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Reptiles sold as traditional medicine in Xipamanine and Xiquelene Markets (Maputo, Mozambique)

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Zootherapy plays a role in healing practices in Mozambican society. Although several studies have focused on ethnobotany and traditional medicine in the country, little research has been conducted on the use of reptiles in zootherapy. The aim of this study was therefore to fill this gap by assessing the reptile species traded for traditional medicine in the Xipamanine and Xiquelene Markets in Maputo, Mozambique. We found that few reptile species are traded domestically for traditional medicine and that their use appears to be in decline in Mozambique. Our findings also suggest that the domestic trade of reptiles for traditional medicines in Maputo markets is unlikely to have a significant impact on the conservation of reptiles in Mozambique. However, we suggest that international trade with South Africa is likely having a larger impact, given observations of Mozambican nationals selling a diverse range of fauna in urban traditional medicine markets in Johannesburg and Durban.

Introduction

The use of animal products for healing purposes is an ancient practice complementary to the body of knowledge on plant-based medicines[1], and trade in wildlife products for these purposes, especially in parts of Asia and Africa, is increasing[2]. Despite the rise of zootherapeutic studies to address a paucity of information on the subject of traditional animal therapies, studies have rarely addressed the use of reptiles by African communities.[2,3] These interrelationships between humans and herpetofauna are referred to as 'ethnoherpetology'.[4]

Reptiles, especially crocodiles and pythons, are typically present and frequently sought after in African traditional medicine markets.[2,3,5-11] Focused ethnoherpetological research and quantitative studies have, however, been largely overshadowed by the generalised ethnozoological studies that document and inventory multiple vertebrate classes.[2] This broad approach may signify a bias towards investigating aesthetically pleasing or charismatic species such as birds and mammals, or fauna that are of conservation concern. What is more, the scarcity of ethnoherpetological records contributes to the traditional importance of herpetofauna (and the degree to which they are exploited) being overlooked and underestimated.[12,13]

Decades of civil war in Mozambique – and the resulting impoverishment – has resulted in reduced public access to conventional Western medicines and, as a consequence, the healthcare system is dominated by a reliance on traditional medicines.[13,14] Consequently, most Mozambicans' first encounter with healthcare is allegedly through a network of traditional medical practitioners.[15] While plants are the primary source of traditional remedies in the country[16] and dominate the products sold by traders in the markets (e.g. Krog et al.[7] calculated that traders on average sell 2 ± 3.5 different animal products compared to 27 ± 12.5 different plant products), animals used in zootherapeutic preparations also play a role[5]. However, there is a shortage of accessible and/or published material on the subject of Mozambican zootherapeutics, particularly on the nature and dynamics of the reptile trade. Studies that have included some information on the sale of herpetofauna in Mozambican markets include reports by Chauqúe[5], Krog et al.[7], Marshall[13] and Cunningham and Zondi[17]. Thus the aim of our study was to document the reptile taxa in urban markets selling traditional medicine in Maputo, and to consider the implications that this trade may have for reptile conservation in Mozambique.

Methods

Market surveys were carried out in the traditional medicine section of informal markets in the capital city of Maputo, Mozambique, in March 2015 (Xipamanine Market) and January 2016 (Xipamanine, Xiquelene and Adelino Markets). Ethics clearance to conduct the surveys was granted by the University of the Witwatersrand Human Non-medical Ethics Screening Committee (protocol number H14/06/02). Permission to conduct the market interviews was granted by the local heads of the traditional healers association (Associação dos Médicos Tradicionais de Moçambique, or AMETRAMO), and the association for retailers of traditional medicines of Mozambique (Associação des Vendedores de Medicamentos Tradicionais de Moçambique, or AVEMETRAMO). These organisations represent the collective interests of Mozambique's traditional healers and vendors in the Xipamanine and Xiquelene Markets, respectively.

Market identification

There are three informal markets selling traditional medicine in Maputo (Table 1). The biggest, Xipamanine, is probably also the largest market for medicinal plants in Mozambique[7]; traders here sell a variety of products in distinct sections of the market, including traditional medicine, meat, livestock, clothing, crafts and raw materials such as charcoal. Xiquelene (or Xikalene) is the second largest market in Maputo, but it has less than half the number of traditional medicine traders as Xipamanine (Table 1). This market is also arranged according to the type of product sold, with traditional medicine vendors clustered together. Adelino is the third informal market in Maputo, but it is minor in size compared with the other two and sells mainly textiles and charcoal. Only Xipamanine and Xiquelene Markets sell animal products for traditional medicine (Table 1).

Table 1: Number of stalls selling traditional medicines in three Maputo markets in January 2016

Market	Stalls registered to sell traditional medicine	Stalls openly selling animals as traditional medicine	Stalls openly selling reptiles as traditional medicine (% of animal traders with reptiles)[a]	Male traders selling reptiles
Xipamanine	150[b]	>36	9 (<25%)	6
Xiquelene	69[c]	36	5 (14%)	3
Adelino	2	0	0	0
Total	**221**	**>72**	**14 (<19%)**	**9**

[a]*These stalls were sampled in January 2016.*

[b]*Information supplied by AMETRAMO. Traders allegedly all have permits to sell plants and animals in the market.*

[c]*Information supplied by AVEMETRAMO.*

There are no significant markets for traditional medicines in Maputo Province outside the city of Maputo, including rural markets (Falcâo MP 2015, written communication, December 22). There are anecdotal reports of a rural traditional medicine market operating once a week near Ponta do Ouro (a coastal town about 130 km south of Maputo and approximately 15 km from the South African border), which also attracts South African traditional healers. However, there was no evidence for its existence when the region was visited in January 2016 (Falcâo MP 2016, oral communication, January 20). Given the notable cross-border trade of ethnomedicinal resources between Mozambique and South Africa (Williams VL, personal observation), it is plausible that such a place where these resources can be occasionally traded exists; however, further investigations are warranted to assess whether these anecdotes are exaggerated.

Based on the available market information, we undertook our first market survey in Xipamanine in March 2015 with seven traders. We had intended to conduct a comparative study in South Africa in 2015 (specifically in Faraday Market in Johannesburg and Warwick Market in Durban), but the Chairpersons of these markets denied permission for the study. Hence we limited the trade study to Maputo and followed up with a second survey conducted there in January 2016, this time in two of the three markets and including all 14 traders that sold reptiles as traditional medicine in the study (Table 1).

First market survey

A semi-quantitative questionnaire-based market survey was carried out in Xipamanine over 2 days in March 2015. Permission to speak to the traders was granted beforehand, and thereafter a discreet pre-survey assessment was conducted (initially without the AMETRAMO head) in order to become familiar with the market and to identify which traders were openly selling animal products. Four reptile traders were counted on the first pre-survey visit. When accompanied by AMETRAMO on the second pre-survey visit, a further three traders were identified (all by AMETRAMO); these traders stored animals out of sight and only reluctantly showed them to us on request of AMETRAMO. Whether there were more reptile traders in the market not known to the AMETRAMO head could not be established. After the pre-survey visits, and before the interviews commenced, the research objectives of the study were explained to the seven known reptile traders to obtain their consent to participate.

An interpreter from Eduardo Mondlane University (Maputo), trained in interviewing techniques, assisted with the interviews. A semi-structured questionnaire (see Appendix 1 in the supplementary material) was used that was verbally translated into Portuguese and Xitsonga – the most commonly spoken languages in Maputo – by the interpreter during the interviews. The questionnaire consisted of three parts: (1) basic trader information (sex; whether traders were traditional healers or not; a participant code for anonymity); (2) market information (species preferences by traders and customers; how reptiles reach the market); and (3) species information (taxon sold; common names; parts sold; geographical harvesting origin; availability; uses; etc.) (see Appendix 1 in the supplementary material). The information was supplemented by informal discussions. All reptiles, except those that were easily identified, were photographed where consent was given and later identified to species level using the taxonomic arrangement of Bates et al.[18] and Uetz and Hošek[19].

Second market survey

A second survey was carried out in Xipamanine and Xiquelene Markets over 3 days in January 2016. Adelino Market was also considered, but none of the traders sold animal parts (Table 1). The intention had been to repeat the 2015 survey using a slightly extended questionnaire (see Appendix 2 of the supplementary material) that included questions added to clarify matters that had arisen during the first survey. As with the first survey, permission to interview traders was first sought from AMETRAMO in Xipamanine. Permission was also required from AVEMETRAMO to conduct the survey in Xiquelene. Although permission to conduct the study was granted, AMETRAMO and AVEMETRAMO requested that certain questions be shortened and/or omitted from the questionnaire; they also discouraged photographs and lengthy interviews. Hence, we were unable to replicate all of the first survey as certain questions had to be omitted, but we were able to include new informal questions on the pricing of body parts and cross-border trade and to record whether reptile fat was sold. Professor MP Falcâo from Eduardo Mondlane University, who has conducted ethnomedicinal surveys in Maputo markets before, assisted us by liaising with the associations and traders, and translating the interviews and discussions.

While we were able to conduct the questionnaire-based survey in Xiquelene with some success, the traders in Xipamanine were hostile and uncooperative on this occasion (despite mediation by AMETRAMO). Consequently, the questionnaire could not be used here and discreet mental and shorthand notes were made instead. The head of AMETRAMO also became a surrogate informant by supplying some answers to key questions. The resurvey of Xipamanine thus focused on recording species, the prices of body parts, and from where the animals had originated. An added challenge, however, was that many live animals were kept concealed – something AMETRAMO had warned us of beforehand. But whereas AMETRAMO intervened in the 2015 survey to coax traders into revealing hidden animals (albeit reluctantly), no such intervention was attempted by them in 2016. Accordingly, we do not consider the species inventory to be complete for the 2016 survey.

As traders in the markets were not traditional healers (and accordingly had limited knowledge about reptile zootherapeutics), we also attempted to interview suburban Mozambican traditional healers on the importance of reptiles to traditional healing. AMETRAMO recommended that we should first contact the Mozambican Ministry of Health for permission to conduct interviews, which we duly did. The representative of the Ministry agreed to assist, but imposed several last-minute administrative hurdles. Unfortunately, timeframes prohibited the completion of this part of the study.

Results and discussion

Reptile traders

There were at least 30 traders selling animal parts in Xipamanine Market in March 2015, but only 7 (all men) were identified as selling reptiles. In January 2016, 36 traders in Xiquelene and >36 traders in Xipamanine were recorded with animal parts; of these, a total of 14 vendors (64.3% men) had reptiles visible at their stalls and all of them were interviewed (Table 1). The sampled reptile traders thus accounted for 100% of all known reptile traders at the market, but <19% of all animal traders. The proportion of traders selling reptiles was unexpectedly low, but the extent of the covert trade (characterised by vendors concealing live animals) was difficult to gauge.

All market traders interviewed worked as permanent traders and lived in Maputo. While none of the respondents was a traditional healer, it appears that most of their customers for reptile parts were healers. None of the traders specialised in selling reptiles (mammals were the preferred vertebrates on sale), and medicinal plants dominated every stall. Xipamanine and Xiquelene are diversified markets with most men selling medicinal wildlife products and most women selling butchered domestic meat and clothes. The dominance of men selling traditional medicines corresponds with the findings for Xipamanine Market by Marshall[13] and Chauque[5] (100% and 95% male traders, respectively), and for traders in three Maputo markets by Krog et al.[7] (86% male traders).

Reptiles sold

In total, 10 reptile species belonging to eight families were observed for sale in the markets in 2015/2016 (Table 2; Figure 1). This figure is higher than the number of reptile taxa documented in previous studies for markets in Maputo.[4,13] The three most frequently recorded taxa were *Python natalensis* (southern African python), *Varanus* spp. (monitor lizards, *V. niloticus* and *V. albigularis*), and *Kinixys* sp. (hinge-back tortoise, most likely *K. zombensis* and/or *K. spekii*) (Table 2). Other species recorded in the markets more than once were *Crocodylus niloticus* (Nile crocodile), *Chamaeleo dilepis dilepis* (flap-necked chameleon) and *Broadleysaurus major* (rough-scaled plated lizard). One trader allegedly sold *Dendroaspis* sp. (mamba) fat.

Table 2: Reptile taxa, common names and observed frequencies in two surveys conducted in two markets

ORDER **Family** *Species*	**English name**	**Common names (P=Portuguese; T=Xitsonga)**	**Respondent frequency in market surveys**			
			Xipamanine 1 (*n*=7, Mar. 2015)	**Xipamanine 2** (*n*=9, Jan. 2016)	**Xiquelene** (*n*=5, Jan. 2016)	**Total** (*n*=21)
CROCODILIA						
Crocodylidae						
Crocodylus niloticus	Nile crocodile	Crocodilo (P); Nguenha (T)	2	1	0	3
SQUAMATA						
Pythonidae						
Python natalensis	Southern African python	Gibóia (P); Nhlaru (T)	1	4	4	9
Elapidae						
Dendroaspis sp.[a]	Mamba	Not known	0	0	1	1
Viperidae						
Bitis gabonica	Gaboon adder	Bululu (T)	1	0	0	1
Gerrhosauridae						
Broadleysaurus major	Rough-scaled plated lizard	Makokorombane (T)	1	1	1	3
Varanidae						
Varanus niloticus	Nile monitor	Nkwahle (T)	1	3	0	4
Varanus albigularis	Rock monitor	Nkwahle (T)	0	1	0	1
Chamaeleonidae						
Chamaeleo dilepis dilepis	Flap-necked chameleon	Lompfanhe (T)	2	1	0	3
TESTUDINES						
Testudinidae						
Kinixys sp.[b]	Hinge-back tortoise	Cágado (P); Futsu (T); Nfutso (T); Chibodze (T)	2	2	1	5
Stigmochelys pardalis	Leopard tortoise	Cágado (P); Futsu (T)	0	1	0	1

[a]*Allegedly mamba, but the fat was sold and thus could not be authenticated*

[b]*Includes* K. zombensis *and/or* K. spekii



Figure 1: Reptiles recorded in the 2015/2016 Xipamanine and Xiquelene Market surveys. (a) Live *Kinixys* sp.; (b) *Stigmochelys pardalis* carapaces; (c) concealed *Crocodylus niloticus* skin; (d) *Python natalensis* skin and vertebrae (rolled up); (e) handful of *Python natalensis* vertebrae; (f) allegedly *Python natalensis* fat; (g) whole *Broadleysaurus major*; (h) live *Chamaeleo dilepis dilepis* in a plastic bottle; (i) *Varanus niloticus* in a container; (j) whole *Varanus niloticus* skin; (k) whole *Varanus albigularis* skin.

Our species count and the number of animals or body parts (Table 3) is likely to be an underestimation of actual numbers because live animals were generally concealed from view and were sometimes only shown on request of the accompanying AMETRAMO representative. The willingness of traders to disclose their stock in the 2016 survey was markedly reduced compared to 2015. Chauqúe[5] similarly noted that some animals are stored out of sight in Xipamanine and are only shown to potential customers. Our role as researchers would thereby have obviated any incentive for vendors to show us the species for sale.

Previous studies in Maputo recorded *P. natalensis* (identified as *Boa constrictor*[5], but likely to be python because boas are not indigenous to Africa) and *C. niloticus* as the reptiles most commonly sold in the markets.[5,13] These studies also indicated the sporadic presence of *Chelonia mydas* (green turtle) and *Eretmochelys imbricata* (hawksbill turtle)[5] and the spiny lizard *Smaug warreni warreni* (Warren's dragon lizard)[13]. Krog et al.[7] also noted the presence of live chameleons and unidentified reptile skins. We recorded two taxa that were either always sold live, namely chameleons (Figure 1h), or generally sold live, namely tortoises (live tortoises were recorded in 2015, but only carapaces were observed in 2016) (Table 3). For all other species, usually the skins were sold (especially those of python, crocodile and monitor lizards) (Table 3). Python vertebrae were on display in 2016, but only in Xiquelene Market.

Bottled animal fats were sold at many of the stalls (ranging from 5 to 15 bottles per trader). We did not inventory reptile fat during the 2015 survey, but one respondent indicated that he sold 'quite a bit' of crocodile and python fat. During the 2016 survey, we recorded four traders willing to acknowledge that they had python fat (Figure 1f), one with crocodile fat, and another allegedly with mamba fat (Table 3). There is a strong likelihood that these fats are mostly fake, and that traders are unable to verify the species (see Chauqúe[5]). For example, one respondent pointed out many bottles of fat belonging to different vertebrates, including three reptiles – but he failed to match the same species to the same bottles when re-interviewed later.

Ethnoherpetological nomenclature

African traditional nomenclature generally limits cultures from recognising the full range of reptile species and classification is not hierarchical[3]; instead, species are generally named in terms of their appearance, habitat and/or behaviour, and some names represent multiple species that are superficially similar.[3,20,21] For example, the common name for sea turtles (*N'futso*) documented in Maputo by Chauqúe[5], is similar to that of the Mozambican Xitsonga name recorded for the tortoises *Kinixys* sp. and *Stigmochelys pardalis* in our study (i.e. *futsu*) (Table 2). However, tortoises are also called *chibodze* (Table 2), which is the same as the group name for *Kinixys* and *Testudo* spp. (now species of *Chersina*, *Homopus*, *Psammobates* and *Stigmochelys*) recorded by Taylor[21] for 'Shangaan' speakers in southeastern Zimbabwe (note: while linguistically similar, the name 'Shangaan' has derogatory meaning to speakers of Xitsonga/Tsonga dialects in southern Africa). All these traditional common names are consistent with the Tsonga names for tortoises in southern and South Africa.[22,23] Hence, the common names for the testudines identify them as a 'morphospecies' across the region and similar taxa are likely to be used interchangeably for the same purposes.

Table 3: Quantities of reptile body part(s) per survey

English name	Quantities of body parts per market survey [number of traders]		
	Xipamanine 1[a]	Xipamanine 2	Xiquelene
Nile crocodile	2 skin pieces [2]	1 skin piece [1]	Fat [1]
Southern African python	1 skin piece [1]	4 full skins [4]; fat [1]	13 vertebrae (1 handful) [1]; 1 full skin and spine, 1 full skin and fat [1]; 1 full skin [1]
Mamba	–	–	Fat [1]
Gaboon adder	1 full skin [1]	–	–
Rough-scaled plated lizard	1 whole body [1]	1 whole body [1]	1 whole body [1]
Nile monitor	1 whole body [1]	3 full skins [3]	–
Rock monitor	–	1 full skin [1]	–
Flap-necked chameleon	4 live [2]	1 live [1]	–
Hinge-back tortoise	2 live [2]	2 carapaces [2]	1 carapace [1]
Leopard tortoise	–	3 carapaces [1]	–

[a]*Did not inventory animal fat in this survey*

The naming of *Varanus* spp. (*nkwahle*), *C. d. dilepis* (*lompfanhe*) and *C. crocodilus* (*nguenha*) in this study was also consistent with the names recorded in Taylor[21], namely *gwahli, limvani* and *ngwenya*, respectively. The naming of the *Varanus* spp. is supposedly based on their habitat; in South African Tsonga, the Nile monitor is called *ngwehle* and the Rock monitor is called *ngwahle*.[23] The Nile monitor is also called *gwahli mati*,[21] where the term *mati* means water. Although the spelling of the names is slightly different, they are phonetically similar.

The Xitsonga name *bululu* for the Gaboon adder (*Bitis gabonica*) is allied with the isiZulu name *imbululu* or *ibululu* for species of adders (*B. arietans, B. atropos, B. cornuta*) in South Africa.[3] Because elements of the isiZulu language are linguistically related to Xitsonga, all adder-like species in the region are thus likely to be similarly named. The similar names for individual morphospecies reflect the distribution of taxa that resemble each other, as well as the distribution of Tsonga speakers, across southern Mozambique, southeastern Zimbabwe and eastern South Africa. However, *makokoromba* (*B. major*) is the only Mozambican Xitsonga common name for which we found no linguistically similar ethnospecies name in South African Tsonga or isiZulu.

Species use

Documenting species uses is a controversial matter that risks breaching rights concerning indigenous knowledge.[24] We were informally made aware of the therapeutic use for only one species in 2015, namely chameleons for asthma (Table 1), and we were discouraged from discussing uses in 2016. Asthma is allegedly widespread in Mozambique according to one trader, and the tails are used to treat the condition. Non-therapeutic uses for two other species were also cited, namely tortoises for food, and python skins as part of the traditional attire of healers. Uses for the body parts of other species were either unknown (which is plausible as none of the traders was a traditional healer) or deliberately not divulged. The use of python skin in ceremonial regalia is a common practice among traditional healers and has been recorded in South Africa among Zulu-speaking people.[16]

Although the uses for the other species and their parts were not documented, their therapeutic values are less likely to be species-specific and more likely to be similar to previously documented uses for allied morphospecies with similar-sounding common names in the region. For example, uses for *B. gabonica* skin were not mentioned in our survey, but they are likely to be similar to other *Bitis* spp. and taxa collectively known as *bululu* that are used as snakebite antidotes and protective charms.[3,17] However, primary uses for certain taxa can be highly variable and characterised by a low degree of consensus among consumers.[24] What is more, uses are generally associated with the 'Doctrine of Signatures' and the complete or partial resemblance of a species to a bodily attribute or function, hence some uses can in some cases be deduced – such as the use of pythons to imbue strength.[24]

Sale prices of reptile parts

The prices of reptile parts seem variable and negotiable, and are dependent on the customer and on the freshness of the material. Fresher, more recently harvested, animals sell for higher prices because the medicines are seen as more effective. Because the respondents in Xipamanine were generally non-responsive to questions, we could only document prices for three species sold in Xiquelene in 2016. Prices of tortoise carapaces were quoted as MZN300 (ZAR95; USD6) for the whole carapace and MZN100–MZN150 per scute (where 1 Mozambican metical (MZN) = 0.3156 South African rand (ZAR) = 0.02 US dollars (USD)). The whole body of a relatively fresh-plated lizard (*B. major*) was quoted as MZN500. Python bones were sold for MZN10 per vertebra, and MZN150 per handful of vertebrae (see Figure 1e).

The unpredictability of the prices is evident when comparing information reported in trade studies conducted previously. In January 2016, prices quoted to us for python skins were: (1) whole: MZN300; (2) 200-mm piece: MZN100; (3) unknown size: MZN100–MZN150. In 2010, however, Chauqúe[5] listed the average price of a smaller 100 x 50 mm piece of python skin to be MZN208.33 (ZAR48; USD6) (exchange rate for June 2010; MZN1 = ZAR0.2304 = USD0.00288). Chauqúe[5] also listed the price of crocodile skin (no size specified) to be MZN587.5, ranging from MZN500 to MZN750 per unit. This range in pricing and the practice of negotiating is not uncommon throughout informal African markets.

Trade dynamics and procurement

Vendors report that the trade in animals, especially reptiles, is largely sporadic and not as profitable as that in medicinal plants. This irregular demand translates into some specimens being kept in the market for more than a year (Chauqúe[5] reported 3 years) before being sold and/or discarded if the stock becomes too decomposed. Given the losses associated with disposal of stock, these factors partially explain the preferences for live animals.

It is clear that traditional healers are the primary, if not sole, purchasers of reptile-based medicines in the markets. Crocodile and python were cited in the 2015 survey as the species that healers request most often, and also the species the traders would prefer to sell if they could acquire the stock (Figure 2) (note: these questions were deleted on request in the 2016 survey). Chameleons and tortoises were also mentioned as species that are in demand (although less often than crocodiles and pythons, and perhaps the reason for keeping them alive).

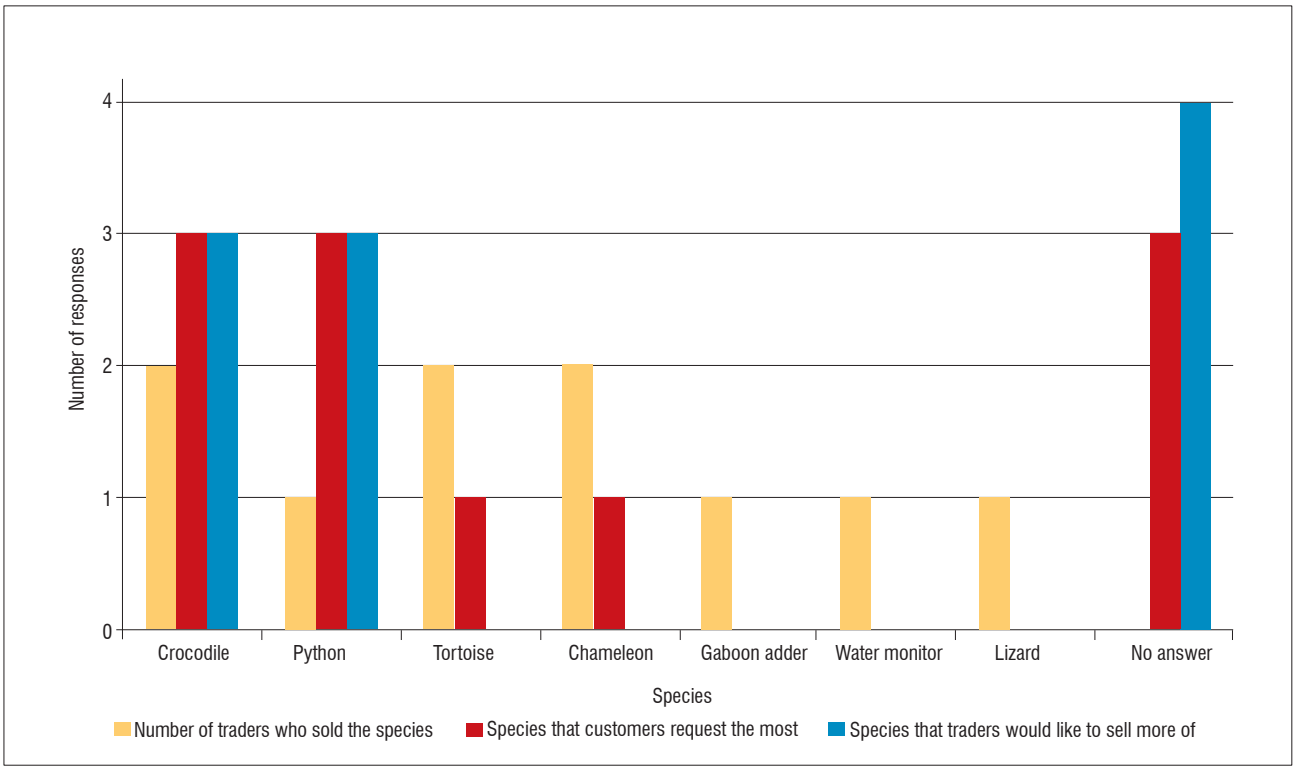

Figure 2: Variation in the number of traders selling reptile species, and the customers' and traders' preferences for medicinal reptiles. (Xipamanine Survey 1, March 2015. A comparative study in January 2016 was not permitted.)

Rural harvesters and suppliers are central to the provision of animal products to the market. None of the respondents harvested animals themselves – they bought stock directly from sellers or harvesters at the market. While some traders know rural harvesters they can contact to place an order, no special deliveries of reptiles are made and they almost always accompany a much larger consignment of medicinal plants. Smaller reptiles such as chameleons and tortoises tend to be acquired opportunistically year-round when harvesters find them whilst collecting medicinal plants. Other species are mostly brought to the market in summer – usually because frequent veld fires and brumation of reptiles during winter decreases their seasonal detectability. The hunting of crocodiles, however, is not opportunistic nor incidental because of the effort required to kill them. Large reptiles tend to be killed in situ and the products (e.g. skin, fat, bones) are transported to the markets hidden in bags of charcoal or medicinal plants. Confiscation of material at roadblocks is a constant risk to the suppliers, which adds to their costs along with the cost of transport from the harvesting catchment to the markets. Poor and/or rural-based harvesters are thus especially vulnerable to the risks of transporting large and/or protected species without the necessary permits.

Origin of acquired reptiles

The procurement of reptiles from three provinces (Gaza, Inhambane, Maputo) and 10 districts (including all 7 districts within Maputo Province) (Figure 3; Table 4) highlights the exchange of resources between urban and rural areas and the cultural ties that exist between them. The use of the same species for traditional medicine in rural and urban areas also suggests that zootherapeutic practices may function as a social conduit between rural people in remote rural areas and people (such as migrants) living in urban areas that helps maintain traditional culture and values, as well as information on illnesses and potential treatments.[12]

Most specimens were collected from districts within Maputo Province (Table 4), but python, crocodile and the Nile monitor were also acquired from the adjacent provinces of Gaza and Inhambane (particularly along the Save River in northern Inhambane). The Chicualacuala District in Gaza is approximately 430 km from Xipamanine and was noted by Chauqúe[5] to be a major supply area for all animals sold in Maputo markets – probably because of the high faunal diversity in the region and its proximity to the Greater Limpopo Transfrontier Park. However, Krog et al.[7] also noted that most traders (of medicinal plants) interviewed in Maputo markets originally came from the neighbouring provinces of Gaza and Inhambane before becoming permanent traders at the market, and that the majority of plant products was acquired from these two provinces and Maputo. Although we did not record the respondents' ethnic group, Chauqúe[5] further reported that *Mashope* vendors (Chopi-speaking and originating from northern Gaza and southern Inhambane) were the second-most common ethnic group of the animal traders. Therefore, links to 'home' and familial ethnic ties to certain rural areas may also function as important harvesting conduits for acquiring species.

Cross-border trade

There is a cross-border trade in reptiles between neighbouring countries and/or customers from Tanzania, Zambia, Malawi, Zimbabwe and Swaziland, and especially with traditional healers from South Africa. However, respondents indicated that medicinal plants are the main focus of this cross-border exchange of resources and that animals are a minor accompaniment. When considering the number of ethnomedicinal animal traders in the Johannesburg and Durban markets (≈60 in Durban; Moshoeu TJ, personal observation), and the presence of fauna procured from Mozambique (Williams VL, personal observation), then rumours of a weekly ethnomedicinal market operating at Ponta do Ouro, only 15 km from the South African border, are plausible. It is suspected, however, that these Mozambican resources are mostly smuggled through the nearby Kosi Bay border area given its proximity to South Africa and the relative remoteness of the region. Transport of fauna and flora across the Lebombo/Ressano Garcia border is less likely given the higher levels of security there.

Table 4: Harvesting localities/sources for reptiles sold in the markets

English name	Localities per survey Province (district, number of traders)		
	Xipamanine 1	**Xipamanine 2**	**Xiquelene**
Nile crocodile	Gaza (Chicualacuala, 1) Not known (1)	Maputo (Moamba, 1)	–
Southern African python	Not known (1)	Inhambane (Govuro[c], 1; along the Save River, 1) Maputo (Boane, 1; Manhiça, 1)	Gaza (Chibuto, 1; Chicualacuala, 1; not known, 1) Maputo (Namaacha, 1)
Mamba	–	–	Not known (1)
Gaboon adder	Maputo (Manhiça [a], 1)	–	–
Rough-scaled plated lizard	Not known (1)	Not known (1)	Maputo (Magude, 1)
Nile monitor	Maputo (along rivers, 1)	Inhambane (along the Save River, 1) Maputo (Manhiça, 1) Not known (1)	–
Rock monitor	–	Maputo (Marracuene, 1)	–
Flap-necked chameleon	Maputo (Marracuene, 2)	Not known (1)	–
Hinge-back tortoise	Maputo (Maputo[b], 1; Namaacha, 1)	Maputo (Marracuene, 1; Namaacha[d], 1)	Maputo (Boane, 1)
Leopard tortoise	–	Maputo (Matatuine[e], 1)	–

Specific localities mentioned: a, Nhongonhane; b, outskirts of the city of Maputo; c, Mambone; d, Changalane; e, Ponta do Ouro

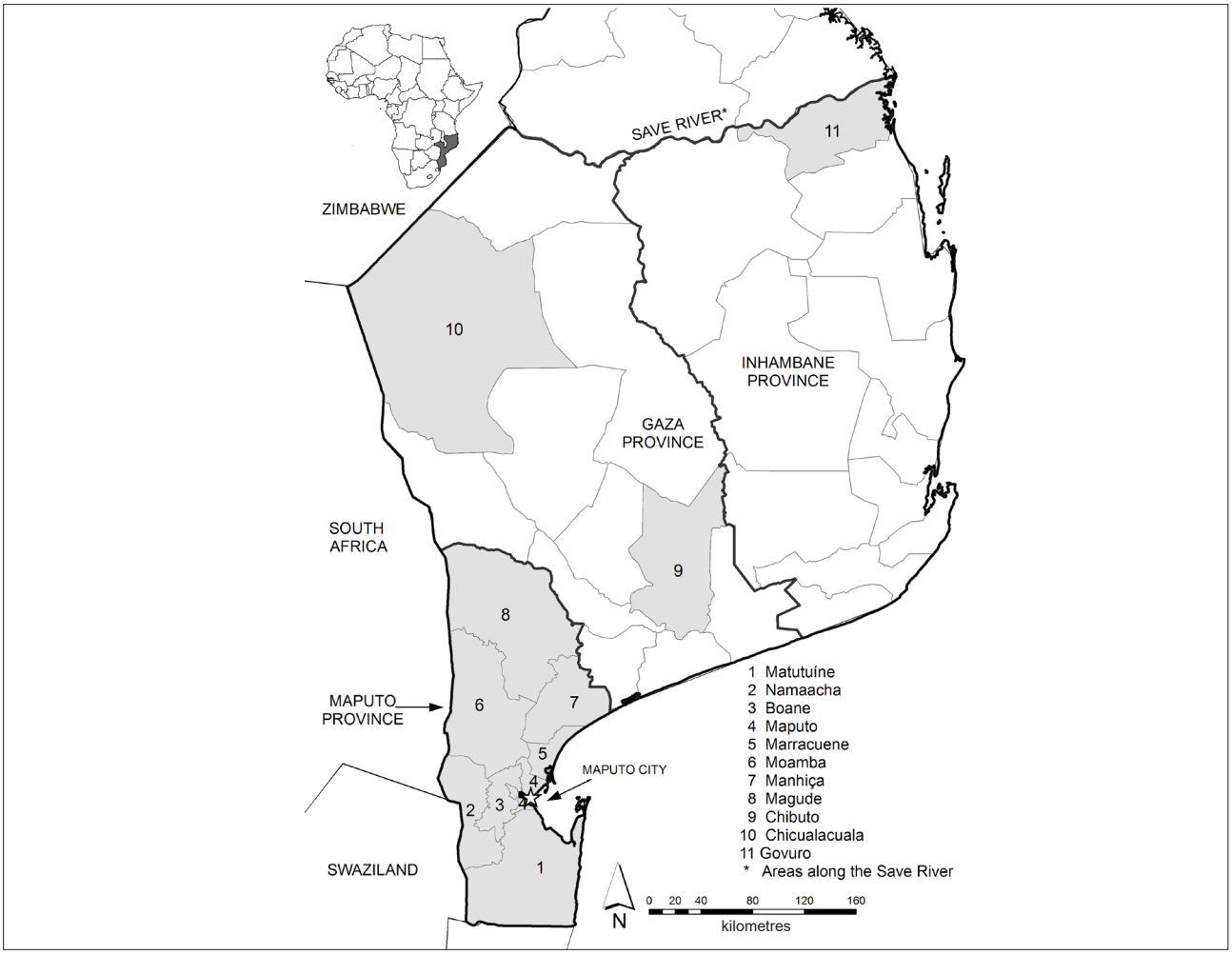

Figure 3: Map of Mozambique indicating the provinces and districts cited as source areas for the reptiles documented during the 2015/2016 market surveys.

Perceptions of resource availability

During the 2015 Xipamanine survey, all the traded reptile species were perceived by the sellers to be declining in the wild, and frequent veld fires were cited as the primary cause for the decline, especially in the case of chameleons. As we were prevented from asking this question during the second survey, no comparative results are available for 2016. Difficulties in the acquisition of medicinal animals sold in Mozambique markets owing to their scarcity were also noted by Marshall[13]; of special concern were *P. natalensis* and *S. w. warreni*. Chauqúe[5] further noted that the turtles *C. mydas* and *E. imbricata* were in 'danger of extinction' and urgent action was required to reverse the situation.

Despite the reported 'shortages' and declines, most respondents reported that reptiles were no longer in great demand – suggesting that there has been a change or adaptation in consumer requirements, and accordingly a drop in stock numbers compared to previous years. Is diminishing indigenous knowledge of reptiles' therapeutic and symbolic properties one reason for the reduced demand? Or, are consumers increasingly less likely to utilise zootherapeutic remedies relative to plant-based remedies? We do know that there is a large demand for certain reptiles (especially crocodiles, pythons and tortoises) in the urban traditional markets of South Africa.[11,17,24,25] Even though elements of the trade within Mozambique appear to be small, we believe that trade with South African consumers (in both urban and rural areas) is negatively impacting some species. For example, Ngwenya[25] reported that there is a high demand for turtle products and eggs in Maputaland (a region in the northern part of the South African province of KwaZulu-Natal adjacent to Mozambique and between Swaziland and the coast). Turtle eggs are alleged to make poultry more fertile and consumption of turtle meat improves longevity[25]; hence, turtles are killed and their nests are robbed in neighbouring Mozambique and along the northern KwaZulu-Natal coastline.[25]

Implications for conservation

Of the 10 reptile taxa recorded, only *C. dilepis*, *C. niloticus* and *S. pardalis* have been subjected to global conservation assessments by the International Union for Conservation of Nature and Natural Resources (IUCN), and are all listed as Least Concern (as of 24 January 2016). Regional assessments have been conducted on nine species for South Africa, Lesotho and Swaziland.[18] *Crocodylus niloticus* is listed regionally as Vulnerable in this assessment[26], *B. gabonica* as Near Threatened[27] and the remainder as Least Concerned[28-32]. No corresponding national IUCN Red List assessment has been done for Mozambique. Given the wide distribution of *B. gabonica*, and lack of genetic differences between populations,[27] it is likely that it too would be listed as Least Concern in a global assessment. Thus, none of the species that we recorded being traded in Maputo markets in 2015/2016 are of particular global conservation concern. Given the low numbers of individual reptiles traded at the market, the IUCN status of each, and the apparent long-term decrease in the importance of the reptiles for zootherapeutic needs, we believe that the reptile trade in these markets is unlikely to pose any grave conservation concern.

Conclusion

We recorded few reptile species for sale in the Xipamanine and Xiquelene Markets and traders appear to have limited knowledge on the traditional uses of the species that they sell. Traders also claim that there is a declining demand for reptiles, which is why some of them prefer to keep the animals alive and have fresh material available for when customers (usually traditional healers) do request them. However, trade in animals is mostly illegal and traders routinely store species out of sight. It is thus possible, in addition to there being a limited urban demand in the markets, that our survey did not document the full extent of the domestic trade.

With these caveats in mind, our findings suggest that trade of reptiles via the markets in Maputo is unlikely to have any significant conservation consequences for the species concerned. However, we believe that the ethnoherpetological trade between Mozambique and South Africa is active, especially to the large urban traditional medicine markets in Johannesburg and Durban where there are more than 60 traders (some of them Mozambican) in each market selling animal products. Consequently, it is likely that, while the domestic market in Maputo is quite small, consumption in the rural areas and the international trade are having a larger impact and that warrants further investigation, possibly from the South African end of the supply chain.

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Authors' contributions

Design and planning was carried out by T.J.M. and V.L.W. The market survey was carried out by T.J.M. Species were identified by G.J.A. V.L.W., T.J.M. and G.J.A. wrote the manuscript. All authors read and approved the manuscript.

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