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Traditional knowledge applied to hunting and breeding of the vulnerable Yellow-footed Tortoise (*Chelonoidis denticulatus*) in the Cazumbá-Iracema Extractive Reserve, Acre, Brazil

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ABSTRACT

Hunting is intensely practiced in the Amazon and is related to the survival of riverside communities as a source of income and food. This study was conducted at Resex Cazumbá-Iracema between June and November, in the dry season and the beginning of the flood period. Twenty-one families were monitored, six hunting events were followed, and 23 *C. denticulatus* individuals were recorded, all of which were categorized as opportunistic. Among the studied individuals, 11 were males and 12 females, and those with a carapace over 40 cm were considered adults. The tortoise is captured mainly for food, but there are beliefs concerning its medicinal use in treating inflammatory diseases. Reptiles, in general, are among the least hunted species for food in the Amazon. This preference may be related to the higher mammals' biomass and the birds' species richness. However, its importance for consumption may vary according to the location.

Keywords: Biodiversity; Chelonians; Ethnoecology; Subsistence hunting.

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SIGNIFICANCE STATEMENT

We present information on the breeding and popular knowledge of extractivists about *Chelonoidis denticulatus*. We highlight popular beliefs related to the consumption of the meat and related diseases, botanical species consumed in the natural environment, locations most likely to be captured, how they are fed in captivity, and the relation of consumption to commemorative dates.

INTRODUCTION

Hunting is historically practiced throughout Brazil (Alves et al. 2011; Constantino, 2018; Félix-Silva et al. 2018). Its importance as an income and food source in the rural populations' survival throughout the Amazon (Shoobridge 2018) may vary according to the populations involved and/or the communities' purchasing power (Nunes et al. 2019), access to other protein sources (Cajaiba et al. 2015), or as a protein source complement (Damasceno et al. 2019). In Acre state, Brazil, hunting plays an important role in the diet of different populations, being essential to guarantee food security for people living in the forest (Chaves et al. 2018). However, the use of hunting resources has established a critical debate regarding its sustainability in tropical forests in the ethical and scientific field (Bragagnolo et al 2019; Figueiredo and Barros 2015; van Vliet et al. 2019). It reinforces the need to understand different aspects of hunting to perform adequate management actions, considering local peculiarities. Hunting is part of a network of food choices and use influenced by ecological, economic, and cultural patterns that impact its social context (Figueiredo and Barros 2016). In this way, research on animals' use contributes to the fauna valorization from a social, medicinal, ecological, and economic view (Félix-Silva et al. 2018).

Reptiles are among the least hunted species in the Amazon (Chaves et al. 2018; Shaffer et al. 2017), which may be related to the higher mammals' biomass and birds' species richness (Cajaiba et al. 2015). However, its importance for consumption may vary according to the location (Félix-Silva et al. 2018; Oliveira et al. 2022; Pezzuti et al. 2004, 2010; Reis et al. 2018). These species are mainly consumed in warmer and wetter tropical and subtropical regions, which present higher reptiles diversity and larger sizes (Alves and van Vliet 2018).

The Amazon chelonian species have been highly exploited as food resource and medicine for riverside communities; wildlife trafficking; besides being impacted by human and natural activities (Alves et al. 2011; Cantarelli and Verdade 2014). Its products have high nutritional, ornamental, and medicinal value for many rural and urban populations in Brazil (Alves et al. 2011). *Chelonoides* species (tortoises) stand out among turtles due to their easy capture since they do not require any equipment or experience (Félix-Silva et al. 2018; Figueiredo and Barros 2015; Reis et al. 2018) and due to its meat flavour (Fuccio et al. 2003). In addition to being a food resource, the *C. denticulatus* species can be sold as a pet (Alves et al. 2019; Fernandes-Ferreira et al. 2013) or meat (Morcatty and Valsecchi 2015a; van Vliet et al. 2015).

Understanding the aspects related to this group's hunting, use, and breeding is paramount to avoid overexploitation, threatening the local population's income and nutritional quality (Mocartty and Valsecchi 2015a,b) since the distribution of species susceptible to human activity can be affected even in light hunting regimes (Hallett et al. 2019). This study aimed to characterize the local population knowledge concerning the hunting of *Chelonoidis denticulatus* in the Cazumbá-Iracema Extractive Reserve, highlighting aspects related to the local belief system and maintenance in captivity.

MATERIAL AND METHODS

Study area

This study was performed in the Cazumbá-Iracema Extractive Reserve (Resex) (750,794.70 ha) located in the southwestern Brazilian Amazon (9°30'50.78"S 69°28'21.58"W), in the Purus River basin, Acre state (Figure 1). The Resex is divided into five macro-regions (ICMBio 2007), including Cazumbá, where this study was conducted. This region concentrates the highest population density of the Resex, which is called Núcleo do Cazumbá. The study was conducted with residents who live in a system like a village. The residents are about 27 km from the region's centre and about 5 km from each other. Their income comes from flour production, cattle raising, corn and rice plantations, rubber extraction, Brazil nuts, and vegetable leather crafts (ICMBio 2007). Meat is obtained from hunting and fishing and local farmers' occasional beef and poultry sales.

The predominant vegetation in the study area is the Terra Firme Open Ombrophilous Forest with bamboo. Taboca (*Guadua* spp.) is the predominant vegetation genera, being clonal, with opportunistic growth, presenting a great capacity to invade disturbed areas (Smith and Nelson 2011). The population residing in the Núcleo do Cazumbá has a Hunting Agreement that restricts activity to specific species considering specific reproductive stage, sex, and age, in addition to specific locations and hunting strategies. Although it restricts foreign sales, the agreement does not have any restriction involving *C. denticulatus* (Oliveira and Calouro 2019).

Data collection

The Hunting Calendar and Participant Observation methods were used for data collection. The Hunting Calendar method proposed by Oliveira et al. (2018) consists of calendars, where each sheet corresponds to a month and hunted species or capture localities informed by the residents are displayed. The following data were recorded for each hunting

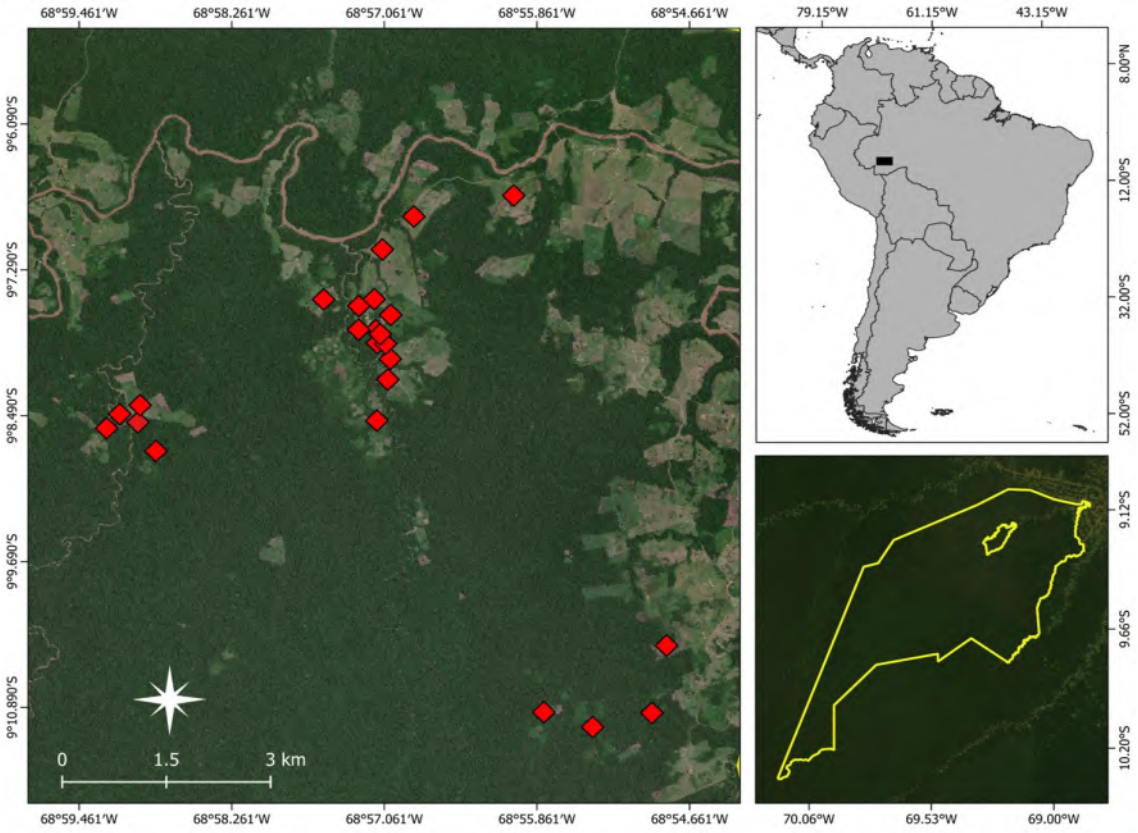

Figure 1. Study area. The diamonds represent the sampled residences.

event: sex, age group, and hunting category. Hunting events were categorized as opportunistic (associated with other work activities) or intentional (intention to capture). The Participant Observation method was used to complement information received from hunters (Ferreira et al. 2012). The goal of this method was to deepen the understanding regarding the aspects related to hunting, maintenance in captivity, and local beliefs.

Data collection was conducted between June and November 2011, comprising the dry season and the beginning of the flood period. Twenty-one hunters and families were monitored, all of legal age, where they were informed about the project's purpose and the information anonymity was assured.

RESULTS

Twenty-three individuals of *C. denticulatus* were captured, 11 males (seven adults and four juveniles) and 12 females (11 adults and one juvenile), with a 1:0.9 sex ratio. All individuals were categorized as opportunistic, where ten were captured during their displacement to a different area in the community (always on roads in areas of terra firme forest). Other two individuals were found in plantation areas, four during the rubber tree latex collection (*Hevea brasiliensis*), and seven during hunting activities focused mainly on medium and large mammals. All records were diurnal, predominantly (97%) during the early hours of the day, between 05:00 and 09:00 am. There was no record of the use of traps or specific capture methods.

The hunters defined an adult as individuals with carapace size over 40 centimeters. Two hunters reported that *C. denticulatus* meat and fat consumption has medicinal properties for rheumatism treatment. The fat is melted and stored in a jar and later used in a plaster placed over the affected area. There was only one report of eggs consumption for eggnog. All hunters stated that the tortoise meat could be allergenic (locally known as "*reimosa*"), increasing the probability of a disease called "febrão", characterized as a high, constant, and disabling fever of variable duration. Meat should also be used when needed for wound healing and pregnant women.

Six hunting events were followed, where a *C. denticulatus* was found randomly on the hunting trail. It was possible to locate the so-called "Yellow-footed Tortoise's bed" during the activity in two events. This

environment consists of very low entangled branches, bamboos, or liana with a single entrance, with a 60 cm maximum height from the ground and a large leaf accumulation. The entrance is the only area free of leaves, branches, and lianas, with a very clean trail (Figure 2). The active search for tortoises is considered a secondary event during the hunt. When hunters move to their hunting areas, they actively search for any animal traces, being able to locate the bedding or foraging sites known locally as "feeders". The hunters agree that the beds can be more easily found in environments with a dense density of buriti (*Mauritia flexuosa*), tucumã (*Astrocaryum aculeatum*), babaçu (*Attalea speciosa*), uxi (*Endopleura uchi*), genipapo (*Genipa americana*), and piquiá (*Caryocar villosum*). The "feeders" are characterized by the presence of partially crushed fruits from the plants mentioned above. *A. hunter* reported digging the bed searching for eggs carried in pockets wrapped in banana leaves (Heliconaceae).

Once found, the animals are placed belly-up to prevent escape. Subsequently, two small sticks are placed in the gular and anal portion of the plastron to reduce limb movement. Bark strips from the envireira tree (Annonaceae) are taken and braided with the sticks to resemble a backpack and facilitate transport. If the hunter chooses to continue the hunt after capturing the tortoise, it is left in the belly-up position on the hunting trail (Figure 3).

After the capture, the animals were kept in small fences, locally called "pigsties", during a variable period influenced by the demand for meat and the animal's size, with no record of breeding for pet purposes. The minimum time spent in the pigsty was a month, corresponding to the procedure called cleaning the meat. Such procedure consists of feeding the animals with leafy vegetables or cassava husks and, more rarely, food scraps, avoiding any animal protein once it can lead to flavour change. According to hunters and residents, this procedure occurs because *C. denticulatus* feed on rotten meat, which gives the meat a bitter taste and bad odour, which is the only restriction regarding the future meat preparation. Furthermore, there is a higher possibility of disease transmission in the absence of this procedure, especially worms. For young individuals, maintenance was performed to reach the ideal size for slaughter. According to all hunters, the ideal minimum size was 40 cm, but animals could be slaughtered earlier, depending on the meat supply available or some celebratory event. All hunters reported preferentially consuming captive animals during religious commemorative dates such as Easter, Christmas, or birthdays.

The animals' slaughter follows a specific preparation method to optimize the meat. The animals should be thrown to the ground at least three times before bleeding so that the liver expands and have greater use, which is considered the best part for consumption. After that, bleeding could occur, consisting of cutting the head entirely to the blood be collected for other dishes, but this procedure was not mandatory. Afterwards, the carapace and plastron were separated through longitudinal cuts. Blood is collected for food preparation. The limbs, organs, meat, and eggs (if any) were removed and seasoned with salt and pepper. The only form of preparation recorded was cooking due to the meat texture (Figure 4).

Although it was impossible to record directly, there is a trade to supply the urban market. The transportation of these animals to the urban centre occurs through small boats during the flood season. Thus, there is greater security to inspection and favouring a higher number of animals to be transported. The residents mentioned the expulsion of a person from the community for transporting about 30 *C. denticulatus* to be sold in Sena Madureira, the closest city to the Resex, based on the rules imposed by the Hunting Agreement.

DISCUSSION

Reptiles are an important component of different populations' diets worldwide (Alves et al., 2011). However, our data reinforce the preference for other groups as observed in other portions of the Amazon (Oliveira et al., 2022) and the state of Acre, due to the opportunistic characteristics of the capture (Calouro and Marinho-Filho, 2005; Lemos et al., 2018; Sampaio et al., 2022). The capture sex ratio is an important biological indicator (Mocartty and Valsecchi 2015), where a prominent disproportion between males and females can cause damage to the population (Reis et al. 2018). Hunting *C. denticulatus* is likely driven by chance rather than hunting investment since it occurs opportunistically. The balance found in the males and females collection demonstrates no capture trend related to sex, and the population growth rate may not be affected.

Active search and visitation are among the least cited by hunters in the Peruvian and Brazilian Amazon, although the active search has a good capture efficiency (Tavares et al. 2020). The absence of traps and dogs in the hunting activity can be explained by the hunting agreement followed by a large part of the population of the *Núcleo do Cazumbá* that prohibits both modalities (Oliveira and Calouro 2019). The use of traps is the strategy that has the greatest success in capture and the best cost-benefit compared to active search (Morcatty et al., 2020). Together with the protected areas' geographical isolation, these management initiatives play an important role in managing fauna (Sampaio et al., 2022), especially species under

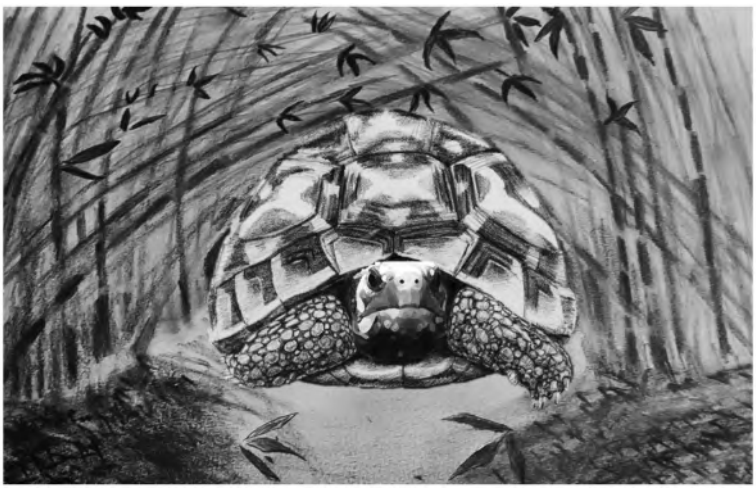

Figure 2. Schematic representation of the "Yellow-footed Tortoise's bed". Elaboration: Thiago Bento de Alencar.

Figure 3. Adult individual of *Chelonoidis denticulatus* captured and belly-up position. Photo: Luiz Henrique Medeiros Borges.

some threat of extinction.

Chelonoids denticulatus is captured mainly for use in food, but there is a medicinal value perception of its meat (Alves et al. 2013). The *C. denticulatus* medicinal use is related to rheumatism treatment documented by Pezzuti et al. (2010) in the Jaú National Park, Amazonas. In addition to the fat and meat consumed in meals, other body parts of the individuals can be used for treating issues such as swelling, toothache, inflammation, bruising, and haemorrhage (Pezzuti et al. 2010). Bellfort et al. (2020), in Baixo Madeira, Rondônia, recorded the use of fat for the treatment of dislocations and inflammation. Barros et al. (2012), in the Riozinho do Anfrísio Extractive Reserve, Pará, recorded the use of fat in hernia and pneumonia treatment. In the urban center of Cruzeiro do Sul, State of Acre, Oliveira et al. (2019) recorded the use of fat to treat acne and burns. These different uses demonstrate the therapeutic purposes employed in different locations and contexts and with pharmacological potential. It highlights the importance of the fauna for food and as an alternative medicinal source originated from years of experimentation. Restrictions on consumption are inexpressive, although there are myths in other regions of the state concerning the consumption of older individuals, which are

Figure 4. Slaughter and preparation process of *Chelonoidis denticulatus*. Photos: Luiz Henrique Medeiros Borges.

believed to cause the hunter's death (Lemos et al. 2018).

The species is solitary, being found and captured especially in forest environments (Böhm 2011; Ferronato and Morales 2012; Pezzuti et al. 2010). This aspect is related to two factors: preference of hunting environment due to food availability for the target species (Figueiredo and Barros 2015), the distribution of fruit components of the species' diet, and habitat preference (Stevenson et al. al. 2007; Tavares et al. 2019). The presence of bamboos as the landscape's predominant elements in the Resex can favour the formation of beds and reduce the hunters' locomotion capacity, emphasizing the importance of recognizing landscape elements for the animals' location and tracking. The preference for fallen trees and foliage, elements that produce the resting places, were documented by Tavares et al. (2019), highlighting the local residents' knowledge about the species' environmental preferences (Barboza et al. 2013). The diet informed by the hunters (fruits and fresh and decomposing meat) is supported by studies in captivity (Castro et al. 2018) and in the wild (Stevenson et al. 2007), characterizing a generalist diet that can act positively as a seed's disperser (Sobral-Souza et al. 2017) reinforcing the importance of traditional knowledge, which is accumulated over several years of environment experimentation and the knowledge transmission, for understanding the species' ecology.

Chelonoids denticulatus is economically important since it is easily sold (Morcatty and Valsecchi 2015a,b). Thus, its capture may be strongly related to trade and not consumption (Pezzuti et al. 2010), supplying mainly local markets (Alves et al. 2011).

For this reason, their trade is maintained, even with the hunter possible expulsion from the community or by inspection. The tortoise is among the most captured species by the locals and seized in surveillance activities in the Serra do Divisor National Park, at the Acre's extreme northwestern (Lemos et al. 2018), reinforcing the species' monetary value. As observed in the present study, local agreements strengthened by management plans are essential to combat illegal hunting (Constantino 2018) and preserve species (Oliveira and Calouro 2019). In addition, the tortoise is the main species seized by IBAMA in Acre state (Fuccio et al. 2003), highlighting the need for intensifying inspections in the rivers that can be used as routes for the transportation of the animals and meat from illegal hunting (Chaves et al. 2018).

Pigsties are widespread throughout the Amazon (Pezzuti et al. 2010) and can have different purposes. The use of these places for storing live animals may be related to the seasonal availability of other meat sources (Fuccio et al. 2003), especially in the winter period (Félix-Silva et al. 2018) or to gain weight (Figueiredo and Barros 2016). In the present study, this use was more related to the cleaning and maintenance process for the festivities than to a meat stock related to the low availability of other meat sources. In a quilombola community of the Ipaú-Anilzinho Extractive Reserve, Pará, Figueiredo and Barros (2016) recorded a higher frequency of *C. denticulatus* consumption in the Holy Week period due to the influence of the Judeo-Christian tradition, reinforcing the species importance as a religious element. The degree of importance within this aspect may be related to the community religious adherence, species abundance, and/or other species insertion with the same symbolic role. The consumption preference associated with commemorative events indicates the connection between fauna and local traditions, highlighting hunting with utilitarian value beyond human biological needs and as a socialization and cultural identity element, as highlighted by Figueiredo and Barros (2015).

Another important aspect is the *C. denticulatus* meat characterization as allergenic. This characteristic refers to a binary food restriction dividing hunting meat that is safe for everyone to consume (non-allergenic) and another that is dangerous (allergenic). The state of allergenic is not static, being applied to people who are more physically or socially susceptible to worsen their situations or manifest new clinical conditions, such as postpartum women or sick people (Alves et al. 2013; Maués and Motta-Maués 1978; Oliveira et al. 2019; Panzutti 1999; Pezzuti et al. 2004). The species is among the most allergenic species in the Caxiuanã National Forest, in Pará state, but they are also the most consumed hunting species (Félix-Silva et al. 2018) with no direct relationship between restriction and consumption. As the allergenic reactions show fluctuating manifestations and the animals can be kept alive for a prolonged period, this restriction may not influence the capture rate and/or consumption. However, it can influence food preferences and other hunting species' abundance and/or availability. Other restrictions, such as disgust, pity, and palatability, are related to consumption and can act positively on the absence or low consumption (Oliveira et al. 2019).

Urban centres' populations highly appreciate freshwater turtles (Chaves et al. 2020; El Biziri et al. 2020; Morcatty and Valsechi 2015a). *Chelonoidis denticulatus* stands out among other chelonians as it is highly appreciated in urban centres in the State of Acre (Fuccio et al., 2003; Oliveira et al., 2019). This demand may be related to the migration of the rural population to the urban area (Chaves et al., 2020; Parry et al., 2010), where food preferences are kept and encourage species trafficking (Chaves et al. 2018; Fuccio et al. 2003). The possible unsustainable capture rate of the species associated with high demand outside the protected areas may positively favour the *C. denticulatus* population's decline. Despite the species being categorized as Vulnerable (VU) on a global scale by Tortoise & Freshwater Turtle Specialist Group (1996), in Brazil, its conservation status is considered as Least Concern (LC) (Vogt et al. 2016), which indicates the need for studies to assess local population variations resulting from its use.

CONCLUSION

These data contribute to understanding the traditional beliefs associated with *C. denticulatus* and its importance on the people or community cultural identity beyond consumption. These factors highlight the need to deepen these aspects in decision making regarding the capture and consumption of hunting species. Understanding how it occurs and the intensity of the species' use, both in terms of its populations' sustainability and the sociocultural aspects involved in its capture, allow management strategies, if necessary, to present a greater chance of success. Participatory management, with the inclusion of residents in decision-making, considers the cultural aspects of hunting activity and the appreciation of empirical knowledge about the hunted species' ecology.

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DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: MAO.
Carried out the experiment: MAO.
Carried out the data analysis: MAO, APVC-R.
Wrote the first draft of the manuscript: MAO, APVC-R.
Review and final write of the manuscript: MAO, APVC-R, AMC.
Supervision: AMC.

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