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Exploring the Africa-Asia Trade Nexus for Endangered Wildlife Used in Traditional Asian Medicine: Interviews With Traders in South Africa and Vietnam

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Abstract

Many species in Southeast Asia have been over-hunted to supply the demand for Traditional Asian Medicine (TAM) ingredients. As access to their parts become more difficult, consumer's demand is shifting to novel substitutes. Accurate estimation of the level of illegal wildlife trade is therefore important to ensure long term sustainability. The primary aim of this study is to provide an understanding of the current illegal wildlife trade market for TAM purposes in South Africa. The secondary aim is to explore the possibility of applying different survey methods in detecting the trade in endangered wildlife parts. As the number of criminal's wildlife of Vietnamese origin has increased in South Africa in recent decades, we surveyed 183 traditional medicine shops in both South Africa and Vietnam between April – August 2017, using direct observation and sensitive questioning techniques to estimate the magnitude of the wildlife trade for TAM purposes. Our results show that the Randomise Response Technique resulted in highest prevalence estimates for the trade in wild animal parts, while False Consensus Bias does not appear to be effective in this study. It is clear that wild animal parts are not only being trafficked from Africa to Asia for TAM use, but Asian originated products such as bear parts might also be smuggled into South Africa for domestic consumption. We recommend that improving wildlife law enforcement and providing protection for non-native species in domestic legislation in both South Africa and Vietnam is required to ensure the survival of these species.

Keywords

consumption, demand, diaspora, immigrants, illegal wildlife trade, muthi, wildlife traders, traditional medicine practitioners

The consumption of endangered animal parts for Traditional Asian Medicine (TAM) has been identified as one of the main drivers for wildlife trafficking globally (Craig et al., 2009). The variety of wildlife products used in TAM is extensive and includes many species that have been designated as threatened by the IUCN Red List (Gratwicke et al., 2008; Nowell et al., 2011; Wasser & Jiao, 2010). Species in Southeast Asia that have been extirpated from the vast majority of their former range due to over-hunting to supply the demand for TAM ingredients include the Indochinese tiger (Stoner & Perushina, 2013), the Sumatran and Javan rhinos (Brook et al., 2014; Kretzschmar et al., 2016). Vietnam has long been identified as a major consumer market for wildlife and wildlife products, and in recent years there has been a sharp increase in the volume of shipments from Africa being seized, particularly African rhino horn and pangolin scales (Heinrich et al., 2016; Nguyen et al., 2018). As access to their parts become more difficult, due to increased rarity and expense or improved law enforcement, consumer's demand is shifting to novel alternatives, as seen by the increase in lion

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bone being traded from Africa to Asia as a substitute for farmed tiger bone (Williams et al., 2017), and the poaching of African rhinos to satisfy an increase in demand for rhino horn in Vietnam and China where rhinos are now extirpated (Brook et al., 2014; Milliken & Shaw, 2012).

China's ambitious and visionary Belt and Road Initiative (BRI) involves an estimated USD4 trillion worth of infrastructure investment in 65 countries along the former Silk Road - an ancient trade route - linking it with a network of countries in Europe, Asia and Africa (Tambo et al., 2019). However, the potential impact of the BRI on biodiversity cannot be overestimated (Hughes, 2019; Lechner et al., 2018; Sutherland et al., 2019). Chinese migrants, expatriates and tourists have been documented to have an impact on the growth of the local wildlife trade markets in a number of countries in Africa (Brennan & Kalsi, 2015), as well as in Southeast Asia (Lao PDR: Livingstone et al., 2018; Krishnasamy et al., 2018; Myanmar: Nijman & Shepherd, 2014; Nijman et al., 2016 and Cambodia: Nguyen & Frechette, 2017). Increased connectivity with the Chinese market through Chinese nationals being present as tourists or through business and development projects, as part of the BRI, could therefore result in an expanded trade in wildlife. Special Economic Zones (SEZs) are geographical areas that have economic laws different from a country's typical economic laws, with the goal of increasing foreign investment and boosting the country's gross domestic production (Akeredolu, 2018). In the Southeast Asian region, the Chinese-run Golden Triangle SEZ in Northern Lao PDR has been identified as a wildlife trade hub, where parts of highly threatened species, such as bear (Ursidae) and tiger (*Panthera tigris*), are being sold openly to consumers as luxury products and as ingredients for Traditional Asian Medicine (TAM) (Krishnasamy et al., 2018; Tan, 2012). In recent years, China has become South Africa's largest trading partner (Mona, 2018), with 7 SEZs established since 2007, with plans to create a further 6 SEZs in the coming years (The Minister of Trade and Industry, 2019). The establishment of SEZs across Africa and especially in South Africa, with high numbers of workers from China and Southeast Asia, may therefore pose a serious threat to the local African wildlife.

Direct observation is often used to detect frequencies of wild animal parts being sold illegally in the market (Nguyen & Frechette, 2017; Nijman & Shepherd, 2015). However, detectability should be considered, as illegal products might not always be visible at the counter, and sales may become more covert over time (Barber-Meyer, 2010). Interview surveys therefore provide a useful method to complement direct observations. A number of methods have been developed to allow researchers to ask questions around sensitive topics. These methods provide respondents with additional privacy, as the truthfulness of the answers is unknown to the interviewer, thereby reducing response bias (St John et al., 2012). This is achieved by using a randomising device (e.g. a die) to integrate an element of probability in the question-answer process (Lensvelt-Mulders et al., 2005). These methods include the Randomised Response Technique (RRT) (Hejri et al., 2013), crosswise (Jann et al., 2012; Korndorfer et al., 2014), horizontal and parallel (Liu & Tian, 2014). RRT in particular has been widely use, including in the estimation of prevalence in illegal product usage (St John et al., 2012; 2015). Other methods do not require participants to use a randomising device, these include the Unmatched Count Technique (UCT) and False Consensus Bias (FCB); these have also been successfully applied to address conservation questions (Davis et al., 2019; Nuno et al., 2013; St John et al., 2012). FCB operates on a theory that people who conduct certain behaviours tend to believe that others are more likely to behave in the same manner, therefore the respondents give a higher estimation of the population involved in such behaviour (Ross et al., 1977).

Here we aim to provide an understanding of the status and scale of wild animal parts trade in TAM, specifically the available African wildlife parts used as substitutes in TAM, and the involvement of Asian traders in the local African wildlife trade markets. In addition, we aim to evaluate the interview survey techniques by comparison to the direct observations. We surveyed local African wildlife markets, Traditional South African Medicine (*muthi*) shops and TAM shops in South Africa, as well as TAM shops in Vietnam to compare different types of wildlife parts being sold in both markets, their origin and the use of these parts in TAM.

Methodology

The study received ethical approval from the Research and Ethics Committee of the School of Anthropology and Conservation, University of Kent. Participants remain anonymous, their names and details were not recorded.

Study Site

Market surveys in South Africa were conducted in Cape Town, Durban, Johannesburg and Pretoria (Figure 1). These locations were chosen as they are known to have large communities of Asian origin (Park & Rugunanan, 2009) and also some of the largest wholesale and retail markets for traditional medicine in South Africa (i.e. Warwick market in Durban, Faraday and Kwa-MaiMai market in Johannesburg) (Williams et al., 2011).

In Vietnam, surveys were conducted at TAM shops and clinics in Hanoi and Ho Chi Minh City, the two

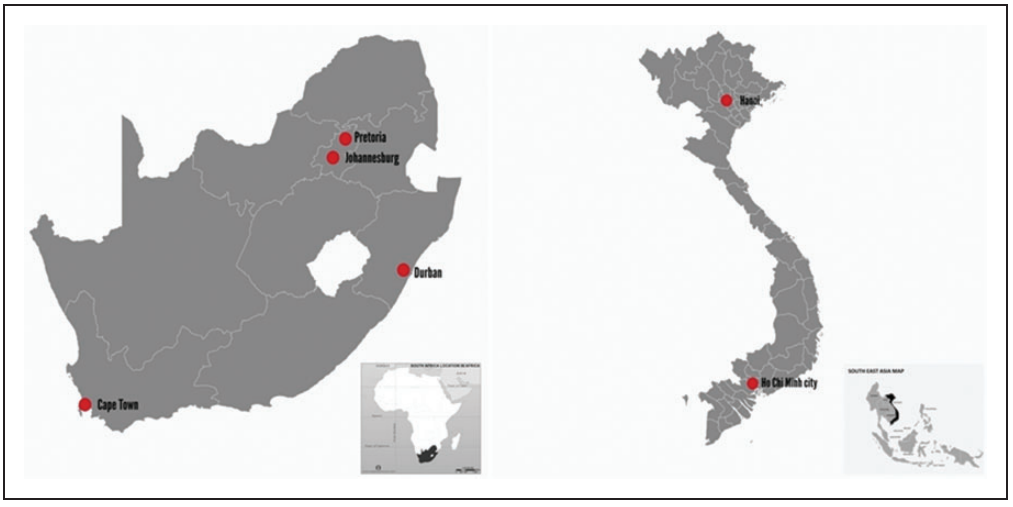

Figure 1. Location of Study Sites (red circles). South Africa, specifically Johannesburg, Pretoria, Durban and Cape Town, and Vietnam specifically Hanoi and Ho Chi Minh City.

largest cities in the country with a high rate of wildlife consumption (Davis et al., 2020; Drury, 2011). TAM shops and clinics were identified through a systematic survey in these cities.

Survey Method

Market surveys were conducted in South Africa between 10th April and 30th October 2017 and in Vietnam between 20th September and 8th October 2017. In South Africa, all TAM shops, clinics, pharmacies, massage therapies and local wildlife markets selling ingredients for traditional medicines were surveyed at the four chosen cities by the author (TN), accompanied by a local assistant. Due to the linguistic diversity of South Africa, at least one assistant fluent in isiZulu or Khoisan was always present at the market survey. Similarly, at least one assistant fluent in Mandarin or Cantonese was present at every interview with Chinese traders and practitioners in South Africa.

In Vietnam, TAM clinics, shops and pharmacies were surveyed in Hanoi and Ho Chi Minh City with the support of Vietnamese staff and volunteers of a local conservation NGO (WildAct) experienced in wildlife trade research. Each survey was carried out by pairs of interviewers to minimise risk and fatigue. In Vietnam, all surveys were conducted in Vietnamese. Prior to each interview, participants were given an oral consent form in English, isiZulu, Khoisan, Mandarin, Cantonese or Vietnamese.

Direct Observation

Direct observations were carried out prior to the interview. Data were recorded on the number of ingredients, such as wildlife parts, derivatives and products (such as pills, paste or powdered items), especially those from rhino, tiger, lion, pangolin and bear, as they are known to be endangered but are also popular wild animals used in TAM (Ellis, 2005). Animal taxa were recorded as stated by vendors and confirmed visually by the author (TN) where possible. Pictures were taken of unidentified parts with consent from vendors and sent to South African wildlife experts to seek further advice on identification. It is not possible to easily distinguish visually between the bones of lions and tigers, or between the gallbladders of bears and other similarly sized mammals such as pigs. Information was recorded as advertised by the traders and practitioners.

We recorded demographic details of the shop owners such as gender, age and education level. The retail prices stated in this research are the asking prices. In South Africa, prices were stated in South African Rand, and in Vietnam it was recorded in Vietnamese Dong. Prices were then converted into USD using the online exchange rates of Oanda (oanda.com) (1 USD = 14.070 South African Rand on 10th April 2017; 1 USD = 22.467 VND on 20th September 2017).

Interview Surveys

Prior to the survey, the interviewers introduced themselves as a PhD student (and/or assistants of the student) from the University of Kent and that they would like to ask the potential interviewee some general questions about the use and trade of wild animal parts in traditional medicine. Potential interviewees were told that their participation was voluntary and they can refuse to answer any questions or stop the interview at any time if they feel uncomfortable. The interviewees were asked questions about their demographic, followed by FCB, RRT and finally direct questions (see supporting

documents). In average, the interview took 40 – 50 minutes to complete.

In the FCB section, respondents were asked to estimate how many individuals among the people they know have been selling wild animal parts for traditional medicine purposes over the last 2 years. They were given ten categories to choose from (see Supporting documents).

In the RRT section, participants were asked closed end questions on whether they have traded pangolin, lion, tiger, rhino and bear parts over the last 2 years. Participants were provided with a dice as a randomising tool; the dice had one green side, one red side and four blank sides. Participants were instructed to shake the dice in a cup to hide results from the interviewers and answer accordingly to the result of the dice roll. For example, if the dice came up red, participants will always say "no" as an answer and if the dice came up green, they will always say "yes". If the dice was blank, they should answer the question truthfully. Three trial questions on non-sensitive behaviours were conducted with the respondents to ensure they understood the method (see St John et al., 2012).

In addition, direct questions (DQ) about sensitive behaviours were asked at the end of the survey. This result was used as a baseline to compare with estimation obtained from direct observation, FCB and RRT.

Analysis

Data collected were coded and statistically analysed using the R 3.4.4 software program (R Core Team, 2017). Chi-square tests were used for comparison between differences of gender, ages and ethical groups, the Bonferroni correction method is used to compensate for errors from multiple testing.

One-way ANOVA were used to test the difference in number of ingredients found as we expect there will be differences between *muthi*, TAM shops in South Africa and Asian owners. Samples were, therefore, grouped in to African *muthi* shop, TAM shops in South Africa and TAM shops in Vietnam. Due to the small sample size from the TAM shops in South Africa, it was grouped as one with TAM shops in Vietnam for this analysis. Results are significantly different if the p value is less than 0.05 (Fisher & Paediatr, 1950).

In addition, multidimensional scaling (MDS) technique was also used to analyse the market survey data. This technique uses similarities or dissimilarities between different variables in a data set as input. The similarity number indicates how similar variables are in term of relatedness. Similar variables, therefore, will appear closely in the map produced by MDS. In this study, value of all 17 species detected through direct observation across 183 shops were inputted for MDS analysis. K-means clustering was applied separating species of wildlife into two distinct groups.

Data from RRT was analysed by using a formula adopted from previous research (St John et al., 2012):

$$\pi = \frac{(\lambda - \theta)}{s}$$

where π is the estimated proportion of the respondents that have consumed the specified wildlife parts as TAM, λ is the proportion of all answers that are "yes", θ is the probability of the answer being a prescribed 'yes', and s is the probability of being asked to answer the question truthfully. The 95% confidence intervals were calculated for FCB and RRT from 10,000 bootstraps (St. John et al., 2010).

To analyse data obtained from FCB method, we counted the amount each category was chosen by respondents. The category that was chosen the most by respondents is used as the prevalent estimation. Respondents were also separated into users and non-users groups and FCB responses between groups were compared using Chi-squared test. This allowed us to explore if the prevalence of behaviour is higher among those who admitted having sold protected wild animal parts in comparison to those who have not.

Results

Socio-Demographic Structure of Respondents

A total of 183 *muthi* and TAM shops in both South Africa and Vietnam were surveyed. 55.2% from African *muthi* clinics/shops (n = 101), 15.8% from TAM clinics/shops in South Africa (as 97.1% were of Asian origin, hereafter Asian) (n = 29) and 29.0% from Vietnamese TAM clinics/shops in Vietnam (n = 53). See demographic information of the respondents summarised in Table 1. African respondents were more likely to participate in an interview, refusal rate 1:5.5, while refusal rate of Asians in Africa was 1:3 and in Vietnam 1:1.5.

More women were working in TAM shops than *muthi* shops, with 57.3% (n = 47 out of 82) at TAM shops compared to 21.8% (n = 22 out of 101) in *muthi* shops. A significant difference was detected between *muthi* and TAM traders regarding their financial dependence on trading wildlife parts as traditional medicine ingredients ($\chi^2 = 160.274$, df = 1, $p < 0.001$). All African *muthi* traders and practitioners stated that selling wildlife parts was their main income (100%), whereas only 32.9% of Asian and Vietnamese traders/practitioners reported this.

Table 1. Demographic Information of Respondents From Traditional South African medicine (*Muthi*), Traditional Asian Medicine (TAM) Shops in South Africa and TAM Shops in Vietnam.

	Muthi shop	TAM shops in South Africa	TAM shops in Vietnam
Gender			
Male	78.2% (n = 79)	43.4% (n = 12)	47.6% (n = 25)
Female	21.8 % (n = 22)	58.6% (n = 17)	52.8% (n = 28)
Age Average Range			
	43.1	47.2	39.5
	21–79	30–78	17–70
Education Common highest:			
	Secondary school n = 42	Secondary school n = 10	College/university n = 53

Figure 2. Examples of Wildlife Products Found During The Survey. (a): Pangolin scales and skeleton at Warwick market, Durban, South Africa. (b): Dried bear bile found at Chinatown, Johannesburg, South Africa. (c): Bear bile for sale in Hanoi, Vietnam. (d): Cooked tiger balm found in Ho Chi Minh City.

Status and Magnitude of the Market

A total of 219 incidents of trade in the five focus species was observed from 183 of the surveyed shops (Figure 2). The most common observed violation was the sale of pangolin parts (n = 95, 51.9%), followed by lions (n = 57, 31.1%). Observations of bear parts (n = 42, 23.0%) and tigers (n = 19, 10.4%) were only found at TAM shops. Rhino horn was the least observed product; however, they were found for sale in all shop types (n = 6, 3.3%).

There was a significant difference in the personal income of Asian and Vietnamese traders/practitioners and *muthi* trader ($\chi^2 = 68.136$, df = 2, p = 0.001). 37.8% (n = 31) of Asian and Vietnamese traders earned more than 1000 USD/month compared to only 0.9% (n = 1) of *muthi* traders. There was also a significant difference between the frequency of restocking between TAM and

muthi shops, with a majority (62.2%) of Asian and Vietnamese traders restocking every 2 – 6 months, while a majority (60.4%) of African traders restock after more than 6 months ($\chi^2 = 19.051$, df = 2, p = 0.001).

Interview surveys showed that within the *muthi* respondents, RRT consistently produced higher prevalence estimates for the trade of all 5 focus species in comparison to direct question (DQ) and FCB. These patterns were also found at TAM shops in South Africa and Vietnam, with highest estimations yielded from RRT for all 5 focused species (Figure 3). There were significant differences between RRT and DQ amongst TAM respondents in South Africa and Vietnam regarding pangolin parts, but no difference was found for *muthi* respondents. Prevalence estimates obtained from RRT was significantly higher than DQ for lion parts amongst *muthi* and TAM respondents in Vietnam, however no difference was found for TAM respondents in South Africa.

For rhino horn, prevalence estimations were statistically higher than DQ across all three groups. RRT estimations were also significantly higher for bear parts amongst TAM South Africa and Vietnam. This pattern was also found for tiger parts in Vietnam, however confidence intervals overlapped between RRT and DQ regarding products from tiger within TAM respondents in South Africa. Amongst the *muthi* respondents, RRT confidence intervals overlapped between pangolin and

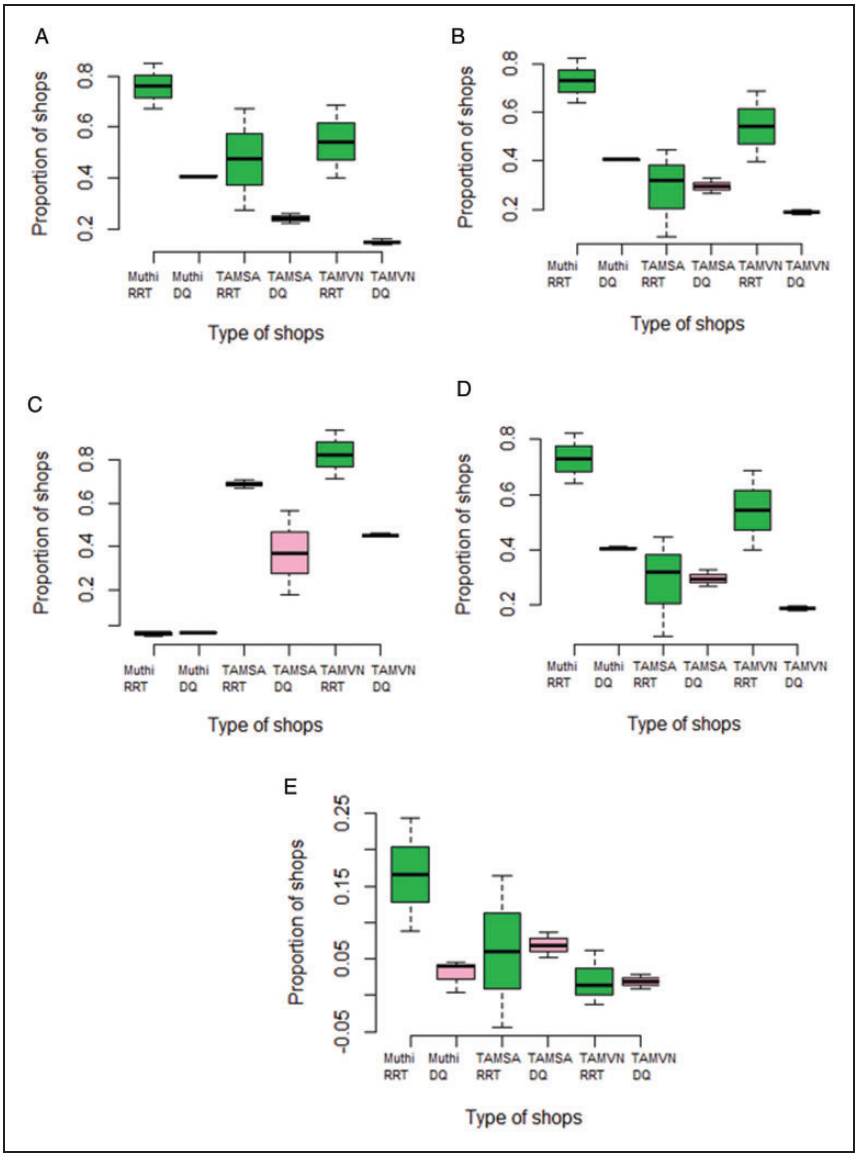

Figure 3. Estimated Proportion of Show Selling (a) pangolin, (b) Lion, (c) Bear, (d) Tiger and (e) Rhino Products Based on the Randomise Response Technique (RRT) (green bars) and Direct Questioning (DQ) (pink bars) for Traditional South African Medicine Shops (*muthi*), Traditional Asian Medicine Shops in South Africa (TAMSA) and Traditional Asian Medicine shops in Vietnam (TAMVN).

lion parts, but significantly differed for rhino horn. Products from pangolin were significantly different to lions, bears and rhinos amongst TAM South Africa respondents, however bears and tigers did not differ. In the TAM Vietnam group, prevalence estimations obtained from RRT were significantly different across all 5 species. It is important to note that products from lion and tigers yielded an almost identical results, suggesting that there could be a mistaken identity of these products.

Estimations from FCB are illustrated in Figure 4. Estimates for prevalence in the trade of all 5 products fell within the category 0–10%. No significant difference was found between the traders and non-traders of products from pangolin ($\chi^2 = 5.956$, df = 9, p = 0.744); lion ($\chi^2 = 5.368$, df = 10, p = 0.865) and rhino ($\chi^2 = 1.035$, df = 4, p = 0.940). Bear and tiger parts were not analysed as respondents self-reported that they did not sell these two products in their shops within the *muthi* group. These animal parts were also not detected through the market survey.

Tests of the hypotheses were conducted using Bonferroni adjusted alpha levels of 0.01 per test (0.05/5). Results indicated no significant difference was found between traders and non-traders within the TAM group in South Africa for pangolin parts ($\chi^2 = 10.427$, df = 4, p = 0.034), lions ($\chi^2 = 3.538$, df = 3, p = 0.316), bears ($\chi^2 = 0.884$, df = 3, p = 0.829), tigers ($\chi^2 = 0.042$, df = 3, p = 0.998) or rhino ($\chi^2 = 5.368$, df = 10, p = 0.865). In Vietnam, significant differences were also not found between traders and non-traders for products from pangolin ($\chi^2 = 13.756$, df = 7, p = 0.056), lion ($\chi^2 = 1.336$, df = 2, p = 0.513), bear ($\chi^2 = 3.128$, df = 4, p = 0.537), tiger ($\chi^2 = 10.244$, df = 8, p = 0.248) and rhino ($\chi^2 = 0.298$, df = 2, p = 0.861).

Substitution

There was a significant difference between the type of cheapest ingredients nominated by traders across locations ($\chi^2 = 16.696$, df = 2, p = 0.001). In both *muthi* and TAM shops, plants tended to be cheaper than animal parts, however there were more animal parts named as cheapest ingredients in *muthi* shop (mean price = 0.74$, median price = 0.52$) than in TAM shops in both South Africa (mean price = 8.56$, median price = 7.03$) and Vietnam (mean price = 6.32$, median price = 5.11$). In general, prices of wild animal parts offered at *muthi* shops were significantly cheaper than those at TAM shops in South Africa and Vietnam (U = 2128.000, p = 0.024).

Most animal parts in South Africa offered at surveyed *muthi* shops came from local sources (54.5%), with 45.5% originating in other African countries as cited by respondents. None were imported from another continent. However, TAM shops in South Africa and Vietnam reported importing products containing wildlife parts from Asia and other African countries (34.2% and 4.8% respectively). For example, bear bile and bear gallbladders were found during this survey in TAM shops in South Africa, while lion balm (cooked lion bone) were found in 2 TAM shops in Vietnam. In addition, 3 TAM shops in Vietnam falsely advertised that it is legal to harvest tiger bone in Thailand and that they have imported tiger balm from there.

The Trade in Wild Animal Parts for Medicine

The use of 5 focal animal species was recorded throughout the surveys in both South Africa and Vietnam (Table 2). Significant difference recorded at Bonferroni adjusted alpha levels of 0.01 per test (0.05/5). Amongst these species, there was a significant difference in the number of shops trading pangolin scales in *muthi* and TAM shops ($\chi^2 = 19.719$, df = 2, p < 0.001). Pangolin scales were most frequently found in *muthi* shops (59.4%, n = 60), compared with TAM shops in South Africa (13.8%, n = 4) and TAM shops in Vietnam (58.5%, n = 31). Rhino horn was also found for sale in all three locations; however, it was rare; *muthi* shops (3.0%, n = 3), TAM shops in South Africa (3.4%, n = 1) and Vietnam (3.7%, n = 2). There was a significant difference between locations of lion product found ($\chi^2 = 39.374$, df = 2, p < 0.001), with the largest number of *muthi* shops selling lion products in South Africa (50.5%, n = 51), followed by 7.5% (n = 4) TAM shops in South Africa and TAM shops in Vietnam (6.9%, n = 2). Tiger bone were only found at TAM shops in South Africa (27.6%, n = 8) and Vietnam (20.8%, n = 11). There was no significant difference in the number of shops found with these products ($\chi^2 = 0.491$, df = 2, p = 0.483). Significant differences were found between the number of shops trading in bear products (bile and gall bladder) ($\chi^2 = 27.330$, df = 2, p < 0.001) with 13.8% (n = 4) in South Africa and 74.50% (n = 38) in Vietnam.

TAM shops had wider variation in the forms of ingredients offered than *muthi* shops ($\chi^2 = 139.630$, df = 1, p = 0.001). For example, wild animal parts found in *muthi* shops were mostly stored as dried and powdered form. However, TAM shops in South Africa and Vietnam processed animal parts in various forms: dried raw products (100%, n = 82), boiled liquid ready to consume (14.6%, n = 12), mixture of powdered animal parts and herbs with honey in a paste (13.4%, n = 11), pills (47.6%, n = 39) and "glue" or "balm" (8.5%, n = 7).

Results from MDS are illustrated in Figure 5. Two distinct clusters were identified, cluster 1 includes wild animal that are commonly found at TAM shops (deer, tiger, bear, saiga, shark and seal) and cluster 2 includes

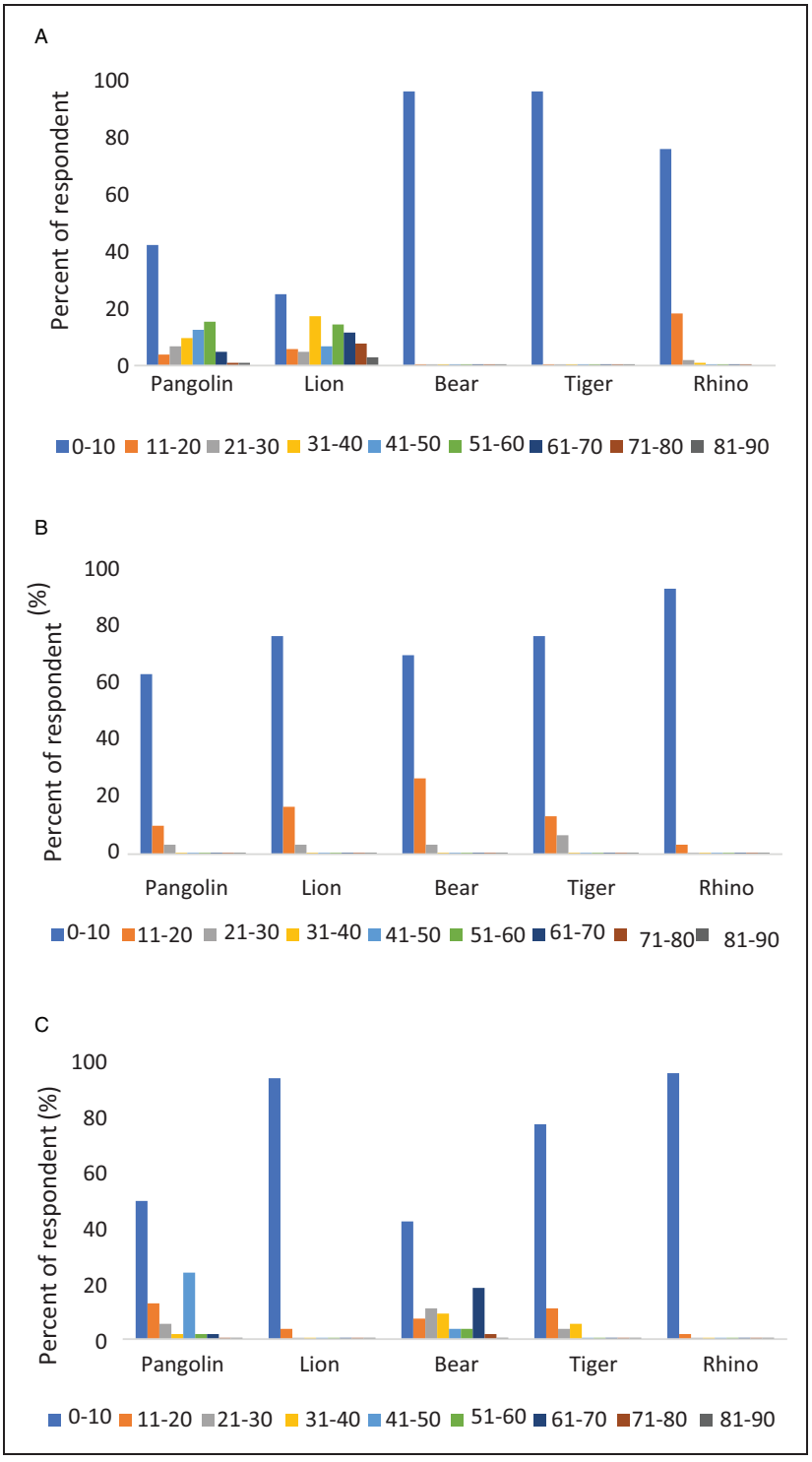

Figure 4. Estimated Frequency of Traders in Wildlife Products (i.e. Pangolin, Tiger, Bear, Lion and Rhino) by Respondents Using False Consensus Bias, for (a) Traditional South African Medicine (*muthi*) shops (n = 101), (b) Traditional Asian Medicine (TAM) Shops in South Africa (n = 29) and (c) TAM Shops in Vietnam (n = 53). Respondents chose one of 10 different categories, from 0% to 100%.

the rest. It is worth noting that there were overlaps between some species, such as tiger and bear, lion and avian, elephant and giraffe. The goodness-of-fit values was a good fit, at 0.8767543 0.8767543.

Discussion

This research is the first in-depth study into the trade of wild animal parts for traditional medicine consumption

Table 2. Number of Wild Animal Parts and Products One Sale at Traditional African Medicine (*Muthi*) Shops (n = 101) and Traditional Asian Medicine (TAM) Shops in South Africa (n = 29) and Vietnam (n = 53) for Five Focal Species (i.e. Pangolin, Tiger, Bear, Lion and Rhino).

Species	*Muthi*	TAM SA	TAM Vietnam
Rhino	3	1	2
Pangolin	4431	21	152
Tiger	0	31	55
Lion	1168	68	15
Bear	0	31	388

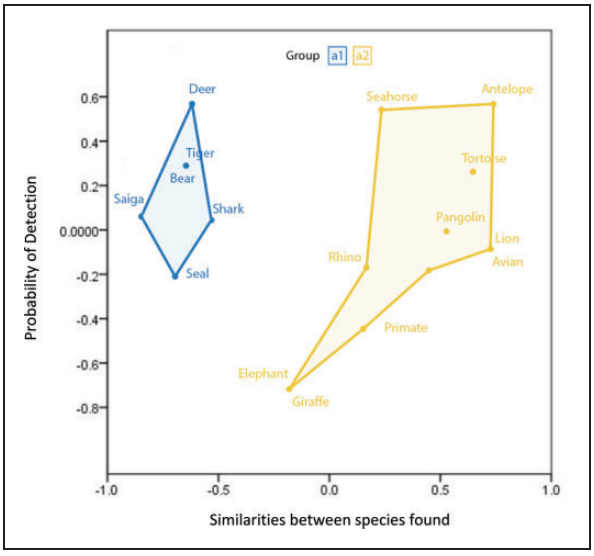

Figure 5. A Two-dimensional Multidimensional Scaling of Parts From 17 Wild Animals Found at 183 Traditional South African Medicine (*Muthi*) and Traditional Asian Medicine (TAM) Shops in South Africa and Vietnam. Group (a1) refers to wild animals found in TAM and group (a2) refers to those found in *muthi* shops.

in both South Africa and Vietnam. By comparing product availability in the three sample groups (*muthi* shops and TAM shops in South Africa, and TAM shops in Vietnam), we gained a knowledge of the use of wild animal parts in both countries and provide an understanding of the complex illegal trade between Africa and Asia. The results enable us to understand the market characteristics and identify target groups for future conservation initiatives.

Comparison of Trade Between Africa and Asia

Regarded as the most trafficked mammals in the world, the trade of pangolin parts is estimated to account for 20% of all illegal wildlife trade (Heinrich et al., 2016). In our survey, pangolin scales were the most frequently traded wild animal products found in both South Africa and Vietnam. Pangolin scales were offered in different forms: at the *muthi* market, they were sold as individual scales and the prices varied from 20 Rands (1.37 USD) to 60 Rands (4.12 USD), depending on their sizes. At TAM shops in South Africa and Vietnam, pangolin scales were often found as processed products, either ground up and mixed with other types of herbs as a prescription for illness, or made into commercialised products, such as pills, paste and liquor.

Amongst the most frequently observed commercialised products found at TAM shops in South Africa were pangolin scales and tortoise shells that have been ground into powder or made into tablets. These tablets had a long list of applications, including the treatment of eczema, acne, scabbing, skin allergic reactions, and genital infection. In Vietnam, pangolin scales labelled under the name "*xuyên sơn giáp*" as an ingredient for commercialised cough syrup have been advertised widely on the internet and television. This product can also be found at modern (or western) pharmacists across the country. It is noteworthy that these products, manufactured in Asia, were also found at 3 different TAM shops across South Africa, indicating that there is a demand for TAM products containing pangolin scales within the domestic market in this country.

In Vietnam, two TAM shops with lion balm were found in Hanoi and Ho Chi Minh City. Tiger bone products, such as tiger bone marinated rice wine, tiger balm (slow cooked bone into hard, gluey paste) and pills advertised to contain tiger bone as an ingredient were found at 8 TAM shops across South Africa. In addition, four TAM shops were found in Johannesburg and Pretoria, South Africa, with a dried bear gallbladder and bear bile products. According to the label, bear bile products were manufactured by the Chinese company Guizhentang Pharmaceutical. This indicates that, in addition to threatened wild animal parts being smuggled from Africa to Asia for consumption (Challender & Hywood, 2012; Heinrich et al., 2016; Pietersen et al., 2014), processed wild animal parts as TAM are potentially being trafficked into South Africa for domestic use.

It is important to note that all pangolins species, rhino, tigers and bears are listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix I, and therefore the international commercial trade in parts and derivatives is prohibited. Although domestic trade in farmed bear bile is legal in China (Crudge et al., 2019), and there may not be a law in South Africa prohibiting sale of this non-native taxa, it remains largely illegal to import or export this product for commercial purposes.

Although the frequency at which rhino horn was found on display at *muthi* and TAM shops in both South Africa and Vietnam was low, the presence of this product indicates there is demand for rhino horn

as an ingredient for traditional medicine usage in both countries and practices. The low number of shops found with rhino horn could be due to the increased sensitivity of the issues, and therefore rhino horn may not be on open display, but rather off display elsewhere and only offered to trusted buyers.

The distinct clusters on MDS map showed that there are significant differences in species found between *muthi* and TAM shops. In this study, MDS perceived similarities between species showing a distinct order based on probability of detection. As expected, products of Asian origin and products exclusively found in TAM shops, such as saiga, tiger and bear parts are grouped into one cluster. While those that are found in both *muthi* and TAM shops appeared together in another cluster. Elephant and giraffe parts, which were only detected at *muthi* shops, appeared separately, but closer to the latter cluster. There were overlaps between detections of products from bear and tiger, elephant and giraffe, as well as lion and birds. These overlaps suggest that shops offering one product such as bear parts are also likely to sell the other products (i.e. tiger parts). The overlap between lion and birds is curious and maybe explained by the use of bird and lion parts in *muthi* practices (Whiting et al., 2013).

Our survey results also indicated there is a significant difference in prices of wild animal products for sale at *muthi* shops and TAM shops in both South Africa and Vietnam. One of the reasons for this could be because wildlife parts at *muthi* shops were often sold as raw ingredients, whereas TAM shops processed their products into a more convenient form to consume, such as pills, liquors and paste. In addition, Asian originated products, such as bear bile and gall bladder, are likely to have been smuggled into South Africa as the species are not native to the country. The prices of TAM products, therefore, tends to be higher than those from *muthi* shops.

Poverty, Livelihoods and the Chinese Influence

China has been cultivating relationships with various developing regions of the world (Hughes, 2019; Lechner et al., 2018). In Africa, China's policy aims to secure natural resources and consumer markets, and to establish China's status as a leader in the developing world (Duggan, 2014). China's phenomenal economic growth resulted in a mounting need for energy and raw materials to fuel the Chinese economy, and a subsequent need for markets in which to sell Chinese products (Chen & Duggan, 2016). From 2009 to 2011, the total volume of Chinese African trade reached almost USD200 billion. Within this period, China's export to Africa accounted for USD85 billion, while China's imports from Africa accounted for USD113 billion.

An increased flow of capital and visitors from China has been linked to increased trade in wildlife products in Southeast Asia (Krishnasamy et al., 2018; Livingstone et al., 2018; Nguyen & Frechette, 2017). In 2013, Chinese arrivals, including those from Hong Kong, to South Africa reached 151,847 individuals, representing a 14.7% increase over the previous year. In 2014, China also became a core market for South Africa along with the United States, the United Kingdom, Germany and India (Chen & Duggan, 2016). In order to maximize economic benefits for African countries, local African tour operators need to learn Chinese language and culture, as well as to understand preferences and behaviours (Kings, 2014). In addition, the establishment of BRI and SEZs pose a potential threat to the African wildlife through increasing the Chinese consumer population and transmitting cultural practices to the local populace. The consumption of wildlife products through TAM practice has been shown to spread to the local African peoples (Nguyen & Robert, 2020).

The illegal trade of wildlife has long been associated with rural poverty and the growth of wealth in consumer groups (Atuo et al., 2015; Brashares et al., 2011; Challender & MacMillan, 2014). Poverty may be the driver amongst the *muthi* traders/practitioners' group in trading threatened wildlife parts, with the majority (85.1%) being in the low-income class, earning less than 6000 Rands/month (412 USD). However, our results showed that TAM traders/practitioners in South Africa and Vietnam were not under the same financial pressure, with 37.8% having incomes above 1000 USD; amongst the middle-high income class in both South Africa and Vietnam (General Statistic Office of Vietnam, 2018; Visagie, 2013). While all *muthi* respondents working at *muthi* shops stated it is their main income, only 32.9% of TAM respondents in both South Africa and Vietnam depend solely on income from TAM. As noted previously, it appears *muthi* traders are being coerced by Chinese buyers to provide illegal wildlife products to satisfy the demand for TAM.

The Application of Different Methods to Detect Wildlife Trade

We compared specialised questioning techniques, direct questioning and observations to detect wildlife trade. In general, RRT yielded the highest estimations of wild animal products being sold in the market in compared to FCB and DQ. Significant differences between RRT and DQ showed that overall, the trade of all 5 species were considered as sensitive by *muthi*, TAM South Africa and TAM Vietnam traders. *Muthi* traders had the highest prevalence estimates for pangolin, lion and rhino parts, which may be expected based on the availability of these products in South Africa, as well as their

use in *muthi* practices (Whiting et al., 2013). Significant differences in the estimates for trade in tiger and bear parts between TAM in South Africa and Vietnam could be explained by the availability of these products (i.e. bear parts are more available in Vietnam than South Africa). The high prevalence of tiger products in South Africa could be due to the overlap with lion products and/or South African domestic regulation is not yet in place to protect the trade in tiger parts. As such tiger parts could be being traded more frequently in South Africa than Vietnam. In addition, results show a similarity between lion and tiger products, this is more likely due to the mistaken identity of these two products, as lion parts are being used as alternative for tigers.

FCB estimations for the trade of all five species were very low (0–10%), which is lower than DQ for pangolin, lion, bear and tiger. Significant differences in respondents' estimations using FCB was not detected between users and non-users, suggesting the prevalence of behaviour is not higher among those who admitted selling protected wild animal parts in comparison to those who have not in this study. While it could be that the trade in these species is rare, there is the possibility that traders intentionally provided a lower estimate so as to give an impression that the products are rare and exclusive to their shop. FCB appears not to be successful under this scenario.

Overall, our results show that endangered wildlife parts are being traded for TAM purposes in South Africa and Vietnam, both domestically and internationally. The trade of Asian originated species, such as tiger and bear are much higher than one may expect in South Africa. In this study, RRT was successfully applied in both South Africa and Vietnam. However, FCB did not appear to be effective in estimating prevalence of wild animal parts trade. In addition, future studies should explore the application of other SQTs, such as the ballot box method (Bova et al., 2018; Nuno et al., 2013) in estimating the prevalence of wildlife trafficking, in particular those that have yet to be tested in the field. In this study, SQTs show a higher rate of detecting wildlife parts in comparison to direct observation.

Implications for Conservation

This study highlights the need to develop effective methods for detecting and monitoring illegal wildlife trade. Monitoring of the trade requires a suite of complementary approaches, as trade may become more covert over time, it is important not to rely solely on direct observations or direct questioning. Although it may take time to redress legislative weaknesses that exist in terms of enforcing protection of non-native species, customs and border agencies should record and report all suspected cases of wildlife trafficking, and where possible instances where no punitive action has been taken.

Threatened wildlife parts are not only smuggled from Africa to Asia for consumption, but wildlife parts from Asia are being trafficked into Africa for domestic consumption or sale within Africa. Despite some laudable efforts, most notably anti-poaching and tighten security at airports and borders, South Africa's inability to better conserve its wildlife is partly driven by lack of resources and capacity to respond to the impacts of Chinese investment. Such investment needs to be matched by resources for mitigating impacts, including support for effective enforcement against illegal wildlife trade. The high level of wild animal parts for sale in South Africa presents a challenge for effective conservation management. Traditional African medicine is known for its use of wild animal parts, but the practice of TAM in this country may put more pressure on the fragile populations of protected species in the continent. In addition, improving wildlife law enforcement and providing protection for non-native species in domestic legislation in both South Africa and Vietnam is required to ensure the survival of these species.

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Supplemental material

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