



The trade of *Kinosternon scorpioides* on Marajó island, Brazilian Amazon: from hunting to consumption.

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We studied the trade network of the Scorpion Mud Turtle, *Kinosternon scorpioides*, on Marajó Island, Brazil, from hunting to the final product consumption. We conducted semi-structured interviews at the urban centers of the cities of Soure, Salvaterra and Cachoeira do Arari, where we investigated: A) the socioeconomic profile of the merchants and their activity; B) the origin, form and the frequency of marketing *K. scorpioides*; and C) the demand for the product. Scorpion Mud Turtle hunting was carried out using the following methods: hand-collection (100%), probing (62%) and burning (54%). They were hunted for two reasons: personal consumption and sale, which was conducted in urban centers. The hunters knew the empirical aspects of the species biology in the wild: habitat, trophic ecology, and reproduction, among others. The trade of *K. scorpioides* is still a strong activity on Marajó Island, and the legal regulations are not enough to inhibit this practice, which poses a threat to the future of this species in this area. The establishment of educational efforts and captive breeding programs of this species will contribute to employment, to local family income, and to the conservation of this genetic resource. These efforts also be important for that the local population could produce and consume this species in a more sustainable way.

Key words: biodiversity; ethnobiology; scorpion mud turtle; chelonians

INTRODUCTION

The use of chelonians in the Amazon is not only for meat consumption, but is rooted in the local culture of the people, who for decades learned from their ancestors to use turtles for food, medicine and an alternative source of income (Pezzuti et al., 2010). Such uses of turtles have been socially, culturally and economically important since it originated in pre-Columbian communities, and this persists today (Schaan, 2010). Chelonians are not currently used in a sustainable way, leading to population declines of many Amazonian species (Schaan, 2010; Alcântara, 2014). In addition, due to socio-environmental conditions in the region (Fearnside, 2015) and the permanent demand for consumption of these animals (Pantoja-Lima et al., 2014), species of chelonians are increasingly threatened in the Amazon.

There are few investigations in to the actual uses of this resource, from capture to the final consumer, although there have been some studies in the last decade focusing on the use of chelonians in the Brazilian Amazon (Fachín-Terán et al., 2004; Rebelo et al., 2005; Pantoja-Lima et al., 2014; Morcatty & Valsecchi, 2015). These studies are extremely important for the establishment of viable conservation alternatives for hunting species. To the authors knowledge, there is no information in

the literature on the *Kinosternon scorpioides* trade network on Marajó Island, although this animal has been exploited in this region for decades on a large scale in a non-sustainable way (Alho, 1985).

Due to the demand for their meat and its by-products, as an alternative to the harvesting from the wild, Brazilian law allows some species of chelonians to be bred in captivity subject to regulation by environmental control bodies (*Podocnemis expansa*, *Podocnemis unifilis*, *Podocnemis sextuberculata* and *K. scorpioides*; Araújo et al., 2013).

This study takes into account that existing legal prohibitions do not, in fact, impede the trade of *K. scorpioides* in the Arari microregion (Marajó, Brazil), which may lead to critical loss of natural stock. Therefore, the understanding of the dynamics of the use of this resource will contribute to the development of programs directed toward local sustainability, as well as conservation of this species. The aim of this study was to describe the trade of *K. scorpioides* and the knowledge associated with its biology in the wild.

METHODS

This research was conducted in the Arari microregion, Marajó Island, north of the State of Pará, Brazilian Amazon, in the municipalities of Salvaterra ($n = 12$

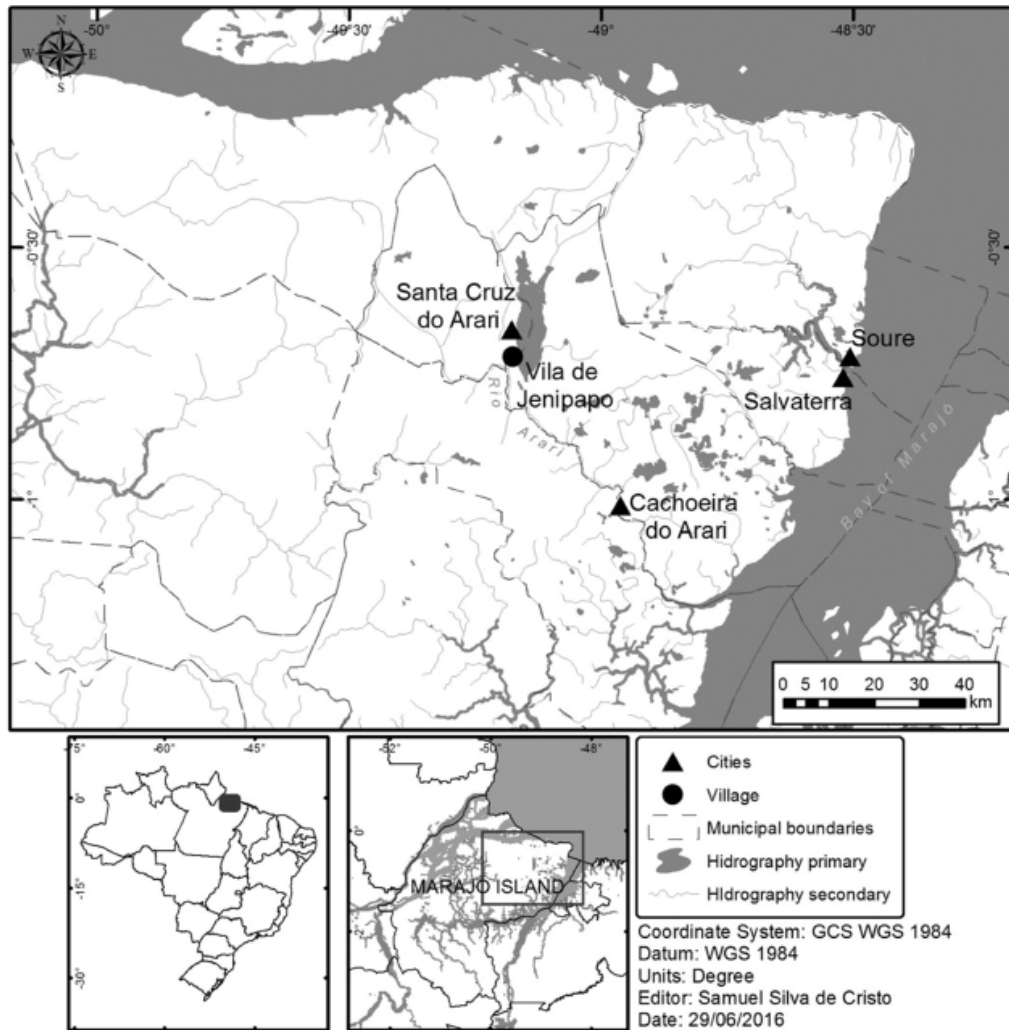


Figure 1. Map of the study area, highlighting the municipalities of the east coast of Marajó Island, Brazil (Soure, Salvaterra, Cachoeira do Arari and Santa Cruz do Arari).

consumers; and $n = 4$ traders) ($00^{\circ}45'21''$ S; $48^{\circ}45'54''$ W), Soure ($n = 13$ consumers; and $n = 2$ traders) ($00^{\circ}43'48''$ S; $48^{\circ}30'24''$ W), Cachoeira do Arari ($n = 14$ consumers; and $n = 4$ traders) ($01^{\circ}00'36''$ S; $48^{\circ}57'36''$ W) and Santa Cruz do Arari ($n = 13$ hunters in the village of Jenipapo; and $n = 17$ consumers) ($00^{\circ}39'45''$ S; $49^{\circ}10'40''$ W) (Fig. 1).

Free and semi-structured interviews were conducted (Albuquerque et al., 2014) with hunters, middlemen, traders and consumers of *K. scorpioides*, whose selection was based on the snowball technique (Albuquerque et al., 2014). The interviews covered: A) the socioeconomic profile of the traders and of their activity; B) the origin, form and frequency of the marketing of *K. scorpioides* and its by-products; C) the demand for the purchase of these products. Informal conversations, participant observation, and free and semi-structured interviews were carried out (Albuquerque et al., 2014), with topics for discussion including use, hunting practices, and knowledge about *K. scorpioides*. A questionnaire was provided to each hunter in each home visited (Viertler, 2002). Data triangulation was used through: a) cross-information, which consisted of subjecting others to the information of a given interlocutor; b) repeated information, which according to Albuquerque et al. (2014)

is a method of control, taking into account the period in which the questions were asked, and which after a time were formulated again; c) lack of contradiction with the interlocutor, based on the model of the union of diverse competences, in which the information provided by only one subject was considered (Hays, 1976).

RESULTS

The commercial network of *K. scorpioides* in the micro region of Arari, from hunting to the final consumer, involved a group of about five social levels (Figure 2), each with characteristics and defined roles.

The hunters of *K. scorpioides* are artisanal fishermen. Hunting of *K. scorpioides* is practiced exclusively by men, both for their own consumption and for commercialisation. Of the 13 artisanal fishermen living in the village of Jenipapo (Santa Cruz do Arari) interviewed, 69% ($n = 9$) stated that they hunted *K. scorpioides*. Of these nine, 78% had performed this activity for more than 10 years, and about 90% had practiced it alone without the help of third parties. It was an activity performed only at a time when it was more difficult to obtain other protein sources (e.g., fish, beef or chicken) or when

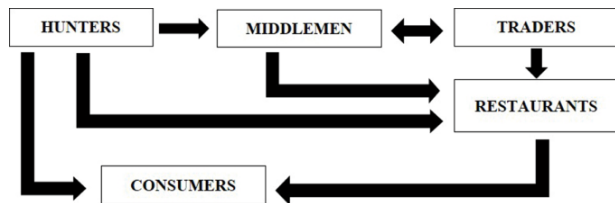


Fig. 2. Commercial network established for the extraction of *K. scorpioides* in Marajó Island, Brazil.

there was a need to diversify the diets. According to the interviewees, during the 1970s and 1980s, *K. scorpioides*, as well as other wild animals, were the only sources of animal protein available for the village of Jenipapo when there was a shortage of other food sources. However, comments on the impacts of hunting *K. scorpioides* were ambivalent, since for some it was a scarce resource due to its long history of use; for others it was an abundant resource.

Traders of *K. scorpioides* were mostly (90%; $n=9$) adult males with a low level of schooling (80% did not complete elementary school). Trade was conducted over 10 years ago, by 100% ($n=10$) of them. Traders residing in the urban area were generally former fishermen ($n=4$) or cowboys ($n=2$), retired and self-employed ($n=4$). The trade of animals was diffuse, being more frequent in peripheral neighbourhoods, near municipal ports.

The monthly income of the activity for 50% of respondents averages US \$377.14. The value of the product varied according to the time of year. The turtles

were marketed alive in groups of twelve animals (bunch), with values ranging from US \$12.86 to US \$28.57 in the driest period (Fig. 3). During the rainy season (December to March), when there was less availability of turtles, supposedly due to the difficulty in collecting, the sale value increased, to around US \$40.00 (12 animals).

K. scorpioides was traded in Santa Cruz do Arari to owners of boats from other neighbouring municipalities (e.g., Anajás, Ponta de Pedras and Cachoeira do Arari). In general, the middlemen who purchased the animals from the hunters in Jenipapo village (Santa Cruz do Arari) resold them to the owners of restaurants in the capital, Belém-Pará. This occurred during the season of greater availability of the animal in nature, that is, in the least rainy period (months of April to November).

The purchase of *K. scorpioides* meat was primarily for consumption (96%, $n=54$), especially by distant relatives and/or friends. Occasionally the product was resold (3%) or sent to neighboring municipalities (5%). In all cases, the animals came from hunting and/or trade, and 55% of the purchases were obtained directly from the hunter by order. All of the consumers interviewed ($n=56$) stated that they had consumed *K. scorpioides* at least once in the last year; 98% with a frequency of three or more times in the year. The main reasons ($n=56$) for *K. scorpioides* hunting were: food flavour (72%), cultural habit (14%), diet diversification (13%), and obtaining income (1%).

The restaurants of Cachoeira do Arari ($n=4$), Salvaterra ($n=4$) and Soure ($n=2$) commercialised the meat of *K. scorpioides* in the form of a delicacy known as "casquinha de muçã", which contained meat of two animals, on average, accompanied by manioc flour (*Manihot esculenta*). The value of this delicacy was between \$4.30 and \$10.00 USD, but it was not on the menu and instead was verbally communicated to the customer. The main consumers were urban dwellers in the region studied (80%), but also tourists. It was observed that this product was in high demand, even in the months of the rainy season, outside the season of greater supply. The average monthly income earned by traders was between \$ 251.43 and \$ 502.86, during the time when there was greater supply.

From the hunting reports, three techniques were described: a) opportunistic hunting by hand-collection; b) burning; and c) probing. These activities were cited by 100%, 54% and 62% of respondents, respectively. The opportunistic hunting by hand-collection involved the manual capture of *K. scorpioides* without the use of any extra utensils tools. It was used at the beginning of the period of fish reproduction, since hunters believed that *K. scorpioides* was "a fish at the beginning of spawning". It also happened when these animals were located in shallow aquatic environments, or during the tide change, when they were feeding under the surface and/or at the edge of the water. Hunting performance was maximised by searching within the flood fields for places where *K. scorpioides* were feeding.

Burning consisted of setting fire to the grasses of the fields during the dry season, which caused *K. scorpioides* to move in to the open to escape from smoke, where they were easily caught by hand. In this way, all animals



Fig. 3. *K. scorpioides* marketed alive in 2015 for the amount of US \$17.14 ($n=12$ animals). Source: Cristo (2015).

in the field were captured regardless of size or sex, and in large quantities. These animals were used for both consumption and sale. The application of this technique demanded empirical knowledge about the seasonal climatic variation in the area of the fields, which included the direction of the wind, the probability of rainfall, and microhabitats for turtle hibernation, estivation and/or thermoregulation. Burning was practiced with the help of other people to control the fire.

Probing was carried out with the use of a long rod of wood or metal, whose tip was protected by a plastic wrap, to locate animals burrowed in mud both in the dry and rainy season. The hunter walks in flooded environments, especially on the edge of watercourses during the dry season, probing the ground until hearing the sound of the metal or wood probe on the turtles' carapace, which are then captured by hand. The application of this technique demands empirical knowledge of the seasonal variation of the lakes and turtle behaviour.

Hunters also had knowledge of the trophic, reproductive, and behavioral biology of *K. scorpioides* life history. They identified a variety of environments in which animals could be found. In the dry season, they would be present in large numbers in fields below or in the middle of the foliage. In the rainy season, when the rivers overflowed and flooded the fields, *K. scorpioides* could be found in shallow flooded areas, pools, ponds, and puddles formed between pastures. They could also be found along rivers and in the archaeological earth mounds on Marajo Island (tesos). As for the diet of *K. scorpioides*, hunters reported that it is omnivorous, and consumes a wide variety of food items including algae, vegetation (*Commelina longicaulis*), small invertebrates (beetles, Coleoptera: Chrysomelidae), and detritus. Hunters believed that the feeding sites of the species are natural floodplains, dry environments, floodplains at low water depth, in open land and/or under various foliage.

The hunters (92%, $n=12$) claimed to be able to distinguish the sex of *K. scorpioides* by observing certain morphological characteristics: specimen size (23%), tail length (15%), and shape of the shell (54%). According to most hunters, the first two characteristics could be observed at any age, but the differences in the shell could only be verified only in adult animals. Mating was believed to occur at the beginning of the rainy season (December), but could continue for five months through the rainy season. Copulation likely occurs underwater in shallow areas, and/or under shrub vegetation. Nesting was reported to begin in April, with increasing intensity in the months of June and July, in diverse microhabitats (mainly between the roots of the trees, in soft and clean earth, or under fallen foliage). Three to eight eggs were deposited with an incubation period of two to five months. After the mating and nesting period, *K. scorpioides* generally showed a pattern of inactivity during the driest period, from July to December, where it would remain burrowed for six months until the next rainy season.

DISCUSSION

The *K. scorpioides* is threatened by illegal trade on Marajó Island. The hunting of this species in this area showed that this activity serves both for consumption and for sale. The empirical biological aspects of this species in the wild is known by the hunters.

The trade of *K. scorpioides* in Arari, Marajó Island was carried out exclusively with live animals extracted from the natural populations, not from legalised breeding facilities, and destined for consumption both locally and in towns. According to our observations, the animals were not used as a medicinal product as identified by Alves et al. (2008), who described the biotherapeutic use of this species in Mexico and elsewhere in Brazil. Unlike the observation of Shiping et al. (2006), the sale of *K. scorpioides* was not carried out only in one place, but occurred in different areas of the cities surveyed. *K. scorpioides* was marketed in a bundle of twelve animals, similar to reports by (Delducque, 2000). Based on the value of a monthly income and the value of the dozen turtles, it is estimated that up to 17 dozen of *K. scorpioides*/month/trader could be traded; that is, 204 animals/month or 2,448 animals/year.

The origin of animals detected for the market indicates that this phenomenon is typically intra-regional (e.g., on Marajó Island) but can reach more distant places, such as large urban centers (e.g., Belém, Pará) and other states. For that to happen, the networks that are established until the final sale must involve several players: *K. scorpioides* hunters who sell to middlemen, traders, restaurants and also directly to consumers.

The frequency of consumption of *K. scorpioides* by the vast majority (98%, $n=55$) of interviewees indicated a high demand. This fact was highlighted by Renctas (2002), Baía-Júnior et al. (2010), Morcatty & Valsecchi (2015), Morsello et al. (2015), and Van Vliet et al. (2016) as a potential threat to wild animals, in this case the sustainability of populations of *K. scorpioides*.

The taste preference for wild meat, according to Koster et al. (2010), influences the choice of which animals are consumed. There are customs linked to the cultural tradition in the local population that the marajoaras that reside in other regions usually request the shipment of these products. According to Nasi et al. (2011), this practice persists because many residents of urban areas in tropical countries still have strong links to rural culture, preferring game meat rather than other sources of protein. This was also observed by Morcatty and Valsecchi (2015) when studying the factors that influenced the hunting and trade of the tortoise *Chelonoidis denticulatus*.

Based on the income of restaurants with dishes based on *K. scorpioides*, at the time of greatest supply, a profit of approximately 50% is estimated on the average sale of 36 to 72 meals of *K. scorpioides*/month. This represents the purchase of six to 12 dozen live animals. According to Morcatty & Valsecchi (2015), middlemen profit more than hunters, and final traders always more than everybody else. The latter, with better purchasing power than the others, control the hunting trade (Van Vliet et al., 2016).

In studies carried out in Belém, Pará, it was observed that the average demand in restaurants was 260 animals/month, or 1,248,000 animals/year to fulfil the demand of the entire market, assuming 400 restaurants (Palha et al., 2006). However, the supply to the market is always based on the extraction from natural populations, since there is no legalised commercial breeding of the species in the country. In this sense, legalised breeding in captivity would be able to supply the market, as well as contribute to the reduction of pressure on natural stocks (Silva et al., 2004, Silva et al., 2014).

Hunting of *K. scorpioides* was affected by water cycles. During the rainy season, opportunistic capture was conducted via hand-capture and probing, and in the dry season, burning was used. Pezzuti et al. (2004) and Barboza et al. (2013) observed the use of artifacts for hunting other species of turtles of the Amazon, such as dart, reeds, mallets, jaticá harpoons, arrows, rifles, baits and longlines, which were not identified in the present study. Barboza et al. (2013) analyzed the hunting methods of the chelonians in the floodplain of the Amazon River in Santarém and identified a wide combination of these techniques based on local ecological knowledge.

Hand collection of *K. scorpioides* occurred mainly due to the reproductive behaviour of the females during the transition between the rainy for dry season, at the tide change. At that time, females could easily be found nesting, which facilitated their encounter and capture. This was also a strategy frequently used for the collection of *P. expansa*, *P. unifilis* and *P. sextuberculata* (Pritchard & Trebbau, 1984; Fachin-Terán et al., 2004; Barboza et al., 2013). Probing has been described in the capture of tracajás *Podocnemis unifilis* (Fachin-Terán et al., 2004; Barboza et al., 2013). Moll & Moll (2004) also verified the use of probing in Asia, Australia and the U.S.A.

The information obtained from the hunters on the diet of *K. scorpioides* corroborated the literature. According to Pritchard and Trebbau (1984), the species is mainly carnivorous, and according to Marques et al. (2008), also an opportunistic omnivore. The sexual dimorphism reported in the empirical reports of this work is in agreement with studies carried out in captivity with *K. scorpioides*, where differences were observed in relation to animal size, shape of the shell and tail length (Marquez, 1995; Berry & Iverson 2001, 2011). Regarding reproduction, mating occurs during the rainy season and is related to the greater availability of resources (Sexton, 1960), followed by a period of nesting, subject to seasonality, during the less rainy period. This pattern was also observed in captivity (Castro, 2006). These facts indicate that the physiological conditions observed in nature are reached in an ex situ environment, which is a positive factor for the captive production of the species and facilitates its conservation.

The so-called “ultimate period”, in which *K. scorpioides* burrows for months in a state of estivation during the dry season was also reported by Delduque (2000), Souza (2004), Pereira et al. (2007), Vogt (2008) and Berry & Iverson (2011). This behaviour was described by these authors as an adaptation for the regulation of the heat water exchange under adverse environmental conditions.

CONCLUSION

Here we show that the commercial network for *K. scorpioides* in the Marajó Island complements the income of hunters and produces profitability for the other actors involved from the extraction of the animal from nature, up to the sale to the consumer. It is difficult to quantify the impact of this trade, although it is crucial to assess the status of *K. scorpioides* populations and to construct appropriate conservation strategies, but the legal status does not prevent the sale of this animal. Further study is needed to establish the connection of the Marajó Island trade to that of large urban centers, and the creation of a productive chain or just a diffuse and seasonal trade. In addition, research on biological data in nature, mainly on reproduction and population density for this species, is necessary. Consumption and high demand of *K. scorpioides* are associated with regional cultural factors, but human overcrowding and lack of in situ management would, over time, reduce the access and availability of this animal. It is necessary to organise efforts to apply environmental education to this activity. It may be possible to meet the market demand for this turtle through the implantation of captive breeding programs.

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