida et al., 2013; Oliveira et al., 2018).

Hunting is the principal route for the introduction of *E. vogeli* into the domestic environment, through the feeding of household dogs (definitive hosts) with the uncooked viscera of paca and agouti (Neves et al., 2017; Oliveira et al., 2018). The metacestode (larval) stage of *E. vogeli* is found in the liver of these rodents, where it develops into numerous bubble-like hydatid cysts of varying sizes (Almeida et al., 2013). Given the importance of paca and agouti as a source of protein in many neotropical regions and their role as the hosts of zoonotic parasites, the present study evaluated the consumption of their meat and the presence of hydatid cysts in the liver of these rodents in forest communities in the western Amazon.

## Methods

This descriptive epidemiological study was conducted in the Cazumbá-Iracema Extractive Reserve, which is located in the basin of the Purus River in the Brazilian state of Acre, in southwestern Amazonia. This reserve includes parts of the municipalities of Sena Madureira (94% of the total area) and Manoel Urbano. The reserve is occupied by 364 families, with a median of four members per household, distributed among the 10 communities or “family conglomerates” of the reserve (Figure 1).

**Figure 1:** The Cazumbá-Iracema Extractive Reserve in the municipality of Sena Madureira, Acre state, Brazil, showing the internal divisions of the local communities or “family conglomerates”.



The fieldwork was conducted during the rainy season, between November 2017 and February 2018, with the support of the local residents. The communities were accessed by boat, via the Caeté River. The data were collected by visiting households in five of the “family conglomerates” (Seguro, Cuidado, Iracema, Cazumba, and Guarani). After confirmation of their informed consent, resident male hunters over 18 years of age were invited

to answer a questionnaire. The interviewees were asked about the consumption of paca and agouti, their hunting grounds, and capture techniques. Photographs of hydatid cysts in rodent livers were shown to the interviewees, in order to determine whether they recalled having observed these structures and could confirm their presence or absence in the livers of the pacas and agoutis they had hunted.

The livers collected by the residents during this fieldwork were sent to the Laboratory of Pathology and Parasitic Biology at the Federal University of Acre, in Rio Branco, for morphometric and parasitological analyses. Liquid was extracted from the observed cysts with a 5ml syringe and placed in a 15ml Falcon tube, where it was centrifuged at 3500 rpm for 15 min. The supernatant was stored at -20°C and the sediment was examined under a microscope using 10x and 40x lenses (Axio Scope A1) for the morphometric analysis of the hook.

The data were compiled, organized, and analyzed using the *EpiInfo* software (CDC, Atlanta, USA), version 7.2.3.1. The descriptive statistics derived from the analyses included both frequencies and proportions. This study was authorized by the Research Ethics Committee of the Acre State Hospital Foundation (FUNDHACRE) through ruling number 2790354. The collection of the biological material was authorized by the Biodiversity Authorization and Information System (SISBIO) of the federal Chico Mendes Institute for the Conservation of Biodiversity (ICMBio), through license number 67436297.

## Results

A total of 42 residents of five of the communities of the Cazumbá-Iracema reserve were interviewed during the present study. The consumption of the meat of both paca and agouti was very common in all the communities, with the paca being the most consumed (Table 1). When asked whether they had ever observed hydatid cysts in the livers of the rodents, 74% (31/42) of the interviewees confirmed having seen these structures in the livers of pacas and 26% (11/42) in agoutis. They referred to the cysts as “little white balls” or “little pebbles”.

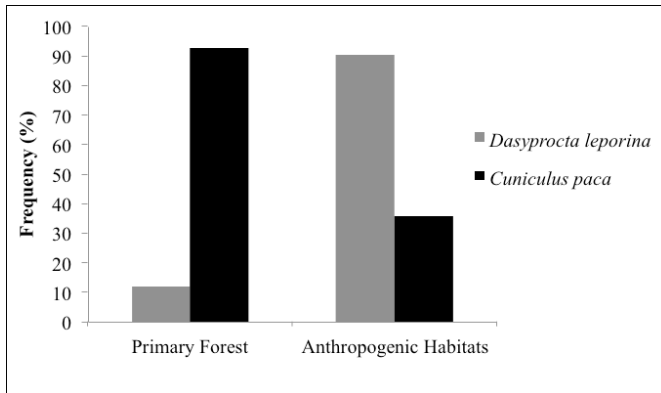
**Table 1:** Frequency of the consumption of paca and agouti meat, and the reported observation of possible hydatid cysts in the livers of these rodents, by 42 residents of the Cazumbá-Iracema Extractive Reserve in Sena Madureira, Acre (Brazil).

Family/Species	Common name	Consumption N (%)	Observation of hydatid cysts N (%)
<b>Dasyproctidae</b>			
<i>Dasyprocta leporina</i>	agouti	36 (86)	11 (26)
<b>Agoutidae</b>			
<i>Cuniculus paca</i>	paca	41 (98)	31 (74)

The interviewees reported hunting in undisturbed primary (or “closed”) forest as well as anthropogenic habitats, that is, secondary forest, known locally as “capoeira”. The interviewees hunted paca in the primary forest, while agouti were generally captured in the vicinity of their dwellings (Figure 2). In all but one

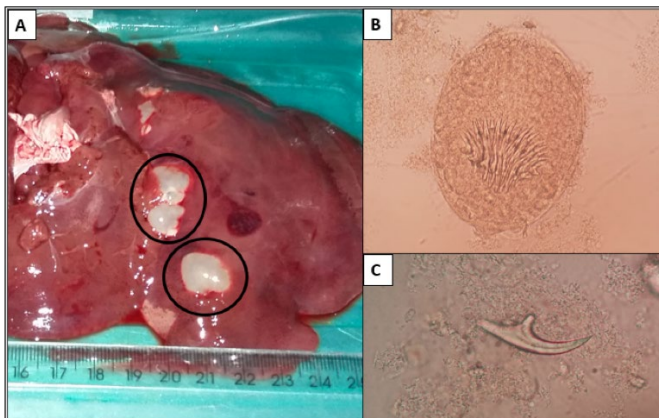
case (97%, 41/42), the interviewees reported using shotguns and ambush tactics (waiting in hides) to hunt game. Just over one fifth (21%, 9/42) reporting hunting with dogs, an activity that typically involved two hunters with two or three dogs.

**Figure 2:** Location of the *Cuniculus paca* and *Dasyprocta leporina* hunting grounds used by the residents of the Cazumbá-Iracema Extractive Reserve in Sena Madureira, Acre (Brazil).



During the fieldwork, it was possible to confirm visually the presence of hydatid cysts in the liver of a paca that had been hunted by one of the interviewees from the Cuidado community (9°08'56.6"S, 69°01'20.1"W). The parasitological analyses identified these structures as larvae of *Echinococcus vogeli* (Figure 3).

**Figure 3:** A – Hydatid cysts, B – Protoscolices and crowns of the rostellar hooks (40x), and C – hooks (40x) of *Echinococcus vogeli* observed in the liver of a paca, *Cuniculus paca*, captured by residents of the Cazumbá-Iracema Extractive Reserve in Sena Madureira, Acre (Brazil).



## Discussion

The subsistence hunting of wild rodents is a common practice for the gathering of animal protein by the residents of Sena Madureira. The consumption of game meat is widespread in the rural populations of the Amazon region, where it has both cultural and socioeconomic value (Damasceno et al., 2019), with the meat of the paca being preferred over that of the agouti

(Chaves et al., 2018; Guimarães et al., 2019). The interviewees reported that ambush hunting with shotguns is the technique most used to harvest wild animals, as observed in previous studies in the Amazon region (Pereira and Schiavetti, 2010). Hunting with dogs is also common, given the potential for the efficient tracking of game animals, which can increase hunting productivity (Guimarães et al., 2019).

This intimate relationship between human beings and the native fauna and flora provides an efficient route for the introduction of zoonotic diseases, including Neotropical echinococcosis, into the domestic environment. In particular, the consumption of paca and agouti meat is the principal means of introducing *E. vogeli* into the domestic environment, given that hunters will typically discard the raw viscera of the hunted animals – which are often infected with parasite larvae – in the vicinity of the residence or feed them to their dogs (Almeida et al., 2013.).

Meneghelli et al. (1990) analyzed a cyst found in the liver of a paca specimen captured by hunters in Sena Madureira in 1989, and described it as *E. vogeli*. In a helminthological study of the livers of 34 pacas from Acre state, Oliveira (2016) observed cystic structures in three animals from Sena Madureira, and confirmed *E. vogeli* as the etiological agent. Almeida et al. (2013) also reported observing cysts in pacas from the municipality of Bujari, in Acre, while Oliveira et al. (2018) found them in pacas from the Brazilian state of Mato Grosso do Sul. The occurrence of cysts in pacas has also been recorded in other Latin American countries, including Colombia (D'Alessandro et al., 1981; Rausch et al., 1981), Bolivia (Gardner et al., 1988), Costa Rica (Matamoros et al., 1991), Argentina (Vizcaychipi et al., 2013), and Peru (Mayor et al., 2015). Reports of agouti infected by *E. vogeli* are rare, however, with only one record of the parasite in the liver and spleen of an agouti from Marajó Island, in Pará, Brazil (Soares et al., 1999).

In the present study area, the paca is hunted primarily between May and August, when fruiting peaks in the primary forest, providing a rich source of food for this rodent, and also facilitating ambush hunting at large fruiting trees (Ferreira et al., 2012). As the agouti is a more generalist rodent, it tends to be found more often in the secondary forest, where it has access to plantations, which facilitates both ambush hunting and dog tracking. In the present study, fieldwork was conducted during the rainy season, when high river levels facilitate access to the local communities by boat. The larger number of records of pacas infected with *E. vogeli*, in comparison with the agouti, may be due to the less frequent consumption of agouti meat, which would reduce the probability of finding cysts, although the paca may in fact be more susceptible to infection than the agouti. No evidence was found to confirm either of these hypotheses, however, which emphasizes the need for further studies to assess the prevalence of infection in other game animals that may act as intermediate hosts, as well as fecal tests in domestic dogs to confirm the infection of these animals.

Canids are the definitive hosts of *Echinococcus*, and the bush dog (*Speothos venaticus* Lund, 1842) is the only known natural host of *E. vogeli* (Rausch and Bernstein, 1972; Soares et al., 2014). However, Neves et al. (2017) identified *E. vogeli* infecting domestic dogs from rural areas in the municipality of Sena Madureira, which demonstrates the potential importance of dogs

in the epidemiology of this parasite. In the Amazon region, dogs are kept by most residents of rural communities, where they are often used to hunt, and are typically fed the raw viscera of hunted game. This is a preoccupying scenario, given that dogs are definitive hosts of *E. vogeli*, and their intimate contact with hunters and their families in the domestic environment may represent a major risk of infection for rural populations.

The popularity of subsistence hunting and the confirmation of the presence of *E. vogeli* in a paca captured by local residents in the present study reflect the potential for the introduction of the parasite into the domestic environment, given that most families have dogs, which are often fed with raw viscera. The results of the present study demonstrate clearly that human intervention in the natural environment may favor the persistence of Neotropical echinococcosis cycle, within the One Health context. Resolving this potential problem will require a multi-sectorial, trans-disciplinary, and collaborative approach to

improve detection rates, reinforce the response capacity of local agencies, and implement effective measures of prevention and control, using different strategies, that are appropriate to a given epidemiological scenario.

## Conclusions

The meat of the paca and agouti is an important source of animal protein for the extractivist communities of the Amazon region. The frequent reports of cysts in the livers of local pacas and agoutis, and the confirmation of infection by *E. vogeli* in a paca, confirm the existence of conditions that ensure the maintenance of the cycle of *E. vogeli*, and favor human exposure. The resolution of this problem will require the implementation of effective health education measures to provide the residents of endemic areas with a practical knowledge of the transmission cycle of the disease.

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