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Hunting of Herpetofauna in Montane, Coastal, and Dryland Areas of Northeastern Brazil

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***Abstract.*—Relationships between humans and animals have played important roles in all regions of the world and herpetofauna have important links to the cultures of many ethnic groups. Many societies around the world use these animals for a variety of purposes, such as food and medicinal use. Within this context, we examined hunting activities involving the herpetofauna in montane, dryland, and coastal areas of Ceará State, Northeastern Brazil. We analyzed the diversity of species captured, how each species was used, the capture techniques employed, and the conservation implications of these activities on populations of those animals. We documented six hunting techniques and identified twenty-six species utilized (including five species threatened with extinction) belonging to 15 families as important for food (21 spp.), folk medicine (18 spp.), magic-religious purposes (1 sp.), and other uses (9 spp.). Although the highest species richness utilized was observed in the montane region, the herpetofauna was more intensively utilized in the drylands. These results reflect biological, historical, cultural, and social-economic issues.**

Key Words.—Atlantic Forest, Brazil, Caatinga, ethnozoology, ethnoherpetology

Introduction

The relationships between humans and animals have been important in all the regions of the world since the very dawn of humanity (Alves, 2009; Alves et al. 2010). Reptiles and amphibians have strong interactions with humans (Klemens and Thorbjarnarson 1995; Gibbons et al. 2000) and have important links to the cultures of many ethnic groups; they represent mythical and legendary animals seen to have positive as well as evil attributes. Snakes, for example, are one of the animals most commonly associated with stories, legends, myths, fables, and beliefs (Vizotto 2003). Perhaps more than any other type of animal, snakes provoke the human imagination to the most varied range of sentiments and perceptions (Oliver 1958; Morris and Morris 1965; Greene 1997; Andreu 2000; Vizotto 2003).

It is extremely common to hear people throughout the world expressing sentiments of aversion and repulsion related to herpetofauna. These perceptions, from simple avoidance to severe phobias, are expressed in every region of the world (Smith and Davidson 2007). Negative perceptions about the herpetofauna represent one of the principal motivations for killing individuals of these groups (e.g., snakes and crocodiles) under the guise of controlling species that offer risks to humans or domestic animals (Alves et al. 2010, 2012c; Fernandes-Ferreira et al. 2011).

While some of human society looks upon herpetofauna negatively, many cultures around the world use these animals for various purposes (Willcox and Nambu 2007; Soewu 2008; Alves et al. 2008, 2012b). At least 744 species of reptiles occur in Brazil (Bérnils, R.S., and H.C. Costa. 2012. Répteis brasileiros: Lista de espécies. Version 2012.1. Available from http://www.sbherpetologia.org.br. [Accessed 22 August 2013]), and at least 11% of these (n = 81 species) are utilized by human populations or killed because of real or imagined conflicting relationships with people (Alves et al. 2012c).

Medicinal uses of herpetofauna have been recorded in many parts of the world in association with the treatment of several different diseases and maladies (Daly et al. 1992; Alves et al. 2008, 2012c). In their review of the utilization of herpetofauna for therapeutic purposes throughout the world, Alves et al. (2013) reported that at least 331 species (284 reptiles and 47 amphibians) are used in traditional folk medicine. Among these species, 182 reptiles and 42 amphibians are listed on the IUCN Red List (IUCN – International Union for Conservation of Nature. 2013. Red List of Threatened Species. Version 2012.2. Available

from http://www.iucnredlist.org [Accessed 11 August 2013]). In Brazil, 54 reptiles (Alves et al. 2012c) and five amphibians (Costa-Neto and Alves 2010) are known to be used for therapeutic purposes in several human communities, corresponding to more than 15% of the total number of animals used for medicinal purposes in the country. This use of the herpetofauna is of significant cultural importance in many rural communities in northeastern Brazil (Moura and Marques 2008; Alves et al. 2012c).

Similarly, there has been a long history of the subsistence consumption of these animals as food, particularly in tropical regions, and this is still very common in many traditional and rural communities throughout the world (Klemens and Thorbjarnarson 1995; Peres 2000; Fitzgerald et al. 2004; Altrichter 2005). In Brazil, at least 38 reptile species are consumed as food (Alves et al. 2012c) and, as can be seen in other countries (see Klemens and Thorbjarnarson 1995), there is considerable variation in the preferences of these human communities for chelonians, caimans, lizards, and snakes.

In addition to medicinal and food purposes, herpetofauna are used in other ways. For example, these animals are also used in magic/religious practices, in commercial markets, as ornaments, and pets (Rumiz and Maglianesi 2001; Altrichter 2005; Moura and Marques 2008; Alves et al. 2012c).

It is important to note that in spite of the intense utilization of herpetofauna by humans, very little information is currently available about the impacts of these human uses on the species involved (e.g., Gibbons et al. 1995; Fitzgerald et al. 2004; Klemens and Thorbjanarson 2005). Despite this, the effects may be great. For example, Gibbons et al. (2000) observed that the subsistence consumption of reptiles is one of the principal factors responsible for the declines seen in many species in the world.

Within this context, the present study examined hunting activities involving the herpetofauna in rural areas of dryland, montane, and coastal human communities in Northeastern Brazil. We examined the diversity of species used, how each species was used, the capture techniques employed, and the conservation implications of these activities.

Materials and Methods

Study areas.—We undertook the present study in 16 human communities from nine municipalities in three different regions of Ceará State, Northeastern Brazil: in a montane area, in the interior dryland zone, and along the coast (Fig. 1).

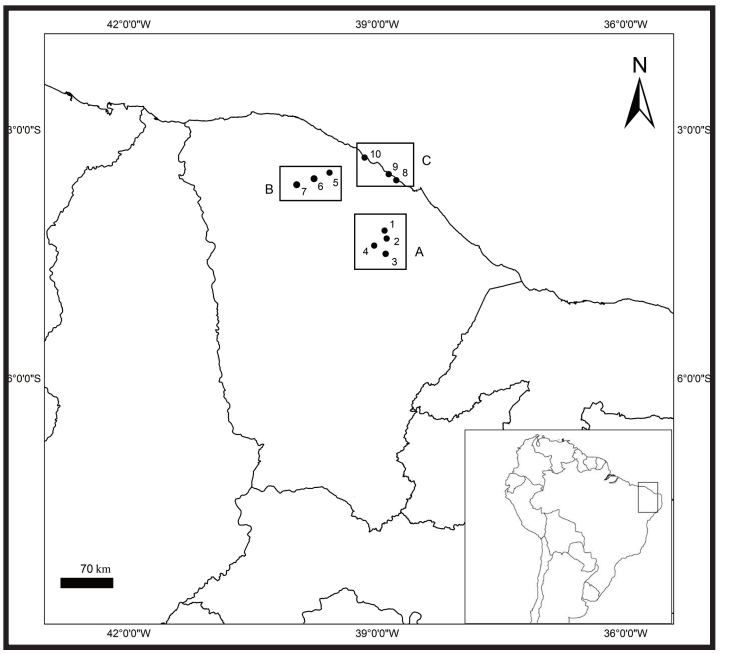

Figure 1. Map showing the surveyed communities in the Ceará State, Brazil (1: 7.000.000). A: montane region; B: dryland region; C: coastal region; 1: Pacoti; 2: Guaramiranga; 3: Mulungu; 4: Aratuba; 5: Tururu; 6: Itapagé; 7: Irauçuba; 8: Cumbuco Beach, Caucaia; 9: Lagoa do Barro, Caucaia; 10: Taíba Beach, São Gonçalo do Amarante.

We visited nine localities in a montane region in the municipalities of Aratuba (4°24'48.85"S, 38°03'19"W; 920 m high), Pacoti (4°13'14"S, 38°55'30"W; 995 m high), Guaramiranga (4°16'17"S, 38°55'56"W; 976 m high), and Mulungu (4°18'12"S, 38°59'33"W; 915 m high) within the Baturité Range, the largest and most representative residual basaltic formation in Ceará (Mantovani 2007). This region is included in a state-run Environmental Protection Area that still holds remnants of the Atlantic Forest biome and humid forest areas with the highest biological richness in the state and that has an important role in the preservation of regional biodiversity and in the maintenance of water resources in this otherwise arid state. This area exhibits significant climatic heterogeneity in humidity depending on its exposure to coastal weather systems and altitudinal variations (Mantovani 2007). Each of the sites studied has around 54 homes and is characterized by relatively low income families, with income sources including agriculture, livestock production, and running local stores.

In the interior drylands of north region of Ceará, we visited four communities with around 20 homes each: Itapajé (3°41'04.58"S 39°35'34.48" W; 95 m high), Tururu (3°35'11.46"S, 39°26'44.10" W; 92 m high), and Irauçuba (3°44'57.19" S, 39°46'49.86" W; 92 m high). These areas have fauna and flora typical of the *Caatinga*, the semiarid biome that occupies the largest portion of the northeast of Brazil (Albuquerque et al. 2012). The region around Itapajé contains remnants of sub-perennial tropical cloud forests as well as sub-deciduous tropical pluvial domains and dense dryland vegetation. Irauçuba and Tururu have tropical semi-arid climate, low rainfall, and areas completely dominated by dense *Caatinga* vegetation. The communities studied are very poor and the local economic activity is completely focused on family-based agriculture and livestock production.

In the coastal region, we visited three localities (each with about 19 homes): Cumbuco Beach (3°37'46.23" S, 38°44'13.24" W) and Lagoa do Barro (3°28'20.88"S, 38°44'31.31" W) within the municipality of Caucaia, and Taíba Beach (3°30'48.56"S, 38°55'27.52" W) within the municipality of São Gonçalo do Amarante. This region is located along the western Atlantic coast of the state and is characterized by formations of migrating dunes, alluvial areas, and paleo-dunes typical of the coastal plains; it is bordered by the vegetation complex growing on the pre-coastal plains on sediments (FIPC 1989; IBGE – Instituto Brasileiro de Geografia e Estatística. 2013. Cidades do Ceará. Available from http://cidades.ibge.gov.br/xtras/uf.php?lang=&coduf=23&search=ceara [Accessed 06 August 2013.]). Most interviewees in this region have low income and their families have economic activity mainly related to trade fishing and tourism.

Ethnozoological data collection.—In each community, we interviewed local residents that interacted in any manner with wild herpetofauna (e.g., hunters, farmers, woodsmen) between 2008 and 2010. We selected the informants based on this sample utilizing the *"*snowball*"* technique (Bailey 1994). We interviewed a total of 170 "local specialists" (30 in coastal, 30 in dryland region, and 110 in mountain region), people who considered themselves, and were likewise recognized within the community itself, to be knowledgeable about the local hunting (Hays 1976). We obtained information using semi-structured questionnaires (Appendix 1) complemented by free interviews and informal conversations (Huntington 2000), focusing on questions concerning what species were used, the purposes for which they were used, and the capture techniques used.

We showed the informants albums with photographs of species of the regional herpetofauna during interviews. These albums were constructed based on surveys by Borges-Nojosa (2007) and Vanzolini et al. (1980) and were used to identify the species cited by the interviewees.

In order to provide greater accuracy in identification, we collected specimens of each species cited in the municipalities within the Serra de Baturité Environmental Protection Area and placed these specimens in the Herpetology Collection at the Federal University of Paraíba (CHUFPB). We complemented this inventory with visual reports and photographs taken during the fieldwork phase or during travels in all the communities.

For each species, we calculated the Use-Value (adapted from the proposal of Phillips et al. 1994), a quantitative method that demonstrates the relative importance of species known locally. We calculated this value using the following formula: $UV = \sum$, where: UV = Use-Value of

the species; U = number of references per species; n = number of informants. The calculations of the Use-Values of any species is based objectively on the importance attributed by the informants themselves, and does not depend on the opinion of the researcher.

We calculated the Average Use-Value of herpetofauna in each region studied using the following formula: AUV = ∑ , where: AUV = use-value of herpetofauna in each region; UV = Use-Value of each species cited; x = number of game species cited.

In addition, we proposed an information-frequency index (IFI) of the herpetofauna used for medicinal purposes; these values were considered "high" when mentioned in more than 70% of the total citations, "medium" when mentioned in 30–70% of the citations, and "low" when mentioned in fewer than 30% of the citations.

Results

A total of 28 species of reptiles and amphibians belonging to 15 families were identified as being used for food (23 spp.), magic-religious purposes (1 sp.) and for others uses (9 spp.;Table 1). In addition, medicinal products involving herpetofauna were mentioned as being made from 18 different species; the most-used body parts in the preparation of these medicines were fats (derived from 13 spp.; Fig. 3A) and meat (4 spp.; Table 2). It is important to note that a single species can have more than one use.

We observed the highest species richness utilized in the montane region (18 spp.). The dryland region was the second with 14 species followed by the coastal region with 13 species utilized (eight continental and five marine species). Comparisons of the average Use-Values for each region, however, gave a different ranking order. The dryland region had the highest Average Use-Value (AUV = 0.51), followed by the montane region (AUV = 0.38), and then by the coastal region (AUV = 0.34).

We documented six techniques for capturing herpetofauna in the study areas. Three of these could be considered active, as they required the presence of a hunter: hunting with dogs (n = 44 citations), with weapons (n = 112), or manual capture (n = 19). Three techniques were considered passive, as captures are made using traps: *quixó* (n = 78), hooks (n = 21), and *mundé* (n = 49; Fig. 2). It is important to note that, among the herpetofauna cited, specific expeditions were only undertaken for the large ground lizard *Tupinambis merianae*, the herpetofaunal species with the greatest use value (UV = 1.00). All of the other species are only opportunistically taken when they happen to fall into traps (which are largely set for birds and mammals), or when a hunter happens to come

Figure 2. Harvesting methods of the herpetofauna in the Ceará State, Brazil. A: *quixó*; B: unbaited hooks; C: dogs utilized for hunting; D: firearm used in the active pursuit. (Photographed by Hugo Fernandes-Ferreira).

Table 1. Reptiles and amphibians used by rural human communities in Ceará State, with their respective common names; the techniques employed in their capture; the objectives of use and the Use-Values in the dryland region (UVd), in the coastal region (UVc), and in the montane region (UVm). Legend: Ap (active pursuit with weapons); Hk (hook); Mn (manual); Qx (quixó); Md (mundé); Hd (hunting with dogs); Fd (fishing devices); Fo (food); Zo (zootherapy); Or (ornamentation); Mg (magic-religious).

Taxon	Common name	Harvesting Strategies	Use	UVd	UVc	UVm
Boidae						
Boa constrictor Linnaeus 1758	Boa	Ap	Fo, Zo, Or	0.86	0.70	0.80
Epicrates assisi (Linnaeus 1758)	Rainbow Boa	Ap	Fo, Zo	0.60	0.40	0.35
Eunectes murinus (Linnaeus 1758)	Anaconda	Ap	Fo	0	0.20	0
Corallus hortulanus (Linnaeus 1758)	Amazon Tree Boa	Ap	Fo	0.10	0	0.02
Colubridae						
Spilotes pullatus (Linnaeus 1758)	Tropical Rat Snake	Ap	Or	0	0	0.20
Viperidae						
Crotalus durissus Linnaeus 1758	Yucatan Rattlesnake	Ap	Fo, Zo, Mg, Or	1.00	0	0.38
Lachesis muta (Linnaeus 1766)	Bushmaster	Ap	Fo, Or	0	0	0.35
Tropiduridae						
Tropidurus hispidus (Spix 1825)	Peter's Lava Lizard	Mn	Zo	0.43	0	0.16
Tropidurus semitaeniatus (Spix 1825)	Striped Lava Lizard	Mn	Zo	0	0	0.12
Teiidae						
Ameiva ameiva (Linnaeus 1758)	Giant Ameiva	Mn, Qx	Fo	0	0	0.14
Tupinambis merianae (Duméril and Bibron 1837)	Tegu Lizard	Ap, Qx, Md, Hk, Hd	Fo, Zo, Or	0.96	0.60	1.00
Iguanidae						
Iguana iguana (Linnaeus 1758)	Common Iguana	Ap, Qx	Fo	0.46	0.16	0.30
Polychrotidae						
Polychrus acutirostris Spix 1825	Brazilian Bush Anole	Mn	Zo	0.03	0	0.25
Polychrus marmoratus (Linnaeus 1758)	Many-colored Bush Anole	Mn	Zo	0	0	0.15
Alligatoridae						
Caiman crocodilus (Linnaeus 1758)	Common Caiman	-	Fo	-	-	-
Paleosuchus palpebrosus (Cuvier 1807)	Dwarf Caiman	Ap, Fd	Fo	0.30	0	0
Testudinidae						
Chelonoidis carbonaria (Spix 1824)	Red Footed Tortoise	Mn, Hk	Fo	0	0	0.09
Kinosternidae						
Kinosternon scorpioides (Linnaeus 1766)	Scorpion Mud Turtle	Mn, Hk	Fo, Zo	0	0	0.55
Chelidae						
Mesoclemys tuberculata (Luderwaldt 1926)	Tuberculate Toadhead Turtle	Mn, Hk	Fo, Zo	0	0	0.45
Phrynops tuberosus (Peters 1870)	Cotinga River Toadhead Turtle	Mn, Hk	Fo, Zo	0.36	0.16	0
Cheloniidae						
Chelonia mydas (Linnaeus 1758)	Green Turtle	Fd	Fo, Zo, Or	0	0.56	0
Eretmochelys imbricata (Linnaeus, 1766)	Hawksbill Sea Turtle	Fd	Fo, Zo, Or	0	0.20	0
Caretta caretta (Linnaues 1758)	Loggerhead Sea Turtle	Fd	Fo, Zo, Or	0	0.20	0
Lepidochelys olivacea (Eschscholtz, 1829)	Olive Ridley Turtle	Fd	Fo, Zo, Or	0	0.20	0
Dermochelyidae						
Dermochelys coriacea (Linnaeus 1766)	Leatherback Sea Turtle	Fd	Fo, Zo	0	0.20	0
Leptodactylidae						
Leptodactylus vastus A. Lutz 1930	Northeastern Pepper Frog	Mn	Fo, Zo	0.26	0.70	0.67
Bufonidae						
Rhinella jimi (Stevaux 2002)	Cururu Toad	Mn	Fo, Zo	0.66	0.16	0.80

across a useful animal (or one judged to pose a risk to human lives or domestic animals).

The *quixó* is a type of dead-fall trap made with a heavy rock (with a smooth underside) suspended over a trigger structure (made out of wood) that will allow the rock to fall when an

Table 2. Species used in zootherapeutic practices in Ceará State, Brazil, citing the parts of the animals utilized, the modes of preparation of the remedies, the illnesses treated, the geographical regions in which these treatments were practiced, and their Information-Frequency Index (IFI). Legend: M (montane); C (coastal); D (dryland).

Taxon	Parts	Modes of preparation	Ilnesses treated	Region	IFI
Boidae					
Boa constrictor	Fat	Melted	Rheumatism	M/C/D	High
			Asthma	M/C	High
			Muscle aches	M/C	High
Epicrates assisi	Fat	Melted	Ear ache	D	Medium
Viperidae					
Crotalus durissus	Fat	Melted	Rheumatism	M/C/D	High
			Tonsillitis	M	High
	Rattle	Macereted rattle tea	Rheumatism	D	Medium
			Asthma	M/D	High
		Macereted rattle with sugarcane hootch	Asthma	D	Medium
			Fatigue	D	Low
			Impotence	D	Low
Teiidae					
Tupinambis merianae	Fat	Melted	Rheumatism	M/C/D	High
			Tonsillitis	M/D	High
			Ear ache	M/C	Medium
	Skin	Macerated skin tea	Asthma	M/D	Low
Tropiduridae					
Tropidurus hispidus	Meat	Roasted	Measles	M/D	Low
Tropidurus semitaeniatus	Meat	Roasted	Measles	M/D	Low
Polychrotidae					
Polychrus acutirostris	Meat	Roasted	Male infertility	M/D	Low
Polychrus marmoratus	Meat	Roasted	Male infertility	M	Low
Kinosternidae					
Kinosternon scorpidoides	Fat	Melted	Muscle Aches	M	Low
Chelidae					
Mesoclemys tuberculata	Fat	Melted	Muscle Aches	M	Low
Phrynops tuberosus	Blood	Boiled	Rheumathism, asthma	D	Medium
Chelonidae					
Chelonia mydas	Fat	Melted	Ear ache, asthma	C	Low
Eretmochelys imbricata	Fat	Melted	Ear ache, asthma	C	Low
Caretta caretta	Fat	Melted	Ear ache, asthma	C	Low
Lepidochelys olivacea	Fat	Melted	Ear ache, asthma	C	Low
Leptodactylidae					
Leptodactylus vastus	Fat	Melted	Tonsillitis	M	Low
			Ashma	M/C	High
			Hoarseness	M	Low
	Abdomen	Topical use	Wounds and allergies	M/C	Medium
Bufonidae					
Rhinella jimi	Abdomen	Topical use	Sores and warts	M/D	Medium
	Fat	Melted	Tonsillitis	M	Low

animal takes the bait place under the trap (Fig. 2A). A baited hook is used to capture *T. merianae* and all the inland turtles (Fig. 2B). A *mundé* is another dead-fall trap made from a tree trunk placed across a game trail. Active hunting with dogs involves chasing and cornering the *T. merianae*, which is then captured or killed by the hunter (Fig. 2C). A hunter can also simply walk

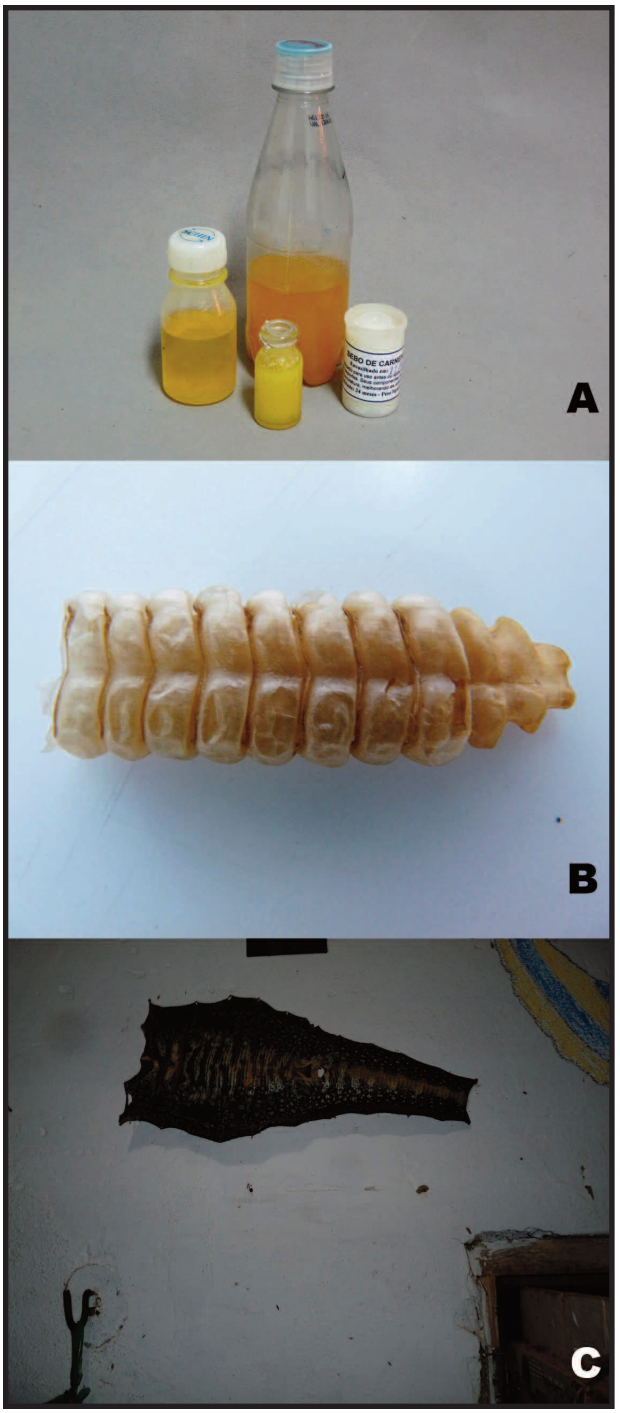

Figure 3. Uses of herpetofauna in the Ceará State, Brazil. A: melted fats in bottles for zootherapy; B: rattle of *Crotalus durissus* used for medicinal and magic-religious purposes; C: skin of *Tupinambis merianae* in a local home for ornamentation. (Photographed by Hugo Fernandes-Ferreira).

along established trails through the forest (without using dogs), looking for game species to kill. He can use a firearm (Fig. 2D) or sometimes an animal will be encountered unexpectedly and killed using any weapon at hand (a hoe or an axe, for example, or even a piece of wood). Manual capture is most commonly used for collecting amphibians and small lizards. The choice of each technique depends on several factors, such as species involved, season, weather, moon phase, and availability to the hunter. Other studies have also reported the influence of these factors on hunting practices in South America (Ayres and Ayres 1979; Alves et al. 2009b).

Discussion

Previous studies indicate that the richness of animal species and their consequent availability and accessibility influences the use of them by local human communities (Adeola 1992; Apaza et al. 2003; Alves et al. 2007, 2008; Fernandes-Ferreira et al. 2012). Thus, it is not surprising that the highest richness of species utilized in the montane region can be largely explained by the fact that the Baturité Range contains the greatest biodiversity in all of Ceará State (Mantovani 2007). However, the different ranking order of the Average Use-Value of dryland, montane, and coastal areas reported here reflect the biological, historical, cultural, and social-economic contexts of each region. In the montane region, climatic conditions are more favorable to agricultural and cattle raising activities than in the semi-arid zone (Oliveira et al. 2007), which in turn, could be reflected in the less-intense use of native species. In addition, the montane region has a higher diversity of large-sized mammals and birds than in the other regions (Girão et al. 2007; Fernandes-Ferreira 2011) and these are the most preferred game animals in semiarid region of Brazil (Alves et al. 2009a, 2012c; Bezerra et al. 2012; Fernandes-Ferreira et al. 2012). These facts likely reflect a less intensive use of herpetofauna in the montane region. Historically, the dryland populations have repeatedly suffered from severe and frequent droughts (when their crops and domestic animals were barely sufficient for survival) – and they often had to rely on natural food sources. In addition, previous studies have shown that the trade hunting can reduce populations of game species, mainly large birds and mammals (Robinson and Redford 1991; Peres 2000), a pattern also reported in the *Caatinga* biome (Albuquerque et al. 2012; Alves et al. 2012a;

Fernandes-Ferreira et al. 2012). With a possible reduction on populations of these animals in the dryland areas studied, the herpetofauna has been used more intensively than in the other surveyed regions. As the economic base of coastal communities is centered on marine resources, principally fish, mollusks, and crustaceans, the herpetofauna (being principally continental) is less frequently exploited.

The Use-Values of the species utilized by the human communities in each region vary according to their respective faunal compositions. The species *Crotalus durissus*, for example, is a species with a high Use-Value in the dryland region and was cited by all of the interviewees in the three municipalities visited; in the montane region this species was only cited by residents in the rain shadow of the Baturité Range, which has a drier climate and its vegetation is strongly influenced by the *Caatinga* biome. The greater exploitation of this snake species in dryland areas is certainly related to its higher abundance – as open areas constitute the main habitat type of this snake within the *Caatinga* domain (although it can be occasionally encountered in closed forests and humid regions; Vanzolini et al. 1980; Campbell and Lamar 2004). In the coastal municipalities, where there were no documented records of this snake, it received no use-citations.

Nevertheless, *Tupinambis merianae* and *Boa constrictor* occur in the three regions studied and they were accordingly given high Use-Values in all the areas. Both species are widely distributed and abundant in Northeastern Brazil (Rodrigues 2003). Species that are endemic to only certain localities received fewer Use-Values, such as *Lachesis muta*, which in the Ceará State has only been documented in the Baturité Range (Borges-Nojosa and Lima-Verde 1999), and *Eunectes murinus*, which in this state has only been recorded in the estuary region of the municipality of Aquiraz (Mendonça et al. 2009). This direct relationship between the local faunal composition and the prevalence of utilized species is, of course, expected and corroborates previous ethnozoological studies (Apaza et al. 2003; Alves et al. 2009b; Fernandes-Ferreira et al. 2010, 2012).

Use of the hunted herpetofauna as food.— Regarding snakes and lizards, hunting activities were exclusively directed towards medium- and large-sized species in the communities studied.

Table 3. Marine turtle species and their respective conservation categories according to the Brazilian Red List (BRL; Martins and Molina 2008) and the IUCN (IUCN. 2012. *op.cit.*). Legend: VU (vulnerable), EN (endangered), CR (critically endangered).

Species	BRL	IUCN
Chelonia mydas	VU	EN
Eretmochelys imbricata	VU	CR
Caretta caretta	EN	EN
Lepidochelys olivacea	EN	VU
Dermochelys coriacea	CR	CR

This pattern of use of these animals has been reported globally by many authors (Fitzgerald et al. 2004; Klemens and Thorbjarnarson 1995; Peres 2000; Rumiz and Maglianesi 2001; Alves et al. 2012c).

Ten interviewees in the dryland region indicated that hunters from a nearby municipality (Itapipoca, Ceará State) hunt caimans for food. Lima et al. (2011) recorded the occurrence of *Paleosuchus palpebrosus* in this municipality, and it is very probable that this species is killed and eaten by hunters. In the municipality of Crateús, also in the Ceará State, there are records of occurrence of *Caiman crocodilus*, also related to food consumption by local residents (Borges-Nojosa and Lima 2008).

Only two species of amphibians (*Leptodactylus vastus* and *Rhinella jimi*) were used by the inhabitants of the human communities examined for food purpose. Their low Use-Values reported can be explained by the fact that most of the inhabitants of these communities mentioned strong aversions to amphibians. Only few local people use these animals. This fact corroborates that some studies point out although this repulsion to amphibians is common (Smith and Davidson 2007), the use of these animals as food can be noted in human communities from many different countries (Boll 2004; Garner et al. 2009; Mohneke et al. 2009; Alves et al. 2013).

Some interviewees (n = 11) from the coastal communities indicated that the five marine turtle species that occur off the coast of Ceará (*Eretmochelys imbricata*, *Caretta caretta, Lepidochelys olivacea, Dermochelys coriacea* and *Chelonia mydas*) were commonly used 20 years ago, when there was essentially no effective prohibition of capturing these animals.

Nonetheless, all of the interviewees stated that marine turtles are still being harvested, principally when they become entangled in fishing weirs, fish traps made from wooden poles driven into the sediments of shallow marine environments. Most reports of accidental capture of marine turtles in the Ceará State involve these fishing weirs (Costa 1969; Marcovaldi et al. 1998; Lima et al. 2010).

Chelonia mydas was the turtle species with the highest Use-Value (UV = 0.56), and according to Marcovaldi et al. (1998), approximately 92% of the accident captures of turtles in Ceará State involve this species, that frequents the coastline while feeding. The Brazilian Red List (Martins and Molina 2008) as well as by the International Union for Conservation of Nature (IUCN 2013. *op. cit.*) consider all of these marine turtle species as being threatened with extinction (Table 3).

Regarding continental turtles, the aquatic species *Mesoclemys tuberculata*, *Phrynops tuberosus*, and *Kinosternon scorpioides* that inhabit small lakes and reservoirs, and the terrestrial species *Chelonoidis carbonaria* were reported as taken for food. Although continental turtles are not widely utilized by humans communities in Northeastern Brazil – as seen in the low Use-Values presented, this fact is quite different from other South American localities, particularly in the Amazon region (Cuesta-Rios et al. 2007; Vogt 2008; Pezzuti et al. 2010a, b), and there have been constant reports of these activities since the first European explorers entered the Amazon region (Vogt 2008).

Use of the hunted herpetofauna in zootherapy.—Zootherapy involving herpetofauna was cited by all of the interviewees (Table 2; Fig. 3) and reflects the historical use of these animals to treat diseases. This practice is still used as an alternative or complement to modern drugs in all areas studied, as well as in several localities around the world (Alves and Rosa 2013). Some species are still being tested for potential medicinal use, such as *T. merianae*, whose fat was not shown to be effective against bacterial infections (Ferreira et al. 2009) but did appear to have anti-inflammatory activity (Ferreira et al. 2010).

The two species of amphibians encountered in this study also had folk medicinal uses and were particularly interesting because they did not need to be killed in order to use their body parts. The interviewees (n = 7) reported that individuals of *Rhinella jimi* and *Leptodactylus vastus* can be kept alive even though their fat is removed for medicinal purposes. This is done by making a longitudinal cut in the abdominal region of these frogs/toads and removing their adipose tissue using a small spatula. After removing the fat, their abdomen is stitched closed, and the frogs will usually survive – thus maintaining the production of the zootherapeutic material without detrimentally affecting populations. This same process was reported by Marques (2001) for *Rhinella* spp. in a region near the São Francisco River, Bahia State, Brazil.

Other uses of hunted herpetofauna.—Forty-six interviewees noted ornamental uses for the leather derived from the skin of *B. constrictor*, *C. durissus*, *L. muta*, *T. merianae*, *I. iguana*, *P. palpebrosus*, and *S. pullatus*, and these skins were observed hanging from the walls of many local residences (Fig 3C) or used in making wallets, small purses, and belts. In addition, eight informants stated that the skins of *B. constrictor, L. muta*, and *C. durissus* would repel rats that pass illnesses to humans or damage their crops.

According to 38 interviewees, the rattles of *C. durissus* (Fig. 3B) confer good luck and many people accordingly carry them in their pockets or use them for personal adornment (as pendants, wristlets, etc.). The same rattles are reportedly used as a lure for hunting *Kerodon rupestris* (n = 9 citations). It is a large, diurnal rodent that lives in groups on open rocky hillsides in dryland areas (Bonvicino et al. 2008). The hunters shake the rattles to attract the attention of these rodents and, according to the informants, these animals will leave their hiding places to investigate the sound and to warn the rest of the group of the presence of a predator. Upon leaving their hiding places they can be more easily shot. This behavior was described by Sousa (2006), who observed that in addition to hiding among rocks, groups of *K. rupestris* utilize sentinels to alert the group of imminent danger – usually males that take on the role of territorial defense (Lacher 1981).

Chelonoids carbonaria is commonly kept as a pet (n = 17 citations), particularly in the state capital of Fortaleza even though many specimens being sold are originated from other states. Additionally, *Boa constrictor* can be domesticated in stockpiles to control rats (n = 4).

Hunting as a means of control.—One of the principal motivations for killing reptiles is associated with controlling species that offer risks to humans or their domestic animals (Oliver 1958; Morris and Morris 1965; Greene 1997; Andreu 2000; Alves et al. 2012c). There is a general tendency among rural inhabitants in Brazil to consider essentially any snake as venomous, and therefore it should be killed (Vizzoto 2003; Fernandes-Ferreira et al. 2011). In addition, some snakes, such as *B. constrictor* and *Drymarchon corais*, are hunted because they are considered predators of domestic animals, including domestic birds.

Conservation implications.—Our results reveal that the local herpetofauna has been used by rural communities for different purposes, as presented in other studies in Brazil and worldwide (Gibbons et al. 2000; Seburn and Seburn 2000; Alves et al. 2013). It is important to point out that the removal of amphibians and reptiles from natural habitats, principally species that are threatened with extinction, represents a grave risk to the sustainability of their populations and, to the maintenance of the cultural traditions associated with their use (Fitzgerald et al. 2004). This situation becomes even more serious when allied with other factors such as habitat loss and fragmentation, the introduction of exotic predators or competitors, road kills, climate change, epidemics, the excessive use of pesticides, contamination of the food chain, and the national and international trafficking of wild animals (Lima-Verde 1994; Seburn and Seburn 2000; Shine and Koenig 2001; Schlaepfer et al. 2005; Tolson and Henderson 2006).

Within this context, some studies demonstrate that to establish sound conservation strategies, it will be extremely important to consider human elements and the impacts derived from human uses of the natural resources in the region (Padua et al. 2006). Investigations of the regional uses of animals, for example, can contribute to the local native fauna being prioritized not just from an ecological, but also from economic and social viewpoints – so that environmental stewardship and the conservation of species will consider and incorporate local social realities (Cullen et al. 2000; Alves et al. 2012a, c).

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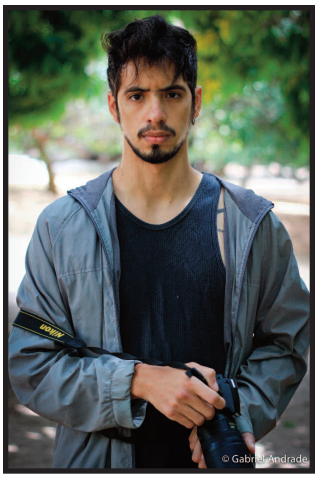

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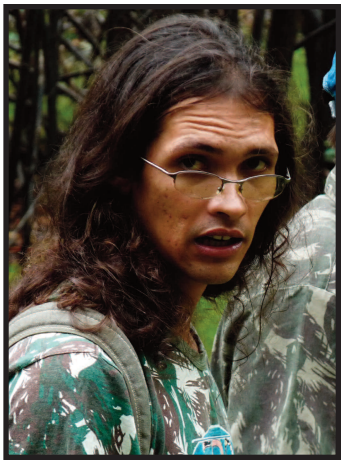

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Appendix 1

Questions for each informant

Locality:_____
Municipality: _____
Date: ____/____/_____
Name:_____
Age:_____ Gender:____
Main profession: _____
Other professions: _____

Questions for each species cited

Popular name cited by the informant:
Species identification:

What is the purpose of hunting?
In case of medicinal purpose, what diseases are treated with this animal? What is the part of animal used? What is the mode of prepare of the drug?
Is this animal dangerous to humans? Why?
Is this animal dangerous to domestic animals? Why?
How this animal is hunted? (including the techniques utilized for capturing; time and duration of the hunting).