Knowledge and use of herpetofauna by rural populations in northeastern Bahia, Brazil: Cultural importance of species and effect of socioeconomic variables

Fabisson L. Campos[1], Ernani M. F. Lins Neto[2,3,4], Eraldo M. Costa Neto[1], Felipe S. Ferreira[1,2,3]*

1 Programa de Pós Graduação em Ecologia e Evolução – UEFS
2 Núcleo de Estudos de Conservação da Caatinga (NECC)/Colegiado de Ecologia - UNIVASF
3 Programa de Pós Graduação em Ciências da Saúde e Biológicas - UNIVASF
4 Programa de Pós Graduação em Ecologia Humana e Gestão Socioambiental – UNEB
*Corresponding author: felipe.sferreira@univasf.edu.br

Received 11 de dezembro de 2023.
Accepted 15 de novembro de 2024.
Published 13 de dezembro de 2024.

Abstract - Brazil has one of the greatest diversities of herpetofauna species in the world. Associated with this diversity, rural communities in Brazil have developed an important knowledge about these animals, composing a rich socio-ecological system. Given the importance of understanding the structure and functioning of these systems, the objective of the study was to characterize the knowledge that the inhabitants of the rural area of the municipality of Alagoinhas, Bahia, Brazil, have about species of reptiles and amphibians, evaluating the total species composition, the variation in species composition by cultural domain and the effect of socioeconomic variables by domain. Data were collected using free lists, a semi-structured questionnaire and complementary interviews. A total of 36 species of amphibians and reptiles were cited by informants. These are used for conflict, food, medicinal, magical-religious and pets. Variation in species composition and cultural importance was observed across cultural domains. Regarding the influence of socioeconomic variables, gender and age explained the knowledge for amphibians (total knowledge of species and conflict relationships) and reptiles (total knowledge of species) These data show the importance of herpetofauna for rural populations in Brazil, and More studies are needed to reconcile traditional practices with herpetofauna conservation.

Keywords: Reptiles. Amphibians. Ethnozoology. Ethnoherpetology.

Conhecimento e uso da herpetofauna pelas populações rurais do nordeste da Bahia, Brasil: importância cultural das espécies e efeito de variáveis socioeconômicas

Resumo - O Brasil possui uma das maiores diversidades de espécies de herpetofauna do mundo. Associado a essa diversidade, as comunidades rurais do Brasil desenvolveram um importante

conhecimento sobre esses animais, compondo um rico sistema socioecológico. Dada a importância da compreensão da estrutura e funcionamento desses sistemas, o objetivo do estudo foi caracterizar o conhecimento que os habitantes da zona rural do município de Alagoinhas, Bahia, Brasil, possuem sobre espécies de répteis e anfíbios, avaliando a composição total de espécies, a variação na composição de espécies por domínio cultural e o efeito de variáveis socioeconômicas por domínio. Os dados foram coletados por meio de listas livres, questionário semiestruturado e entrevistas complementares. Um total de 36 espécies de anfíbios e répteis foram citadas pelos informantes. São utilizados para conflitos, alimentação, medicamentos, mágico-religiosos e animais de estimação. Variação na composição de espécies e importância cultural foi observada entre domínios culturais. Em relação à influência das variáveis socioeconômicas, sexo e idade explicaram o conhecimento para anfíbios (conhecimento total das espécies e relações de conflito) e répteis (conhecimento total das espécies) Esses dados mostram a importância da herpetofauna para as populações rurais do Brasil, e mais estudos são necessários conciliar práticas tradicionais com a conservação da herpetofauna.

Palavras-chave: Répteis. Anfíbios. Etnozoologia. Etnoherpetologia.

Conocimiento y uso de la herpetofauna por poblaciones rurales del noreste de Bahía, Brasil: importancia cultural de las especies y efecto de variables socioeconómicas

Resumen - Brasil tiene una de las mayores diversidades de especies de herpetofauna del mundo. Asociado a esta diversidad, las comunidades rurales de Brasil han desarrollado importantes conocimientos sobre estos animales, formando un rico sistema socioecológico. Dada la importancia de comprender la estructura y funcionamiento de estos sistemas, el objetivo del estudio fue caracterizar el conocimiento que tienen los habitantes de la zona rural del municipio de Alagoinhas, Bahía, Brasil, sobre especies de reptiles y anfibios, evaluando la composición total de especies, la variación en la composición de especies por dominio cultural y el efecto de las variables socioeconómicas por dominio. Los datos se recolectaron mediante listas libres, cuestionario semiestructurado y entrevistas complementarias. Un total de 36 especies de anfibios y reptiles fueron mencionadas por los informantes. Se utilizan para conflictos, alimentación, medicina, mágico-religiosa y mascotas. Se ha observado variación en la composición de especies y la importancia cultural entre dominios culturales. En cuanto a la influencia de las variables socioeconómicas, el sexo y la edad explicaron el conocimiento para anfibios (conocimiento total de las especies y relaciones de conflicto) y reptiles (conocimiento total de las especies), estos datos muestran la importancia de la herpetofauna para las poblaciones rurales de Brasil, y son necesarios más estudios. conciliar las prácticas tradicionales con la conservación de la herpetofauna.

Palabras clave: Reptiles. Anfibios. Etnozoología. Etnoherpetología.

Introduction

The evolution of *Homo sapiens* was strongly influenced by the fauna that was around it, as through human/animal interaction, humans learned which animals they could feed on and which ones to avoid. Thus, this relationship favored the construction of vast knowledge about animals, allowing human societies to develop and maintain interactions with fauna throughout their history (Alves 2012). Among these animals, amphibians and reptiles stand out for having the most varied types of interactions, presenting utilitarian and symbolic aspects with human populations (Ríos-Orjuela et al. 2020).

Brazil has one of the greatest diversity of reptile and amphibian species in the world (Rodrigues 2005). Data from the Brazilian Society of Herpetology indicate that at least 1,080 species of amphibians and 795 species of reptiles occur in Brazil (Bérnils and Costa 2014; Segalla et al. 2014). Associated with this diversity of species, rural and traditional communities in Brazil have developed a vast knowledge about these animals that is reflected in different interactions (Alves 2012).

Data available in the literature indicate that at least 89 species of Brazilian herpetofauna are used in five cultural domains: food, medicinal, magical-religious, pet and conflict relations (Begossi and Braga 1992; Costa-Neto 1999; Bernarde and Santos 2009 ; Alves et al. 2012a; Ferreira et al. 2012; Rodrigues et al. 2012; Mendonça et al. 2014). Thus, understanding how the composition and cultural importance of useful herpetofauna species varies allows us to understand the action of local biological and cultural aspects that influence the way of interacting with fauna.

Another important element to understand how humans choose certain fauna species is related to the action of socioeconomic variables. Evidence suggests that physiological and sociological differences between men and women influence the way they interact with fauna Herzog (2007). Other studies indicate that age differences are also determining factors in how to interact with animals (Hernandez et al. 2015). Furthermore, research indicates that differences related to education and income also alter the structure of socio-ecological systems (Medeiros et al. 2012). Thus, understanding which socioeconomic variables influence knowledge related to herpetofauna is important to elucidate mechanisms of functioning of cultural systems (Ceriaco 2012; García-López et al. 2017).

Considering the above, the present research aimed to characterize the socio-ecological system related to the knowledge that the inhabitants of the rural area of the municipality of Alagoinhas, Bahia, Brazil have about species of reptiles and amphibians. More precisely, we aim to assess the total species composition known by informants, the cultural importance of species and the effect of socioeconomic variables on species knowledge by cultural domain.

Material and Methods

Study area

The present study was developed in the rural area of the municipality of Alagoinhas (12°08'08" S 38°25'09" OW), which is in the Identity Territory of the State of Bahia called Litoral Norte and Agreste Baiano, in the Northeast of Brazil (Figure 1). With a population of 141,949 inhabitants (IBGE 2020), 124,042 residents in urban areas and 17,907 inhabitants in rural areas, the demographic expectation for 2017 was approximately 155,979 inhabitants.

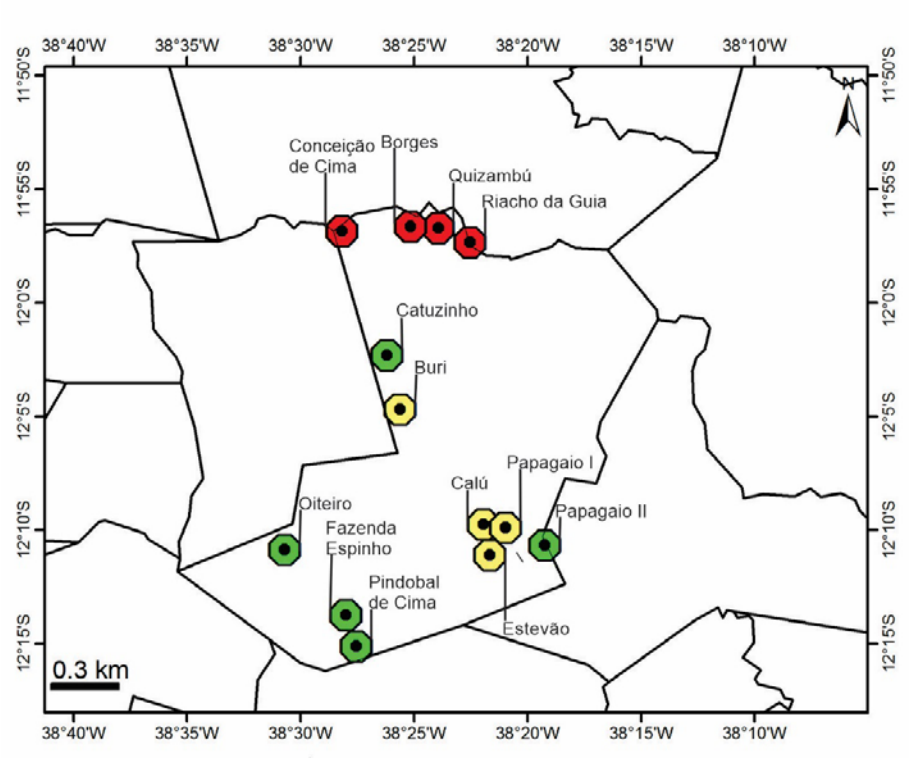
Figure 1. Location of the municipality of Alagoinhas and municipalities belonging to the Identity Territory of the North Coast and Agreste Baiano. Legends Ac: Acajutiba; ARA: Aramari; Ap: Aporá; Ar: Araças; CA: Catu; CS: Cardeal da Silva; ER: Entre Rios; ES: Esplanada; INH: Inhambupe; ITA: Itanagra; IT: Itapicuru; JA: Jandaíra; OUR: Ouriçangas; PE: Pedrão; PO: Pojuca; RR: Rio Real.

The municipality of Alagoinhas has a sub-humid to dry with an average annual temperature of 23.5º C. It is characterized by a vegetation altered by humans, with traces of Caatinga and fragments of rain forest, remnants of the Atlantic Forest, presenting an annual average rainfall of 1478 mm. With these characteristics, the municipality has extensive eucalyptus plantations in its surroundings, a prominent situation approximately the studied areas (IBGE 2020).

Sampling and Data Collection

The study was carried out in 13 communities in the rural area of the municipality of Alagoinhas (Buri, Calú, Papagaio I, Santo Estevão, Catuzinho, Oiteiro, Fazenda Espinho, Pindobal de Cima, Papagaio II Riacho da Guia district, Quizambú, Borges and Conceição de Cima) (Figure 2).

Figure 2. Researched communities in the municipality of Alagoinhas.



The research was carried out in 13 communities in the rural area of the municipality of Alagoinhas (Buri, Calú, Papagaio I, Santo Estevão, Catuzinho, Oiteiro, Fazenda Espinho, Pindobal de Cima, Papagaio II neighborhood, Riacho da Guia, Quizambú, Borges and Conceição de Cima) (Figure 2).

Data collection was carried out between January and May 2018 and began after authorization from the Research Ethics Committee of the Universidade Federal do Vale do São Francisco - UNIVASF (protocol number CAAE 79331217.8.0000.5196). Additionally, this study was registered in the Sistema Nacional de Gestão do Patrimônio Genético e Conhecimento Tradicional Associado (SISGEN: A17F74F). In accordance with Resolution 466/2012 of the Ministry of Health, the Informed Consent Form (ICF) was given to the interviewees to read, so that they could understand the objectives of the research. The sample was randomly selected, and all community residents were invited to participate in the interview. As an inclusion criterion, interviewees who had some interaction (use, knowledge) with amphibian and reptile species were chosen.

Thus, 130 informants were interviewed, aged between 14 and 90 years. The interviews with informants under 18 years of age took place in the presence of their parents, who authorized the interviews. Data were collected using free lists and a semi-structured questionnaire. The free lists were constructed based on the cultural domains known in the literature on the use of herpetofauna (Alves et al. 2012a). Thus, the informants were asked: What species of amphibians and reptiles do you know in your region? What species do you use in your diet? Which species do you use for medicinal purposes? Which species do you use for magical-religious purposes? Which species do you use as pets? Which species do you not use but have conflicting relationships with? Additional questions were asked based on the data obtained from the free list. Thus, informants were asked about parts of animals used in cultural domains such as zootherapy and magical-religious purposes and beliefs associated with

the species that were included in the list of conflicting relationships. Additionally, a socioeconomic questionnaire was administered to obtain data related to gender, age, education and income.

The process of identification of species occurred through descriptions provided by the interviewees combined with consultations of specific bibliography (http://www.reptile-database.org/; https://sbherpetologia.org.br/) and specialists in the groups of animals mentioned by the interviewees.

Data Analysis

Knowledge of the herpetofauna and cultural importance of the species

Knowledge about herpetofauna as well as cultural importance was calculated from the free lists. The number of species cited by each interviewee was adopted as a prerequisite to define the collaborator's knowledge about the species of a given cultural domain. The cultural importance of the species was obtained from the salience index. The salience index was calculated for each of the free lists, using the ANTHROPAC 4.x software for Windows (Borgatti 1996) to determine the salience of the species.

Influence of socioeconomic variables on knowledge between humans and herpetofauna

A generalized linear model (GLM) was performed to verify whether there is a relationship between socioeconomic variables (age, gender, education, and income) and knowledge of herpetofauna (total number of species cited; number of species for food; number of species with conflict relationships). Since the data related to species used for medicinal, magical, and pet purposes were low, we chose to exclude them from this analysis. The socioeconomic variables were organized as follows: age (raw number indicated by informants), gender (female and male); education (illiterate, elementary and high school); and income (raw number indicated by informants). The native R function "glm ( )" was used, considering the Poisson distribution family (poisson (link = "log")), due to the nature of the data. To verify the significance of the relationships between the dependent and independent variables, we used the "Anova ( )" function of the CAR package. The residuals were verified using the "rdiagnostic" function of the MASS package. After checking the residuals, we checked for overdispersion of the data, sometimes requiring the use of the negative Binomial model using the "glm.nb" function, also from the MASS package. For all analyses, the R 3.6.1 software (Core Team 2012) was used.

Results

A total of 130 interviews were carried out in the municipality of Alagoinhas (67 women and 63 men) with people aged between 14 and 90 years. The informants cited 36 popular names of animals of which three were amphibians and 33 reptiles (Table 1). These species are in the categories of food use (14 animals), magical-religious purposes (2), medicine (14), pets (1), and in conflicting relationships (34) (Table 2).

Table 1. Species of herpetofauna cited by informants from rural communities in the municipality of Alagoinhas, Bahia, Brazil. Legends: FO (food), MR (magical-religious purposes), ME (medicine), PE (pet), CR (conflicting relationships), S (salience index).

Species	Number of informants	Categories				
		FO	MR	ME	PE	CR
		S	S	S	S	S
Amphibians						
Bufonidae						
Sapo/Cururu toad - *Rhinella jimi* (Stevaux, 2002)	130	-	-	0.6034	-	0.2807
Leptodactylidae						
Gia/ South American pepper frog – *Leptodactylus labyrinthicus*. (Spix, 1824)	102	0.5251	-	0.0540	-	0.0975
Hylidae						
Rã/ Venezuela Snouted Treefrog *Scinax x-signatus* (Spix, 1824)	129	0.0278	-	0.0129	-	0.2060
Reptiles						
Crocodiles						
Alligatoridae						
Jacaré/ Broad-snouted caiman *Caiman latirostris* (Daudin, 1801)	11	0.0410	-	0.0057	-	-
Amphisbaenians						
Amphisbaenidae	-	-	-	-	-	-
Cobra de duas cabeça / Wagler's Worm Lizard - *Amphisbaena vermicularis* Wagler, 1824	89	-	-	-	-	0.3068
Snakes						
Boidae						
Cobra jiboia/ Red-Tailed Boa Constrictor - *Boa constrictor* Linnaeus, 1758	76	0.3926	-	0.1034	-	0.2371
Cobra salamanta/ Rainbow Boa - *Epicrates cenchria* (Linnaeus, 1758)	3	0.0037	-	-	-	0.0162
Cobra sucuiú - *Eunectes murinus* (Linnaeus, 1758)	62	0.3010	-	0.0445	-	0.2152
Colubridae						
Cobra cainana/ Tropical Chicken Snake - *Spilotes pullatus* (Linnaeus, 1758)	36	-	-	-	-	0.1048
Cobra cipó - *Philodryas* sp.	60	-	-	-	-	0.1994
Cobra corre campo/ Paraguay Green Racer – *Philodryas nattereri* (Steindachener, 1870)	11	-	-	-	-	0.0394
Cobra d'água - *Helicops* sp.	3	-	-	-	-	0.0067
Cobra espada - *Chironius* sp.	22	-	-	-	-	0.0735
Cobra malha de traíra/Rio Tropical Racer - *Palusophis bifossatus* (Raddi, 1820)	17	-	-	-	-	0.0403

Cobra papa-pinto/ Western Indigo Snake – *Drymarchon corais* (Boie, 1827)	32	0.0017	-	0.0198	-	0.1066
Cobra papa-rato - *Cleria* sp.	7	-	-	-	-	0.0264
Cobra verde/ Lichtenstein's Green Racer – *Philodryas olfersii* (Lichtenstein, 1823)	91	-	-	-	-	0.3872
Cobra 11 horas/ Neotropical Black-headed Snake – *Tantilla melanocephala* (Linnaeus, 1758)	5	-	-	-	-	0.0259
Elapidae						
Cobra coral/ Caatinga Coral Snake – *Micrurus ibiboboca* (Merrem, 1820)	103	0.0142	-	0.0560	-	0.5014
Viparidae						
Cobra cascavel/ Cascavel rattlesnake – *Crotalus durissus* Linnaeus, 1758	90	0.0128	-	0.2506	-	0.5082
Cobra jaracuçu/ Jararaca Pintada – *Bothrops* sp.1	13	-	-	-	-	0.1179
Cobra jaracuçu de tabuleiro - *Bothrops* sp. 2 (Wagler, 1824)	1	-	-	-	-	0.0059
Cobra jararaca/ Caatinga Lancehead – *Bothrops erythromelas* Amaral, 1923	71	-	-	0.0172	-	0.3281
Cobra jararaca do rabo branco/jararaca – *Bothrops* sp. 3	7	-	-	-	-	0.0185
Cobra malha de sapo - *Bothrops* sp. 4	64	0.0057	-	-	-	0.2509
Cobra pico-de-jaca - *Lachesis muta* (Linnaeus, 1766)	8	-	-	-	-	0.0096
Cobra surucucu - *Bothrops* sp. 5	21	-	-	-	-	0.0662
Turtles						
Testudinidae						
Jabuti/ Red-footed Tortoise – *Chelonoidis carbonaria* (Spix, 1824)	58	0.0151	-	-	-	-
Lizards						
Gekkonidae						
Lagartixa briba/ House gecko – *Hemidactylus mabouia* (Moreau de Jonnès, 1818)	123	-	-	0.0431	-	0.0217
Iguanidae						
Camaleão/ Common Green Iguana - *Iguana iguana* (Linnaeus, 1758)	102	0.2988	-	0.0307	-	0.0068
Teiidae						
Teiú/ Argentine Black and White Tegu, - *Salvator merianae* DumériL & Bibron, 1839	111	0.5423	-	0.1845	-	0.0026
Testudinidae						

Jabuti/ Red-footed Tortoise – *Chelonoidis carbonaria* (Spix, 1824)	58	0.0151	-	-	-	-
Tropiduridae						
Catende/ Neotropical Lava Lizard - *Tropidurus hispidus* (Spix, 1825)	124	-	-	0.1514	-	0.0133
Unidentified name						
Calango	85	0.0105	-	-	-	0.0056
Cobra 24 horas	7	-	-	-	-	0.0106
Cobra 7 horas	2	-	-	-	-	0.0115
Cobra de vidro	1	-	-	-	-	0.0014

Table 2. General linear model showing the relationship between species knowledge and socioeconomic variables.

Use category	Variables	Estimate	Std. Error	Z-value	P-value
Total citation of reptiles	Intercept	2.270e+00	9.268e-02	24.489	<2e-16 ***
	Schooling (Complete high school)	3.433e-02	6.259e-02	0.548	0.5834
	Schooling (Illiterate)	3.181e-02	8.579e-02	0.371	0.7108
	Income	-1.433e-05	5.349e-05	-0.268	0.7888
	Age	3.474e-03	2.102e-03	1.652	0.0985 .
	Gender (male)	1.041e-01	5.263e-02	1.977	0.0480 *
	Variables	**Estimate**	**Std. Error**	**Z-value**	**P-value**
Food use of reptiles	Intercept	8.784e-01	1.752e-01	5.014	5.34e-07 ***
	Schooling (Complete high school)	1.076e-01	1.164e-01	0.924	0.3554
	Schooling (Illiterate)	-1.031e-01	1.615e-01	-0.638	0.5232
	Income	7.658e-06	9.801e-05	0.078	0.9377
	Age	6.459e-03	3.906e-03	1.654	0.0982 .
	Gender (male)	1.070e-01	9.762e-02	1.096	0.2730
	Variables	**Estimate**	**Std. Error**	**Z-value**	**P-value**
Conflict relations with reptiles	Intercept	1.4825966	0.2293082	6.466	1.01e-10 ***
	Schooling (Complete high school)	-0.0125801	0.1564419	-0.080	0.9359
	Schooling (Illiterate)	0.0210782	0.2202804	0.096	0.9238
	Income	0.0001012	0.0001337	0.757	0.4492
	Age	0.0042433	0.0052698	0.805	0.4207
	Gender (male)	-0.2560680	0.1328614	-1.927	0.0539 .

Use category	Variables	Estimate	Std. Error	Z-value	P-value
Total citation of amphibians	Intercept	3.225e+00	5.958e-02	54.136	<2e-16 ***
	Schooling (Complete high school)	3.782e-02	4.015e-02	0.942	0.3462
	Schooling (Illiterate)	-2.731e-02	5.737e-02	-0.476	0.6340
	Income	-9.836e-06	3.453e-05	-0.285	0.7758
	Age	1.663e-03	1.367e-03	1.216	0.2239
	Gender (male)	7.871e-02	3.420e-02	2.301	0.0214 *
	Variables	**Estimate**	**Std. Error**	**Z-value**	**P-value**
Food use of amphibians	Intercept	2.654e+00	9.885e-02	26.845	<2e-16 ***
	Schooling (Complete high school)	1.474e-01	6.616e-02	2.228	0.0259 *
	Schooling (Illiterate)	9.731e-03	9.560e-02	0.102	0.9189
	Income	-8.020e-05	5.735e-05	-1.399	0.1619
	Age	2.559e-03	2.276e-03	1.124	0.2609
	Gender (male)	6.527e-02	5.668e-02	1.152	0.2495
	Variables	**Estimate**	**Std. Error**	**Z-value**	**P-value**
Conflict relations with amphibians	Intercept	3.525e+00	1.717e-01	20.531	< 2e-16 ***
	Schooling (Complete high school)	-1.013e-01	1.173e-01	-0.864	0.387809
	Schooling (Illiterate)	1.919e-01	1.710e-01	1.122	0.261710
	Income	-1.309e-05	1.021e-04	-0.128	0.897952
	Age	-9.466e-03	4.026e-03	-2.351	0.018704 *
	Gender (male)	-3.692e-01	1.010e-01	-3.654	0.000258 ***

codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**

The category of conflicting relationships had *Crotalus durissus* and *Micrurus ibiboca* with the highest salience scores. In the food uses *Salvator merianae* and *Leptodactylus labyrinthicus* were the most culturally important. For medicinal use, *Rhinela jimi*. In the other categories, the salience was not calculated, since they presented few species (magical-religious purposes with two species, and pets with one species).

The GLM (Table 2) showed that total knowledge about reptiles was explained by gender (men cited more reptile species). However, knowledge about food species and conflict relationships was not explained by any socioeconomic variable. For amphibians, total knowledge about species was explained by gender (men cited more species) while knowledge about species with conflict relationships was explained by gender (men cited fewer species) and age (older people cited fewer species). Finally, knowledge about amphibians used for food was not influenced by any socioeconomic variable.

Discussion

The study showed that the rural population of Alagoinhas has extensive knowledge about herpetofauna species. Possibly, the use of land for planting favors contacts with animals of the local herpetofauna, allowing the development and maintenance of traditional practices with species of amphibians and reptiles (Ríos-Orjuela et al. 2020). When we compare the richness of species mentioned by respondents from Alagoinhas with that observed in other studies, there is a variation. The number of amphibian species cited by respondents was lower when compared to other studies (Rojas et al. 2015; Leyte-Manrique, Álvarez and Hernández-Navarro 2016; Cupul Cicero et al. 2019). For reptiles, the number of species found was higher than in other studies (Mendonça et al. 2014; Rojas et al. 2015; Leyte-Manrique et al. 2016).

Traditional practices within a socioecological system are influenced by specific local contexts, causing variations from one study site to another (Albuquerque et al. 2019). A local factor that varies between different localities is the abundance of herpetofauna species. For example, the variation in the abundance of species in different communities is a factor that leads to different experiences of human populations with animals. Thus, a given community may cite species for a use category, reflecting the high or low local abundance of herpetofauna.

Analyzing species citations by cultural domain, it was found that the food, medicinal and conflict categories are the most important for the rural community of Alagoinhas, since they presented the highest species richness. Amphibians and reptiles are among the species with the highest citations of uses for food and medicinal purposes in northeastern Brazil (Mendonça et al. 2014; Alves et al. 2012). At the same time, they are one of the main targets of conflict with people living in rural areas (Alves et al. 2012). Additionally, the cultural domains of pets and religious magic had the lowest number of species. As previously mentioned, the ways of using the fauna respond to specific local contexts, determining which practices are predominant.

The category of conflict relationships had the highest number of species cited by informants (n = 34). Conflict relationships are characterized by negative feelings of humans against animals that result in the persecution and death of fauna without any utilitarian objective (Ceriaco et al. 2012). Feelings of fear, disgust and repulsion are characteristics identified as triggering relationships of conflict and persecution of fauna (García-López et al. 2017). The literature shows that humans are afraid and/or repulsed by amphibians and reptiles, and consequently persecute and sacrifice animals without a utilitarian objective. Among reptiles, fear is the main motivating feeling in conflict relationships (Ceriaco et al. 2012). For amphibians, disgust and/or repulsion is the determining aspect (Ceriaco et al. 2012). In both cases, feelings directly influence the pursuit of herpetofauna (Ríos-Orjuela et al. 2020; Alves et al. 2012a,b; Kaishauri and Makashvili 2013; Pandey et al. 2016; Liordos et al. 2018).

Respondents cited 14 species of amphibians and reptiles for the food category. The nutritional role of game fauna for rural people in Brazil is highlighted by several authors (Ferreira et al. 2009a, b; Fernandes-Ferreira et al. 2013; Souto et al. 2018). In semi-arid regions, such as Northeast Brazil, wildlife is the main source of animal protein for rural communities. The preference for the species of animal to be used in nutrition is related to factors such as flavor, abundance or biomass (Chaves et al. 2020). However, there is no established pattern in the literature indicating which factors are predominant in the choice of a species used in food. The species mentioned by respondents from the

rural area of Alagoinhas are not large, suggesting that the selection criteria are related to their flavor or local availability.

In the medicinal category, 14 species were indicated by the interviewees. The traditional medical practice based on the use of animals is extremely present in the daily lives of rural people in northeastern Brazil. Among the groups of animals, reptiles and amphibians stand out as the main medicinal resources (Ferreira et al. 2012). In the present study, it was observed that the medicinal use of reptiles and amphibians is closely related to body fats and skins for the treatment of respiratory and musculoskeletal diseases. The knowledge about the use of animals in medicinal practices cited by the rural population of Alagoinhas, corroborates research in Brazil and worldwide, reaffirming the medicinal importance of herpetofauna for human communities (Costa-Neto 1999; Rojas et al. 2015 Barbosa et al. 2018; Teixeira et al. 2020).

According to informants from rural Alagoinhas, traditional medical practice using animals is not as frequent as in the past. The results show that there is knowledge about amphibians and reptiles used in traditional medicine, however the interviewees stated that they currently use little zootherapics. Additionally, respondents stated that the reduction in the use of medicinal animals is related to the improvement of public health services. This reduction in the use of fauna can be explained from the interpretation of changes in socio-ecological systems. These systems are composed of biological (human and animal) and cultural (symbolic mechanisms in the use of diseases) elements (Albuquerque et al. 2019). Over time, new elements can be incorporated, bringing new operating dynamics to the system. Thus, it is possible that changes in the landscape result in a decrease in herpetofauna species, reducing the use of these animals. Concomitant with the reduction of species, the strengthening of public health policies in the interior of Brazil brought improvements in the health of rural residents. These two factors can explain the presence of knowledge about the medicinal herpetofauna followed by the reduction in the use of the fauna.

The magical-religious category was indicated for two species (*Crotalus durissus* and *Rhinella jimi*). This cultural domain is characterized using animals in ritualistic practices associated with religiosity or a way of directing bad luck to other people. Respondents attributed magical properties to the use of *R. jimi* to damage enemies. This practice consists of introducing a person's name into the frog's mouth and over time this could cause death or illness for that person who has conflict. The species *C. durissus* was cited for the magical-religious category, but there was no form of use attributed by the informants. However, Alves et al. (2012c) cited the use of this species for magical-religious purposes such as causing bad luck or diseases through rituals.

This category of use reinforces that the contexts related to the use of animals go beyond physical uses, such as food or medicine (Alves et al. 2012c). Religious magic use brings a demand related to spiritual practices using animals to meet symbolic and non-physiological needs. Consequently, we can explain the use of *R. jimi* and *C. durissis* as magico-religious as follows: using animals for rituals of persecution represents a symbolic way of projecting characteristics perceived as negative for amphibians onto other people. For example, frogs are seen as disgusting and/or repulsive animals. Thus, performing rituals with these animals would be a way of transposing the "repulsive characteristics of amphibians" to people, causing them to become sick.

The species *Chelonoidis carbonaria* was the only one indicated by the informants for the pet category. This species is commonly cited as a pet in studies carried out in northeastern Brazil (Alves et al. 2012a.b). The ease of handling this species tends to be a factor favoring its creation in captivity.

The relationship of fauna use for estimation purposes is commonly cited as something characteristic of the evolution of *Homo sapiens* (Alves 2012), so that more and more taxonomic groups have been included in this use modality. The predilection for mammals and birds as pets is notorious, however reptiles have gained more and more space in this cultural domain (Alves et al 2012a, b).

An interesting point to be addressed is the fact that some of the species mentioned in the present study are used as pets in other rural communities (see Alves et al 2012a). As previously mentioned, the way of interacting with the fauna is influenced by specific local aspects that may vary from region to region. Thus, probably, local biological and cultural factors in the rural area of Alagoinhas favored the use of species for food, medicinal and conflict cultural domains to the detriment of use as a pet.

Species richness data by cultural domain show that 18 species were cited for the category of conflict relationships, representing half of the species listed by informants. However, the other half of the species were cited for more than one category, suggesting the presence of multiple uses for the herpetofauna species. The multiplicity of uses can be discussed within the perspective of utilitarian redundancy, one of the postulates of the theory of maximizing uses, proposed by Albuquerque et al. (2019) to explain the creation and functioning of socioecological systems. The authors admit that socioecological systems work within a logic of potentializing and redundancy of uses. In this way, redundant systems favor resilience, being less susceptible to changes over time. From this context, the presence of amphibian and reptile species in more than one cultural domain suggests the presence of a resilient system with low susceptibility to change its composition and functionality. However, other variables must be considered for this statement to be validated, such as investigating how other groups of animals are organized within cultural domains.

The analysis of the cultural importance of herpetofauna by category suggests that species with high utilitarian value have lower conflict relationships (see values in Table 1). For example, *S. marianae* and *L. labyrinthicus* were the most culturally important species within the food use domain. On the other hand, the two species showed low cultural importance in the category of conflict relationships. The same scenario was observed for *R. jimi* in which this species had a high salience value in the domain of medicinal use and low in the category of conflict relationships. Finally, the snakes *C. durissus* and *M. ibiboboca* were the most culturally important species within the domain of conflicting relationships and both had low salience values in the food and medicinal use categories.

As socioecological systems respond to local factors that determine the use of fauna, the tendency for species with higher utilitarian values to have lower conflict relationships raises an interesting debate. For example, the high utilitarian value of a species can be attributed to local cultural contexts that encourage its maintenance and foster strategies to reduce risks caused by conflicting relationships. In this sense, we can analyze the preference for *S. merianae* consumption by the informants to explain how the high utilitarian value can influence the decrease in the conflict relationship.

The informants from the rural area of Alagoinhas stated that they prefer the consumption of *S. merianae* due to its taste. We can infer that this preference would stimulate learning more about this species, increasing the flow of information related to this knowledge within the social group, favoring this species to have greater cultural importance. Consequently, the high cultural importance of *S.merianae* for food would stimulate local cultural contexts that would lead to lower conflict relationships for this species. Thus, the cultural importance of a species for a category could directly influence the way in which the population uses the species in another category, according to the premise of the functioning of a socio-ecological system. However, further studies should be conducted

to understand the effect of cultural elements that increase or decrease the cultural importance of a species within a socioecological system.

Regarding the effect of socioeconomic variables on the number of species cited by category, the GLM showed that gender and age influenced the number of cited species of amphibians and reptiles. For amphibians, total knowledge was influenced by gender (men cited more species), while knowledge of conflict target species was influenced by age (older people cited fewer species) and gender (men cited fewer species). For reptiles, the genus influenced the total knowledge of species (men cited more species).

Gender is pointed out as a variable that influences ways of interacting with the fauna (Santos et al 2020). Herzog (2007) and Kelllert (1996) discuss hunting, showing that there is a predominance of men in activities related to hunting, so that this behavior can influence men to develop greater knowledge about the fauna.

In addition to the role of men in hunting, another argument about the influence of gender is in the social division of men and women residing in rural areas. Røskaft et al. (2003) indicate a predominance of men in work related to the field (planting or livestock). Possibly this contact with nature favored the knowledge of more species of animals. This becomes evident when we analyze the results obtained in the present study, as men cited more species of herpetofauna in relation to women. Most of the men interviewed work as farmers, so they are interacting with herpetofauna species more frequently.

On the other hand, men cited fewer amphibian species with conflicting relationships when compared to the women interviewed. Possibly, knowing more species (considering the data of total knowledge of species) implies in less stalking relationships. Bird (1999) states that the greater contact of men from rural areas with nature can favor greater knowledge about animal species, possibly influencing the reduction of the number of species that present conflicts.

However, Torres-Avilez and Albuquerque (2017) suggest that the effect of the gender variable on the knowledge of biodiversity does not present a defined model, in which only social aspects that generate differences between men and women explain why a genus knows more species than the other. This is evident in the study by Haas et al. (2020) in which they observed that the predominance of men hunting is recent in the history of H. sapiens. According to Haas et al. (2020), archaeological evidence indicates that hunting was carried out by all individuals of the hunter-gatherer hominid group. In this sense, it is evident that the role of gender is moldable over space and time, so that interpretations of gender modulating knowledge about fauna must consider the individual and collective local experiences of men and women.

Age influenced the number of amphibian species that informants have conflicting relationships, in which there was a negative relationship where older people cited fewer species. The effect of age on traditional knowledge associated with fauna has been evaluated in several studies (Santos et al. 2020; Souto et al. 2018). One argument adopted to explain the effect of age on fauna assumes that older people accumulate greater knowledge than younger people (Hernandez et al. 2015). For example, an older person has more experiences with the fauna (through hunting, medicinal use, among others), allowing to know more species in relation to a younger person. In this scenario, the traditional knowledge associated with nature would have a cumulative character over time.

Another perspective adopted to explain the effect of age is related to the alteration of the landscape of a socio-ecological system over a person's lifetime (Medeiros et al. 2015). This premise considers that the environment where people are inserted can be modified over time, directly influencing

the knowledge associated with this environment. Thus, knowing species would not have a direct relationship with age, but with the current scenario of the landscape of the socioecological system in which a person is inserted. In this way, knowledge about biodiversity takes on an oscillating character over time.

Analyzing the data on the effect of age on knowledge about amphibians with conflict relationships, we observed that older informants cited fewer species compared to younger ones. We can admit that this result is explained within the premise that knowledge can fluctuate over time. For example, we can assume that older informants have reduced their experiences with the fauna over time, either due to a reduction in species or a reduction in hunting activities. With less frequent interaction experiences over time, the knowledge associated with a faunal resource may decrease over the years.

Conclusion

The socioecological system of rural communities in the municipality of Alagoinhas has a high number of species of amphibians and reptiles performing functions within the cultural domains analyzed. The knowledge recorded here is well disseminated in the communities sampled. Thus, our data show that even in rural environments altered by agriculture, and close to urban centers, traditional knowledge about wild fauna remains and registration through scientific studies is extremely important.

The results of species variation by cultural domain bring perspectives for debates on the structure and functioning of socioecological systems, allowing the inclusion of more analytical variables to elucidate their dynamics over time and space. Likewise, data on the effect of socioeconomic variables contribute to discussions related to the effect of gender and age, modulating knowledge about the fauna.

In general, it was found that a socioecological system reflects local ecological and cultural factors, that its structural and functional elements are prone to variation, determining ways of using and acting. Thus, understanding how humans interact with amphibians and reptiles, within a systemic approach, brings an essential debate for the maintenance of traditional knowledge as well as of herpetofauna.

Author contributions: Fabisson L. Campos: Conceptualization, Methodology, Investigation, Writing; Ernani M. F. Lins Neto: Resources, Methodology, Validation; Eraldo M. Costa-Neto: Writing - Review & Editing, Supervision; Felipe S. Ferreira: Conceptualization, Writing - Review & Editing, Supervision.

Ethical approval: The study was approved by the Research Ethics Committee of the Universidade Federal do Vale do São Francisco - UNIVASF (protocol number CAAE 79331217.8.0000.5196). Additionally, this study was registered in the National Genetic Heritage and Associated Traditional Knowledge Management System (SISGEN: A17F74F).

Type of review: Anonymous review.

Data availability: Data is available upon request.

Funding: This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

Acknowledgments: The authors would like to thank the interviewees from the communities of Alagoinhas, who contributed information and knowledge to this research. We also thank Dr. Anderson Feijó for creating the maps.

Conflict of Interests: The authors declare that there is no conflict of interest.

References

Albuquerque, U. P., R. F. P. Lucena, and E. M. F. Lins Neto. 2010. Seleção dos participantes da pesquisa. In *Métodos e técnicas na pesquisa etnobiológica e etnoecológica, edited U. P. Albuquerque, Lucena, R.F.P., and Cunha, L.V.F.C., pp. 21-38. Nupeea, Recife.*

Albuquerque, U. P. Medeiros, P. M. Ferreira Junior, W. S. Silva, T. C.Silva, R. R. V. and Souza, T. G. 2019. Social-Ecological Theory of Maximization: Basic Concepts and TwoInitial Models. *Biological Theory* 14: 73–85. https://doi.org/10.1007/s13752-019-00316-8.

Alves, R. R. N. 2012. Relationships between fauna and people and the role of ethnozoology in animal conservation. *Ethnobiology and Conservation* 1. https://doi.org/10.15451/ec2012-8-1.2-1.

Alves, R. R. N., K. S. Vieira, G. G. Santana, W. L. S. Vieira, W. O. Almeida, W. M. S. Souto, P. F. G. P. Montenegro, and J. C. B. Pezzuti. 2012a. A review on human attitudes towards reptiles in Brazil. *Environmental Monitoring and Assessment* 184:6877-6901. https://doi.org/10.1007/s10661-011-2465-0.

Alves, R.R.N. Rosa, I.L. Léo Neto, N.A. and Robert Voeks. 2012c. Animals for the Gods: Magical and Religious Faunal Use and Trade in Brazil. *Human Ecology* 40, 751–780. https://doi.org/10.1007/s10745-012-9516-1.

Barbosa, J. A. A., J. O. Aguiar, and R. R. N. Alves. 2018. Medicinal use of animals by hunters in north eastern Brazil. *Indian Journal of Traditional Knowledge* 17:485-493.

Begossi, A., and S. Braga. 1992. Food taboos and folk medicine among fishermen from the Tocantins river (Brazil). *Amazoniana. Kiel 12:101-118.*

Bernarde, P. S. and R. A. Santos. 2009. Utilização medicinal da secreção ("vacina-do-sapo") do anfíbio kambô (Phyllomedusa bicolor)(Anura: Hylidae) por população não indígena em Espigão do Oeste, Rondônia, Brasil. Revista Biotemas 22:213-220. https://doi.org/10.5007/2175-7925.2009v22n3p213.

Bérnils, R. S., and H. C. Costa. 2014. Répteis brasileiros: Lista de espécies. *Herpetologia Brasileira* 3:74-84.

Bird, R. 1999. Cooperation and conflict: The behavioral ecology of the sexual division of labor. *Evolutionary Anthropology* 8:65-75. https://doi.org/10.1002/(SICI)1520-6505(1999)8:2<65::AID-EVAN5>3.0.CO;2-3.

Borgatti, S. P. 1996. Anthropac 4.0. *Natick, MA: Analytic Technologies.*

Ceriaco, L. M. P. 2012. Human attitudes towards herpetofauna: The influence of folklore and negative values on the conservation of amphibians and reptiles in Portugal. *Journal of Ethnobiology and Ethnomedicine* 8:8 https://doi.org/10.1186/1746-4269-8-8.

Chaves, L. S., Alves, R. R., and Albuquerque, U. P. 2020. Hunters' preferences and perceptions as hunting predictors in a semiarid ecosystem. *Science of The Total Environment* 726, 138494. https://doi.org/10.1016/j.scitotenv.2020.138494.

R: A language and environment for statistical computing, Vienna, Austria.

Costa-Neto, E. M. 1999. Healing with animals in Feira de Santana city, Bahia, Brazil. *Journal of Ethnopharmacology* 65:225-230. https://doi.org/10.1016/S0378-8741(98)00158-5.

Cupul Cicero, V., W. J. Aguilar Cordero, J. Chablé Santos, and C. I. Sélem Salas. 2019. Ethnozoological knowledge of the herpetofauna from the maya community of Santa Elena, Yucatan, Mexico. *Estudios de cultura maya* 54:285-314. https://doi.org/10.19130/iifl.ecm.2019.54.994.

Fernandes-Ferreira, H., S. V. Mendonca, R. L. Cruz, D. M. Borges-Nojosa, and R. R. N. Alves. 2013. Hunting of herpetofauna in montane, coastal, and dryland areas of northeastern Brazil. *Herpetological Conservation Biology* 8:652-666.

Ferreira, F. S., U. P. Albuquerque, H. D. M. Coutinho, W. O. Almeida, and R. R. N. Alves. 2012. The trade in medicinal animals in northeastern brazil. *Evidence-based Complementary and Alternative Medicine* 2012:1-20. https://doi.org/10.1155/2012/126938.

Ferreira, F. S., S. V. Brito, S. C. Ribeiro, W. O. Almeida, and R. R. N. Alves. 2009a. Zootherapeutics utilized by residents of the community Poço Dantas, Crato-CE, Brazil. *Journal of Ethnobiology and Ethnomedicine* 5:21. https://doi.org/10.1186/1746-4269-5-21.

Ferreira, F. S., S. V. Brito, S. C. Ribeiro, A. A. F. Saraiva, W. O. Almeida, and R. R. N. Alves. 2009b. Animal-based folk remedies sold in public markets in Crato and Juazeiro do Norte, Ceará, Brazil. *BMC Complementary and Alternative Medicine 9:17.* https://doi.org/10.1186/1472-6882-9-17.

García-López, R., A. Villegas, N. Pacheco-Coronel, and G. Gómez-Álvarez. 2017. Traditional use and perception of snakes by the nahuas from cuetzalan del progreso, puebla, Mexico. *Journal of Ethnobiology Ethnomedicine* 13. https://doi.org/10.1186/s13002-016-0134-7.

Haas, R., Watson, J., Buonasera, T., Southon, J., Chen, J. C., Noe, S., Smith, K. Llave, C. V. Eerkens, J. Parker, G. 2020. Female hunters of the early Americas. *Science Advances* 6. https://doi.org/10.1126/sciadv.abd0310.

Hernandez, J., Campos, C. M., & Borghi, C. E. 2015. Medicinal use of wild fauna by mestizo communities living near San Guillermo Biosphere Reserve (San Juan, Argentina). *Journal of Ethnobiology and Ethnomedicine*, 11, 15. https://doi.org/10.1186/1746-4269-11-15.

Herzog, H. A. 2007. Gender differences in human–animal interactions: A review. *Anthrozoös 20:7-21.* https://doi.org/10.2752/089279307780216687.

IBGE. 2020. Instituto brasileiro de geografia e estatística –canal cidades Accessed on 10 March 10, 2020.

Kaishauri, N., and M. Makashvili. 2013. Correlation between the knowledge of snakes and the snake fear. *Asian Jouirnal for Humanities and Social Studies* 1:142-145.

Leyte-Manrique, A., N. G. Álvarez, and E. M. Hernández-Navarro. 2016. Percepción cultural de la herpetofuana en tres comunidades rurales del municipio de irapuato, guanajuato, méxico. *Etnobiología 14:73-84.*

Liordos, V., V. J. Kontsiotis, S. Kokoris, and M. Pimenidou. 2018. The two faces of janus, or the dual mode of public attitudes towards snakes. *Science of the total environment* 621:670-678. DOI: https://doi.org/10.1016/j.scitotenv.2017.11.311.

Medeiros, P. M. Silva, T. C. Almeida, A. L. S and Albuquerque, U. P. 2012. Socio-economic predictors of domestic wood use in an Atlantic forest area (north-east Brazil): a tool for directing conservation efforts. *International Journal of Sustainable Development & World Ecology*, 19:189-195. https://doi.org/10.1080/13504509.2011.614288.

Medeiros P.M. Ramos M.A. Soldati G.T. and Albuquerque U.P. 2015. Ecological-Evolutionary Approaches to the Human–Environment Relationship: History and Concepts. In: Evolutionary Ethnobiology, edited by Albuquerque U., De Medeiros P., Casas A., Springer, Cham. https://doi.org/10.1007/978-3-319-19917-7_2.

Mendonça, L., W. Vieira, and R. Alves. 2014. Caatinga ethnoherpetology: Relationships between herpetofauna and people in a semiarid region. *Amphibian & Reptile Conservation* 8:24-32.

Pandey, D. P., G. S. Pandey, K. Devkota, and M. Goode. 2016. Public perceptions of snakes and snakebite management: Implications for conservation and human health in southern nepal. *Journal of Ethnobiology Ethnomedicine 12:1-25.* https://doi.org/10.1186/s13002-016-0092-0.

Prokop, P., and C. Randler. 2018. Biological predispositions and individual differences in human attitudes toward animals. In *Ethnozoology: Animals in our lives*, edited by R R. N. Alves and U. P. Albuquerque,pp. 447-466. Academic Press, Cambridge, MA.

Ríos-Orjuela, J. C., N. Falcón-Espitia, A. Arias-Escobar, M. J. Espejo-Uribe, and C. T. Chamorro-Vargas. 2020. Knowledge and interactions of the local community with the herpetofauna in the forest reserve of quininí (tibacuy-cundinamarca, colombia). *Journal of ethnobiology ethnomedicine 16:1-11*. https://doi.org/10.1186/s13002-020-00370-8.

Rodrigues, E., J. Santos, S. M. de Souza, and J. H. G. Lago. 2012. The mystery of the 'resin-of-canuaru': A medicine used by caboclos river-dwellers of the amazon, amazonas, brazil. *Journal of ethnopharmacology* 144: 806-808. https://doi.org/10.1016/j.jep.2012.10.026.

Rodrigues, M. T. 2005. Conservação dos répteis brasileiros: Os desafios para um país megadiverso. *Megadiversidade 1:87-94.*

Rojas, M. A. R., A. G. Flores, E. E. N. Castro, A. A. Cano, and R. M. Martínez. 2015. Conocimiento etnoherpetológico de dos comunidades aledañas a la reserva estatal sierra de montenegro, morelos, méxico. Etnobiología 13:37-48.

Røskaft, E., T. Bjerke, B. Kaltenborn, J. D. C. Linnell, and R. Andersen. 2003. Patterns of self-reported fear towards large carnivores among the norwegian public. *Evolution human behavior* 24:184-198. https://doi.org/10.1016/S1090-5138(03)00011-4.

Santos, S. D. S. N., Martins, C. S. G., & de Campos Martins, F. (2020). Is the knowledge about the wild birds influenced by the socioeconomic conditions of the human populations?. Ethnobiology and Conservation, 9.

Segalla, M. V., U. Caramaschi, C. A. G. Cruz, T. Grant, C. F. B. Haddad, J. A. Langone, and P. C. A. Garcia. 2014. Brazilian amphibians–list of species. *Herpetologia Brasileira 3:37-48.*

Souto, W. M. S., R. R. D. Barboza, H. Fernandes-Ferreira, A. J. C. Magalhães-Júnior, J. M. Monteiro, É. A. Abi-Chacra, and R. R. N. Alves. 2018. Zootherapeutic uses of wildmeat and associated products in the semiarid region of brazil: General aspects and challenges for conservation. *Journal of ethnobiology ethnomedicine* 14:1-16. https://doi.org/10.1186/s13002-018-0259-y.

Teixeira, J. V. S., J. S. Santos, D. H. A. Guanaes, W. D. Rocha, and A. Schiavetti. 2020. Uses of wild vertebrates in traditional medicine by farmers in the region surrounding the serra do conduru state park (bahia, brazil). *Biota Neotropica 20.* https://doi.org/10.1590/1676-0611-BN-2019-0793.

Torres-Avilez, W. M., & Albuquerque, U. P. (2017). Dynamics of social-ecological systems: gender influence in local medical systems. Ethnobiology and Conservation, 6.