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Reducing Pangolin Demand by Understanding Motivations for Human Consumption in Guangdong, China

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Pangolins are some of the most trafficked mammals in the world. China is a major destination country for illegal wildlife trade and Guangdong Province is one of the areas of high domestic wildlife consumption. A willingness to consume lies at the root of the illegal wildlife trade. To understand the ideological roots of pangolin consumption, and to propose solutions, we conducted a consumption survey in 21 prefecture-level cities in Guangdong and have collected 1,957 valid questionnaires. In these questionnaires, 108 respondents (5.52%) who had consumed pangolin-related products, scales had been consumed by 61 respondents (3.12%), 58 respondents (2.96%) had consumed meat. We found that scale consumption was primarily motivated by disease treatment (80.43%). The main reason for meat consumption was accidental (44.83%), but among those who intentionally ate pangolin were motivated by curiosity (22.41%) or "showing off" (8.62%). Simultaneously, the respondents' future consumption willingness for medicinal purposes was more difficult to change than its use for other purposes. What's more, the public's insufficient understanding of the status of pangolins in China and weak legal awareness were potential reasons for pangolin consumption. In addition to classifying pangolins as Category I state-protected animals in China and strengthening penalties and enforcement, we recommend creating public awareness of the risk of zoonotic diseases, advocating for the use of alternative medicines in disease treatment and removing scales from ingredients in patented medicines, which will all act to reduce the demand for pangolins. We expect these actions to change public consumption behaviors and their collective understanding of pangolins, which improve pangolin protection efforts around the globe.

Keywords: wildlife trade, pangolin, consumption willingness, species conservation, Guangdong province

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INTRODUCTION

As economic globalization accelerates, the illegal wildlife trade expands (Chen, 2016). Although many different estimates of the worth of the illegal wildlife trade are cited in the literature, it has become one of the most profitable global illegal trades, with an annual value that can reach $20 billion (Chen, 2016; t Sas-Rolfes et al., 2019). Illegal trade is now one of the greatest threats to biodiversity (Zhang et al., 2015; Maxwell et al., 2016).

Pangolins, a group comprising eight species in the family Manidae (Pholidota, Mammalia), are heavily trafficked primarily for their perceived medicinal and edible value or their use as symbols of wealth and status (Zhou et al., 2014; Shairp et al., 2016). Their scales are considered a rare and precious material in Chinese herbal medicine, and their meat is considered highly nutritious (Wu et al., 2002). Heinrich et al. (2016) estimated 809,723 whole pangolins to be involved in the trade for the period between 1977 and 2014. The trade in pangolins is now recognized as the most significant impediment to their conservation, for both Asian and African species (Chaber et al., 2010; Zhang et al., 2017a). In 2019, the International Union for Conservation of Nature (IUCN) Species Survival Commission (SSC) reassessed the status of all pangolin species and classified the Sunda pangolin (*Manis javanica*), Chinese pangolin (*Manis pentadactyla*), and Philippine pangolin (*Manis culionensis*) as Critically Endangered (CR) (Challender et al., 2019a,b; Schoppe et al., 2019). As of January 2017, all eight pangolin species were upgraded from Appendix II to Appendix I in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), meaning that all international trade in wild-caught pangolins and their derivatives is prohibited (CITES, 2017).

Pangolins were once common in southern China, but their populations have been reduced by ∼90% since the 1960s due to over-harvesting (Wu et al., 2005; Zhang et al., 2008). Their low defense capacity, low birth rate, and poor survival lead to a slow population growth rate (Wang, 1998; Johnson, 2002). Thus, intensive harvesting and trafficking have caused dramatic reductions in the pangolin population. Habitat loss and fragmentation have also contributed to their decline. Since 2020, the management of wildlife resources has been strengthened, and penalties for trafficking have also been increased in China. On June 3, 2020, pangolins were upgraded from Category II to Category I state-protected animals in China.

Heinrich et al. (2017) stated that the illegal pangolin trade spanned 67 countries on six continents. China and the United States were the most common destinations, and China was the main destination for scales and whole individuals (Heinrich et al., 2016). China is implicated in many incidents reported in the media, as either a seizure or destination country (Challender et al., 2015; Heinrich et al., 2016). Guangdong Province is a key area for wildlife consumption in China and a major distribution center for pangolin smuggling and trade (Cheng et al., 2017; Guo et al., 2019). Over the 1960s, incomplete data from the Department of Medicinal Materials in Guangdong suggested that the annual capture of pangolin was more than 20,000 individuals (Wu et al., 2002), and Zhang et al. (2010) estimated exploitation in China to involve 150,000–160,000 pangolins annually around the 1960s. This likely increased through the 1990s as increased economic development led to a rise in the cost of and demand for pangolin scales and meat (Wu et al., 2005). Over time, the motivation for international trade in wild-caught specimens within their native ranges has shifted from obtaining a protein source to economic improvement (MacMillan and Nguyen, 2014; Nuwer and Bell, 2014). In the year following the prohibition of the pangolin trade in January 2017, at least six smuggling cases were uncovered in Guangdong, including 11.9 tons of scales seized in July 2017. This suggests that the trade and consumption of pangolins in Guangdong province remain prolific.

Ultimately, consumer demand is one of the root causes driving the illegal wildlife trade. Effective conservation of threatened species depends on a reduction in the use of these animals and their derived products by consumers (Schneider, 2008; Oldfield, 2014). Understanding consumer behavior and motivations is vital for the development of effective long-term campaigns that reduce wildlife consumption (Challender et al., 2014; Theng et al., 2018). Within China, efforts to reduce the consumption of native wild animals have focused on establishing a series of wildlife laws and regulatory systems. With the core value of wildlife protection, the People's Republic of China aims to gradually establish long-term mechanisms for wildlife protection through improved legislation and stronger law enforcement (Chen, 2016). However, these legal efforts have not been satisfactory when contrasted with the number of instances of illegal pangolin trade documented in China in recent years. If we can understand the motivations behind pangolin consumption, we can propose solutions to reduce consumer demand for this threatened species.

We aimed to first examine the level of public awareness of pangolins in Guangdong Province and to grasp the reasons for their consumption in this region. We wanted to make effective suggestions for protection and countermeasures against pangolin consumption to reduce the demand for their consumption. This was assessed using a questionnaire administered to the public in 21 prefecture-level cities in Guangdong. We proposed that consumer behavior is one of the fundamental driving forces behind pangolin smuggling. Using the results of pangolin surveys, we explored—from the perspectives of enhancing public awareness of pangolins, changing public consumption concepts, consumption behavior, and improving legislation—approaches for guiding the public away from pangolin consumption. These findings are of important theoretical and practical value for the protection of pangolin species globally.

MATERIALS AND METHODS

Self-Administered Questionnaires

All respondents completed a self-administered questionnaire. The questionnaire was designed including 23 questions in four parts based on previous, unpublished research (see **Supplementary Material**): (1) basic information on the respondents (except their name and address), (2) their ability to identify pangolins and their derivatives, (3) consumption of pangolin meat and scales, (4) general awareness of pangolins. The purpose of this questionnaire was to grasp the consumption status of pangolins, the public's awareness of pangolin protection and relevant legislation, their purposes with regard to consumption and willingness to consume pangolin meat and scales, and the population characteristics related to pangolin consumption.

This survey was conducted in 21 prefecture-level cities in Guangdong Province, covering all regions of the province. Since the questionnaire involved some sensitive issues such as the consumption of pangolins, it was necessary for investigators

to eliminate respondents' worries about potential punishment for answering questions about the consumption of pangolins and to gain the trust of the respondents during the survey. We recruited one middle school biology teachers as volunteers to help us with this survey in each city, because they had unique social relationships and had established good communication with students and their parents. Given there may be potential limitations regarding honest reporting of sensitive behaviors, using the special trust relationship between students, their parents and teachers, we ensured the smooth progress of the questionnaire survey and maximize the accuracy of the questionnaire's content, although we can't guarantee that all responders who have ever consumed pangolins or their derivatives were able to admit to illegal behaviors to teachers.

Before the survey, we had communicated with all volunteers face-to-face or via WeChat video. Volunteers were given careful training to ensure that they fully understood the survey, including the background, purpose, content of the questionnaire, and the difficulties of conducting the survey. All volunteers were required to master their communication skills with interviewees, and to recognize that they must explain the purpose of the survey to interviewees and assure them that the survey was anonymous, confidential and completely voluntary.

During the survey, our volunteers randomly selected students in their classes or their family members (e.g., parents, grandparents, uncles and aunts, cousins) as respondents, and had face-to-face communication with respondents. If the respondents were willing to fill in the questionnaire, our volunteers would give it to them to fill in; alternatively they were offered the option of completing the questionnaire by structured interview.

As students came from a variety of family backgrounds and were less influenced by their parents' education, occupation and income, selecting family members as respondents was a more comprehensive approach. Moreover, as consumption among members of the same family may be highly correlated, only one questionnaire was issued for each family, and was filled out by one person, so as to avoid deviations in the results.

Samples and Questionnaire Screening

The total population of Guangdong Province in 2017 was 111.69 million. According to the 2% allowable sampling error (Zhang, 2019), we had planned to collect 2,400 valid questionnaires in Guangdong Province; with an estimated recovery efficiency of 75%, we needed to issue 3,200 questionnaires. In total, 3,150 questionnaires were distributed in Guangdong, with 150 questionnaires distributed in each target city. Consider the social limitations of students (i.e., restrictions from parents), we controlled the proportion of students to no more than 20%.

Collected questionnaires were screened electronically. The attitude of respondents to the survey was judged by whether the information in the questionnaire was completely filled out, and whether the answers to the identification questions about pangolins and their derivatives were correct. We removed questionnaires that were missing key information, were from outside the survey area, or had obvious errors of logic in the content of the responses.

Data Analyses

We compiled the types of pangolin products consumed by pangolin consumers and the reported motivations for consumption. We used a chi-square test to check whether the gender ratio of valid questionnaire respondents conformed to the population sex ratio of Guangdong Province in 2017. To analyze the demographic profile of consumers, we conducted a binomial logistic regression, with the following explanatory variables: district, age, education, job, and income. We used these variables to determine which are the most important factors affecting the consumption of pangolins. Variables were selected using logistic stepwise regression ($\alpha = 0.05$). Among the variables included in the model, the variable with the largest change in log likelihood was taken as the most important factor.

Ethics Approval Statement

All questionnaires were in accordance with procedures approved by the Ethics Committee of South China Normal University. Informed consent was obtained from all subjects and the data from questionnaires were anonymized.

RESULTS

Pangolin Status and Consumption Survey Results

Across all 21 target cities in Guangdong, 1,957 valid questionnaires were collected, the rate of effective questionnaire response was 62.13% (the validity of the questionnaire was 97.8% and the confidence level was 95%). Among all respondents, Han Chinese individuals accounted for the vast majority; only 20 respondents were from other ethnic groups. The gender ratio in respondents was balanced relative to the estimated 2017 gender ratio in Guangdong (male:female = 110.48:100, Statistics Bureau of Guangdong Province, 2017), males and females accounted for 53.30% (n = 1,043) and 46.70% (n = 914) of the respondents, respectively ($\chi^2 = 0.48$, df = 1). Respondents were primarily people aged 36–56 years (**Figure 1**) who are more socially active and are the mainstays of consumption in society, whose consumption status often reflects trends in societal consumption. Income status among respondents was consistent with typical income distribution patterns in China, with the majority of the respondents having an annual income of <60,000 yuan (¥) (**Figure 2**). Few individuals were grouped in the high-income classes; only 3.83% of respondents had an annual income of >250,000 yuan (¥). Based on these measures, we consider the respondents to adequately represent the general population in Guangdong.

A total of 108 respondents had consumed or purchased pangolins or their derivatives in 21 prefecture-level cities (**Figure 3**), accounting for 5.52% of respondents (108/1,957, confidence interval 4.51–6.53%, confidence level 95%). All consumers were Han Chinese; 68 were male and 40 were female. Of the 21 prefecture-level cities, Dongguan, Shantou, Maoming, Heyuan, and Yunfu had higher proportions of consumers (**Figure 4**).

The models of the demographic differences among consumers showed that age, job and education were related to consumption

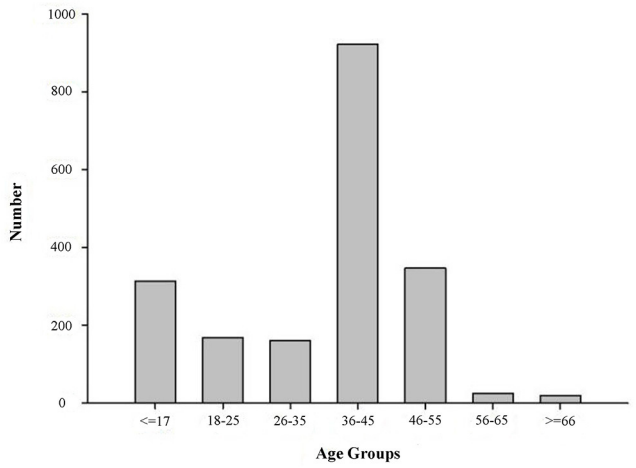

FIGURE 1 | Age-group distribution of 1,957 respondents.

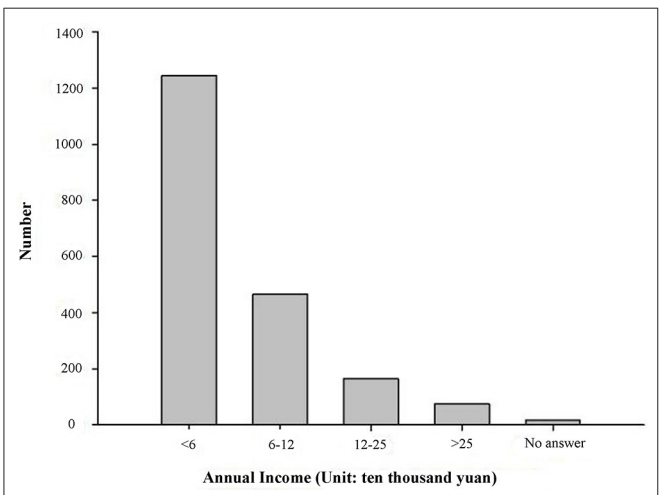

FIGURE 2 | Annual-income distribution of 1,957 respondents.

and job was the most important variable (**Table 1**). Civil servants were the most common consumers of pangolins, up to 17.19% (11/64), followed by enterprise executives and businessmen, at 11.48% (7/61) and 9.57% (9/94), respectively, while the consumption by students and unemployed was the lowest, accounting for 3.47% (14/403) and 2.08% (3/144), respectively (**Figure 5**).

Public Awareness of the Protection and Legal Status of Pangolin

The majority of the respondents were aware that pangolins are protected animals in China, but only 19.47% (381/1,957) could identify pangolins as Category II state-protected animals (**Figure 6A**). Only 0.20% (4/1,957) thought that pangolins were common, unprotected wild animals, and 4.80% (94/1,957) were not sure if the pangolin was a protected animal or not. Fourteen respondents declined to answer.

When asked if the term "threatened" implied pangolins are at risk of extinction, 48.24% (944/1,957) of the respondents believed that threatened does imply extinction risk (**Figure 6B**). Forty-two individuals declined to answer.

The most recent amendment to the "Law of the People's Republic of China on the Protection of Wild Animals" (hereinafter referred to as the "Protection Law") clearly states that the conscious consumption of protected animals is illegal. Upon evaluating public awareness of the Protection Law, an overwhelming majority of the respondents (87.89%) were aware that pangolin consumption was illegal (**Figure 7**). Among reported pangolin consumers, 75% (81/108) were aware of the Protection Law. According to our survey experience and volunteer feedback, we found that although the public understands the contents of the Protection Law, their legal awareness was weak overall or they were willing to flout the relevant law. For example, there are still quite a few people who believe that the consumption of pangolin scales for medicinal purposes is reasonable, and that there is nothing wrong in the consumption of pangolin meat; some people, when asked whether they would consume pangolins if given the chance, gave positive replies.

Types of Pangolin Products Consumed and Reasons for Consumption

The most widely consumed pangolin product was scales, followed by meat. Only a small proportion of individuals consumed pangolin wine and other derived products. Among 108 respondents who had consumed pangolin-related products, scales had been consumed by 61 respondents, 58 respondents had consumed meat, 4 individuals had consumed pangolin wine, and 18 indicated that they had bought or consumed other products, including scale ornaments (16 individuals) and other products (1 individual), or had experienced Guasha (scraping) therapy which is a popular treatment for neck and shoulder pain, gastritis and enteritis by scraping the patient's neck, back or chest (2 individuals). Note that among consumers, multiple pangolin products were consumed by the same individuals.

Regarding the consumption of scales, 80.43% (49/61) of the consumers identified curing diseases as their motivation (**Figure 8A**). General health care was also a common driver of consumption. In addition, in responses to the "other" category, we found that some respondents believed that the scales can ward off evil spirits or used them as decorative ornaments. However, most meat consumption was accidental; i.e., the individuals were invited by their relatives or friends. Among informed meat consumers, curiosity was the most common reason for consumption, followed by "showing-off," and as a nutritional supplement (**Figure 8B**). The treatment of disease and health care were uncommon motivations for meat consumption.

The Characteristics of Pangolin Consumption

Of all consumers (61 scale consumers and 58 meat consumers), nine respondents had consumed scales and 16 respondents had consumed pangolin meat in the past year. Considering that the

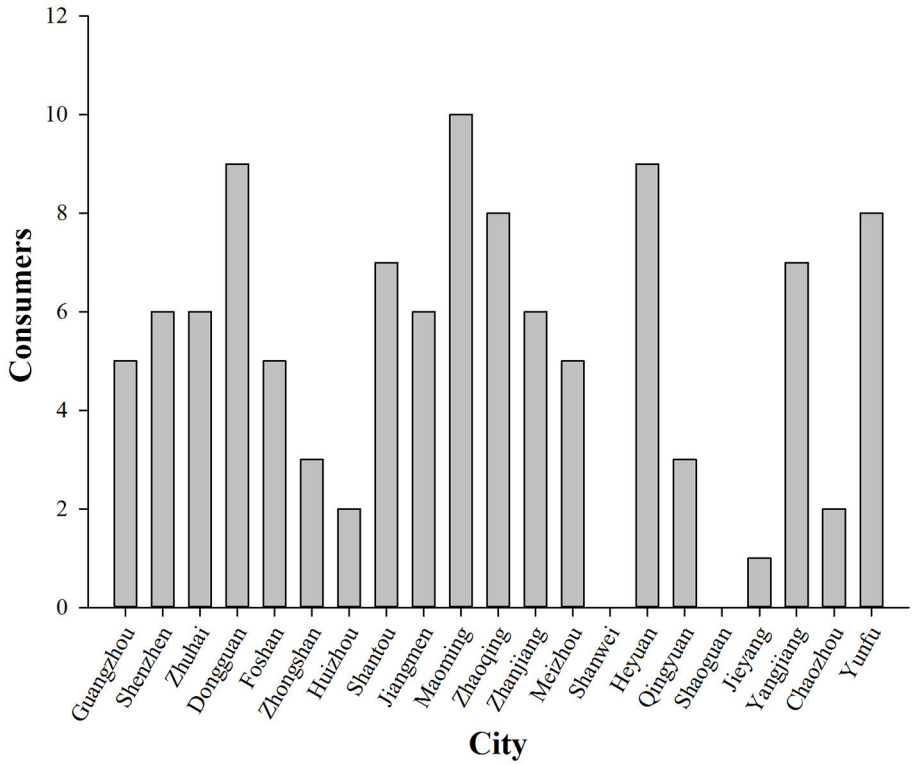

FIGURE 3 | The number of pangolin consumers across 21 prefecture-level cities in Guangdong province.

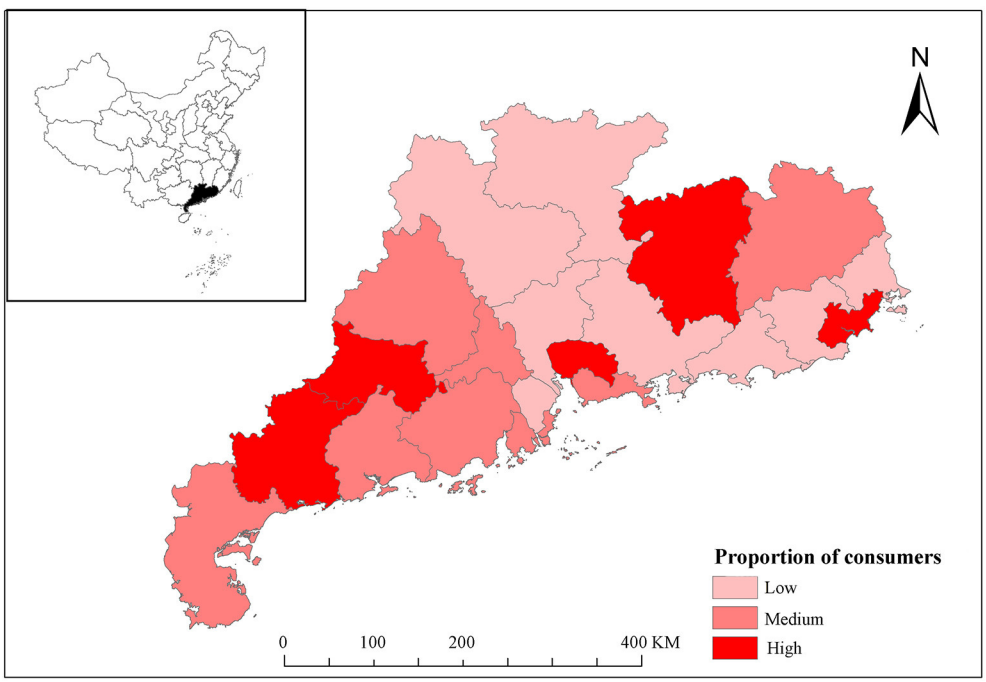

FIGURE 4 | The proportion of pangolin consumers across 21 prefectures in Guangdong province.

number of consumers was small, we did not estimate the amount of pangolin scale and meat consumption, we simply analyzed the consumption characteristics of all recorded consumers. Among meat consumers, nine consumed meat in groups of 4–6 people, four in groups of 7–10 people, and three in groups of >10 people. It can be seen that pangolin meat consumption generally occurred in groups. Additional questionnaire data indicated that 10 of the 16 consumers had consumed pangolin meat once in the past year, 1 had eaten it twice, 4 had eaten it 3–6 times, and 1 had consumed pangolin ≥7 times, resulting in an estimated average consumption rate of 2.31 events annually per consumer. This implied that although meat consumers were a minority among the populace, they were often not accidental, but habitual consumers.

We also attempted to provide statistics on the consumption of pangolin scales and meat, but the feedback on this aspect was insufficient. Among scale consumers, only five provided their consumption amount. Three people consumed ≤10 g of scales, one consumed 36.8 g, and one person consumed >100 g; the remaining four respondents did not provide an amount that they had consumed. Only two meat consumers estimated the amount of meat they ate in one sitting, as 2–3.5 and 5 kg were eaten by their groups, respectively. Therefore, we were unable to estimate pangolin consumption in Guangdong Province through this survey.

TABLE 1 | Models of the demographic differences among consumers*.

Variable	df	Log likelihood	Change in −2Log likelihood	Significance
Distribution	20	−417.844	41.769	0.277
Age	1	−319.973	13.443	0.000
Job	10	−400.732	30.962	0.001
Education	9	−396.940	23.377	0.005

*Based on conditional parameter estimates.

Respondents' Attitudes Toward the Future Consumption of Pangolin

To understand the potential future demand for pangolin more fully, we surveyed the willingness of respondents to consume pangolin in the future.

Regarding active consumption, a survey was conducted to examine whether the respondents would consume pangolin if they were sick or entertaining guests. For medicinal use, even if the efficacy of the scales is uncertain, 10.48% (205/1,957) of the respondents would still use the scales for treatment and the 23.86% (467/1,957) who were vacillating were also potential pangolin consumers (**Figure 9A**). Among banqueting guests, 94.58% (1,851/1,957) of the respondents would refuse to consume pangolin and thought that pangolin meat could be replaced by other high-end items; only 0.97% (19/1,957) were willing to consume pangolin for personal reasons (**Figure 9B**).

In terms of invited consumption, 1.38% (27/1,957) were willing to consume pangolin if they were invited to by relatives or friends, while 16.82% would decide whether to participate depending on the circumstances or who made the invitation. Of the respondents who refused to consume pangolin (80.46%), 19.98% (329/1,957) would also try their best to persuade the host not to consume it and another 43.79% (857/1,957) would choose to report restaurants anonymously to the relevant authorities (**Figure 10**).

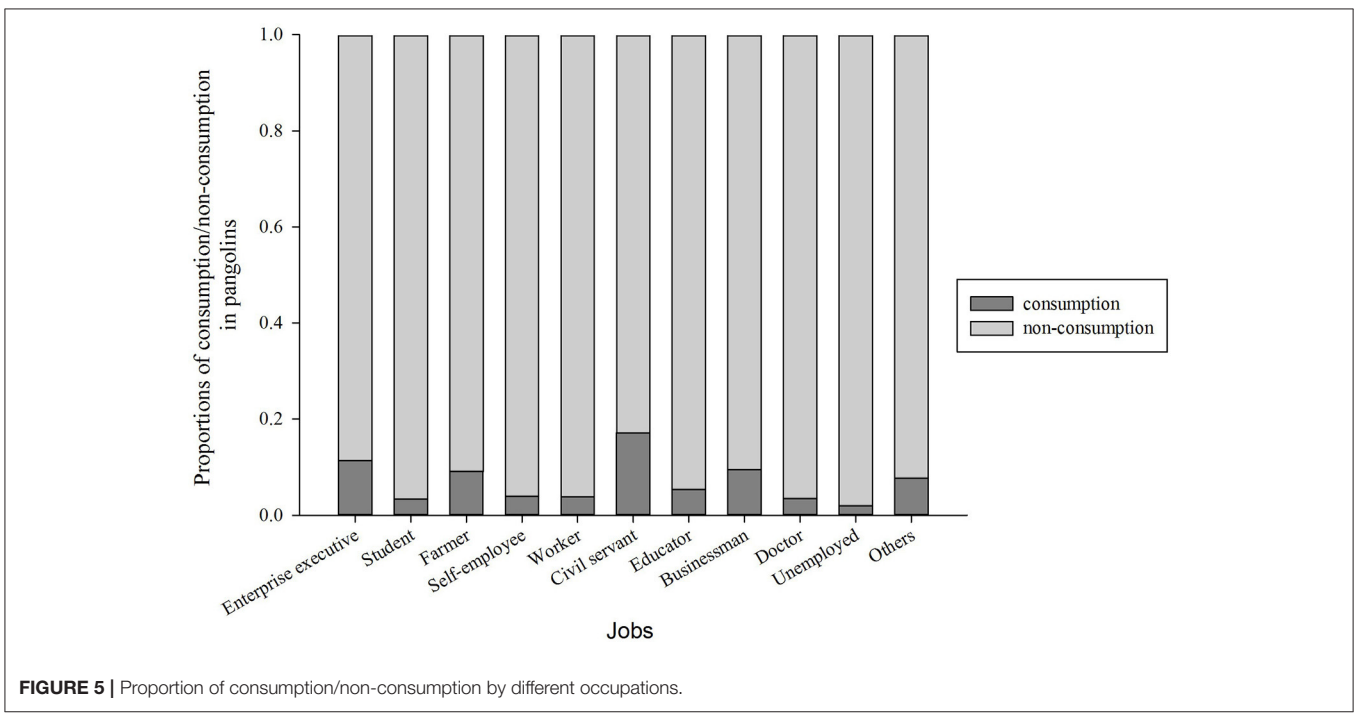

FIGURE 5 | Proportion of consumption/non-consumption by different occupations.

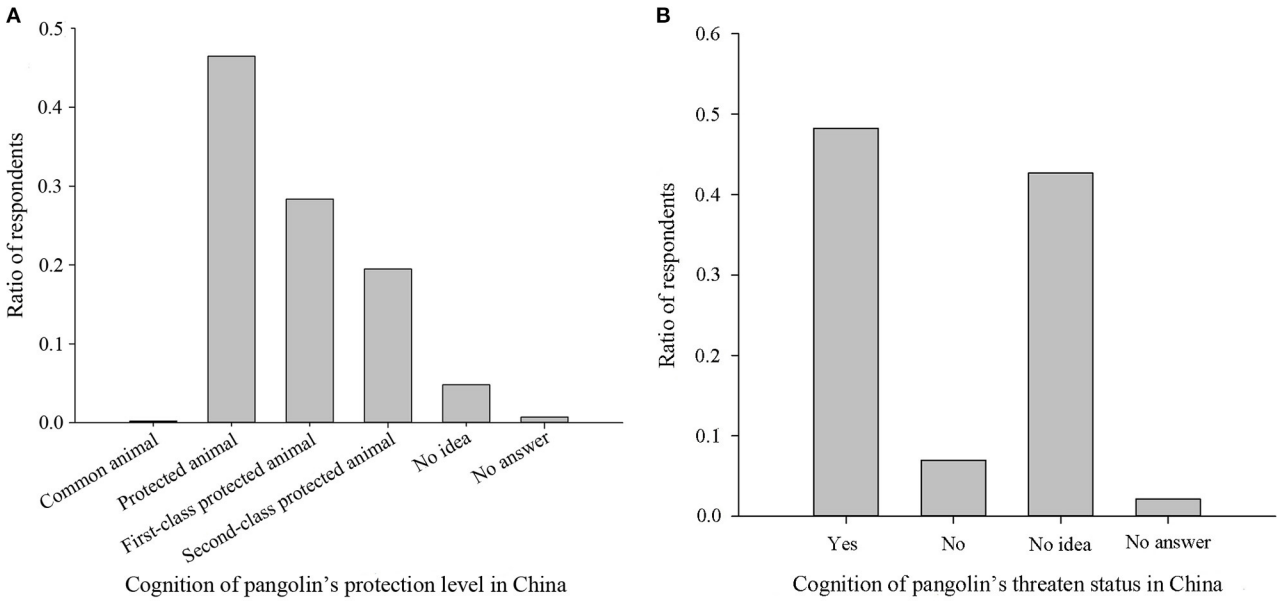

FIGURE 6 | Responses to a survey on pangolin status and consumption (1,957 respondents) asking if respondents were aware of the pangolin's protection level **(A)** and threatened status **(B)** in China.

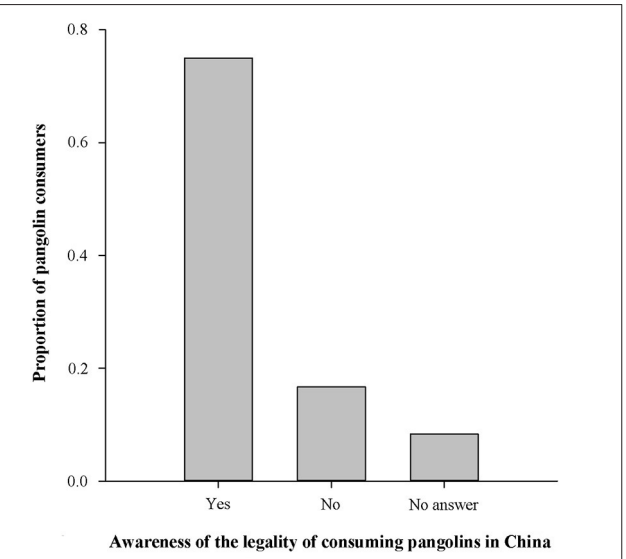

FIGURE 7 | Responses to a survey on pangolin status and consumption (1,957 respondents) asking if individuals were aware that the consumption of pangolin and pangolin products was illegal.

Examining the respondents' future willingness, we found that the public's consumption of pangolin for medicinal purposes was more difficult to change than its use for other purposes.

DISCUSSION

Our goal was to develop an in-depth understanding of the motivations behind wildlife consumption and targeted strategies to change public conceptions regarding pangolin consumption. In light of the present issue of pangolin consumption in Guangdong, we propose and discuss strategies to shift consumer behavior and thereby reduce or potentially eliminate the demand for the illegal pangolin trade.

Increase Public Understanding of Pangolin Status and Decline

The premise and basis for raising public awareness of the protection of threatened species is to first ensure that the public has a clear, comprehensive understanding of the species. Although pangolins receive widespread publicity in China as a species of public concern, only 19.47% of the respondents were aware that pangolins are Category II state-protected animals. Conservation education is critical to sensitize people to the threats facing a species, the need to protect it, and the action required to ensure its survival (Liu et al., 2017). We suggest that using additional local media types including local TV stations to create publicity will help to improve public understanding of pangolins, including their biodiversity value, role in the environment, protected status, population declines, major threats to their survival.

Human consumption psychology can change with improved science literacy and evolution in social culture (Liu et al., 2017). Surveys of wildlife consumption in Hunan Province administered before and after the SARS epidemic in 2003 showed that the consumption of frogs, snakes, pheasants, and hares decreased significantly when people became aware that wild animals are potential hosts for zoonotic diseases (Yang et al., 2007). Through captivity, it has been shown that pangolins can transmit a variety of parasites and multiple viruses (Zhang

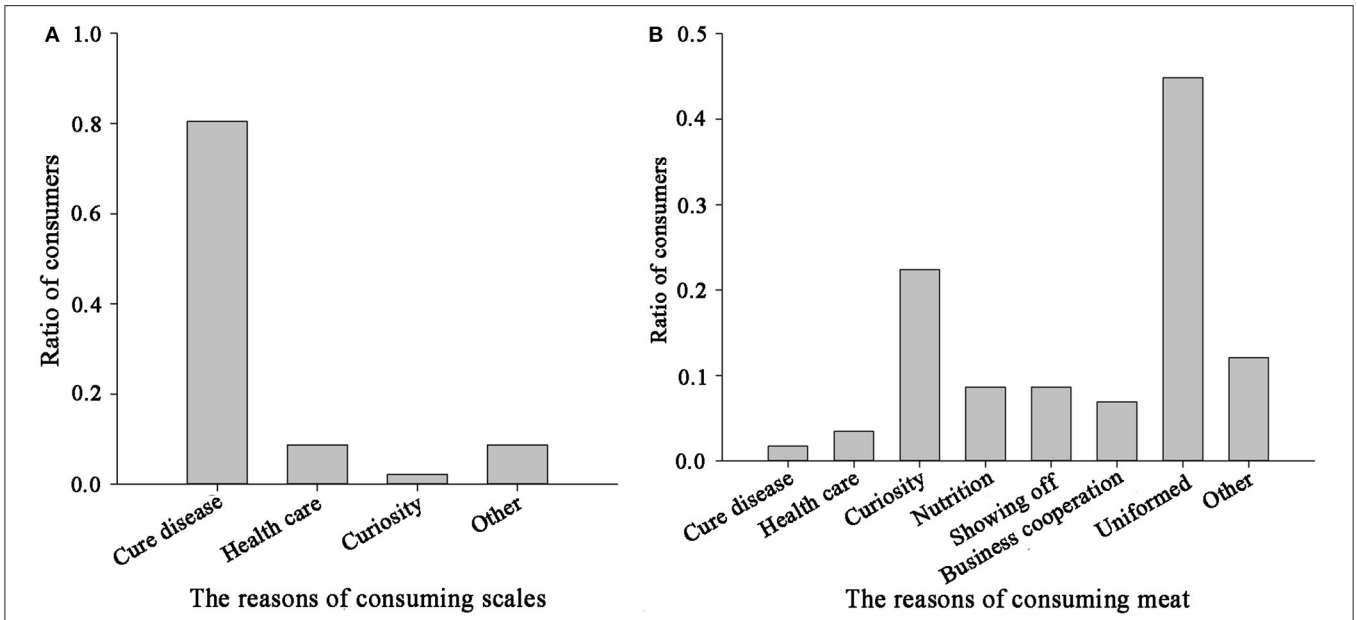

FIGURE 8 | Responses to a pangolin consumption status survey regarding individual reasons for consuming pangolin scales **(A)** and meat **(B)**.

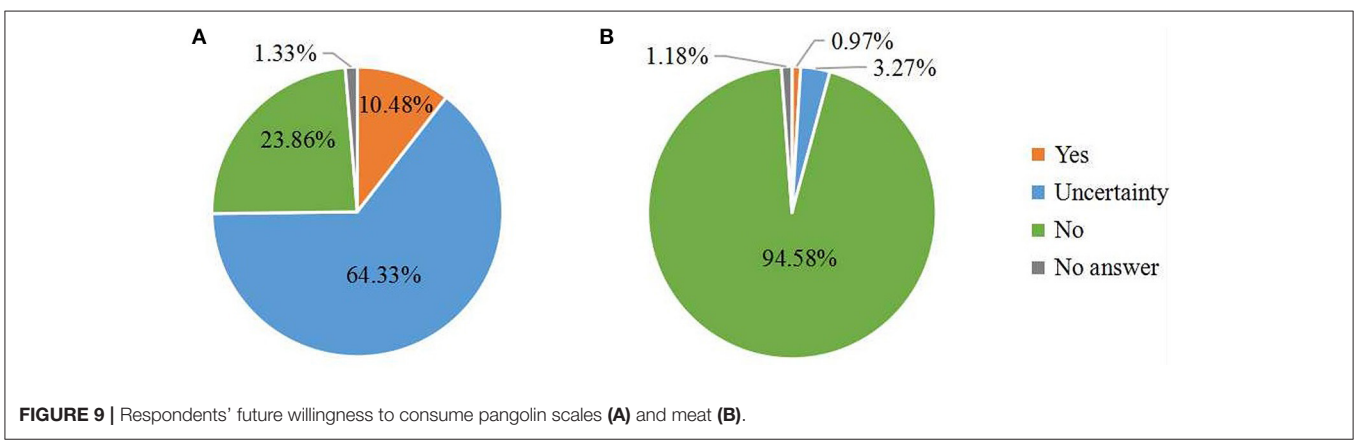

FIGURE 9 | Respondents' future willingness to consume pangolin scales **(A)** and meat **(B)**.

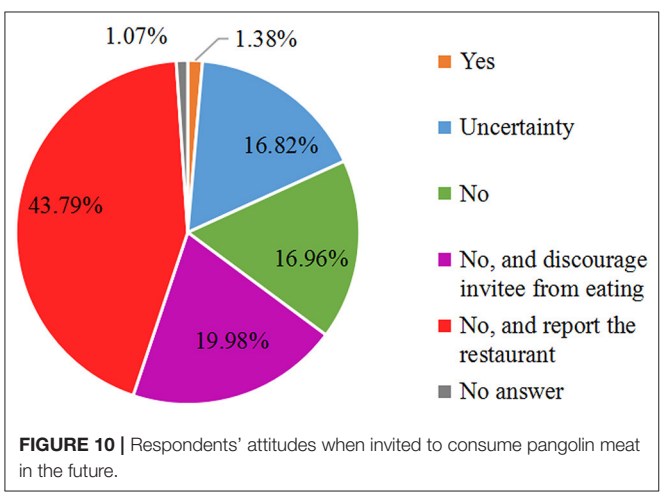

FIGURE 10 | Respondents' attitudes when invited to consume pangolin meat in the future.

et al., 2015, 2017b; Liu et al., 2019), and that there is a risk of human infection (Xiao et al., 2020). However, the vast majority of the public are unaware of this. We suggest that wildlife management institutions collaborate with more generalized science and technology workers to boost public knowledge of pangolin parasites and diseases. The relationship between avian influenza outbreaks and the consumption of birds and other wild animals in China was used as an example to warn the public about the potential risks and serious consequences of eating wild animals (Yang et al., 2007). Further, knowledge of the smuggling process could change public opinion on pangolin consumption. Tranquilizers and medications are administered to trafficked animals, which could have adverse effects for humans who consume them.

Building awareness around the legal implications of smuggling and consuming pangolins may also decrease

demand. In our survey, it was found that some consumers knew only that consuming pangolins was illegal; they did not know the type or degree of punishment. For example, some offenders have even been given suspended death sentences (SINA.COM, 2007). From additional communication with the respondents, it was found that when consumers were told they could face several years in jail for consuming pangolins, they said they would refuse to consume them. Our results indicated that public awareness of the ramifications of the Protection Law was weak, as 75% of the respondents who consumed pangolin were aware that it was illegal. In addition, publicity materials tend to focus on protection knowledge and not related legal knowledge about pangolin consumption. We suggest including legal information in scientific publicity materials on pangolins. Online or televised videos of pangolin trafficking and seizure cases could enhance the understanding of relevant laws as well as the severity of the pangolin population decline due to overconsumption.

Promote Change in Product Choices Among Pangolin Consumers

We found three main motivations for pangolin meat consumption among respondents. The most prevalent was curiosity, with individuals pursuing a novelty food item. Another was "showing off," with individuals consuming pangolin, an expensive food, as a symbol of status and wealth. Finally, some individuals believe that the pangolin has significant nutritional value and their meat is a health supplement. In addition to using pangolin scales to treat diseases, many people believe that the scales also ward off evil spirits or use them as decorative ornaments. In other countries where pangolins are distributed, scales have a high importance value in certain communities' spiritual, cultural and medicinal beliefs (Adeola, 1992; Soewu and Adekanola, 2011; Boakye et al., 2014; Challender et al., 2019b).

We suggest that further public education efforts be made to advocate for a refusal to consume wild-caught wildlife. With the development of the social economy, organic food and food health preservation have gradually become the new fashions in Chinese public food consumption. Hence, people can be encouraged to choose organic foods or novel domesticated animals to achieve the goals of health care and luxury consumption.

Recommend and Develop Alternative Medicines to Cease the Use of Scales as Ingredients in Chinese Patent Medicines

The use of rare and endangered species as traditional medicine can have potentially significant impacts on populations of local species, which are already under pressure (Still, 2003; Williams et al., 2007). Pangolin scale is an effective ingredient in TCM (Xie et al., 2001; Wang et al., 2015; Zhou et al., 2019). The consumption motivation of scales as a drug was very high (80.43%, 37/46), due to doctor's advice. Based on previous, unpublished research, we found there is a lack of awareness among traditional medical practitioners and some old traditional medical practitioners don't even know what a pangolin is. Therefore, it's one of vital aspects to increase awareness among traditional medical practitioners and soliciting their support for pangolin conservation efforts, for instance, doctors should prioritize the use of preparations of Chinese medicine formulas or Chinese medicines that do not contain pangolin scales but are still effective. Boakye et al. (2014) also pointed it out.

In addition, although pangolins have been removed from the pharmacopeia in China, they are still in the lists of ingredients in patented medicines included in the pharmacopeia. Currently there are studies on the substitutes of scales, including cowherb seed (Hsieh, 2005; Wang, 2008), pig hooves (Hou et al., 2000), horns of Cervidae and Bovidae species (Luo et al., 2011), the thorns of Chinese honey locust and cockleshells (Bensky et al., 2004), the effectiveness of these substitutes has not been proven and traditional medical practitioners had reservations about the use of substitutes (Wang, 2008). To achieve the removal of scales from Chinese medicinal use, the pharmacological study of scales must be conducted to determine their efficacy in disease treatment and relevant active compounds, with the goal of creating alternative medicines to replace scales in treating diseases.

Regarding the respondents' attitudes to future consumption, some respondents would still use the scales to treat diseases at the risk of breaking the law, and the willingness to consume pangolin for medicinal purposes was significantly greater than it was to consume it as meat. As a result, it's very important to develop alternative medicines for pangolin protection.

Enhance the Protection Level of Pangolin in China and Strengthen Law Enforcement

Prior to 2020, the Chinese government's monitoring and investigation research was relatively weak and the illegal wildlife trade were relatively active. However, since the COVID-19 outbreak, China has strengthened the management of wildlife breeding, customs, market management, forest police law enforcement and other links. Given that China is a major region

TABLE 2 | The observations of Chinese pangolins in June 2020 in China.

Date	Location	Gender	Mass (kg)	References
2020.6.8	Huangshan district, Anhui	♂	–	Anhui Forestry, 2020a
2020.6.9	Suichang county, Zhejiang	–	–	Zhejiang Forestry, 2020
2020.6.14	Xiangqiao district, Guangdong	♂	1.9	Guangdong Forestry, 2020
2020.6.15	Ningguo county, Anhui	♂	6.6	Anhui Forestry, 2020b
2020.6.19	Ningguo county, Anhui	♂	3.5	CR Zheng pers. commu.
2020.6.23	Huidong county, Guangdong	–	–	C. Li Pers. Commu.
2020.6.25	Chun 'an county, Zhejiang	♂	2.45	Zhejiang Forest, 2020

of pangolin consumption, on the basic of upgrading its protection level and increasing penalties for trafficking, we suggest that the daily monitoring of wild animal and Chinese herbal medicine markets is necessary, wherein appropriate government departments fully investigate illegal trade dynamics and routes related to the pangolin (Yin et al., 2016). Associated businesses such as game restaurants should also be monitored. The illegal trade of pangolins is inseparable from human behavior. Social norms which include descriptive norms and injunctive norms, have important influence on people's consumption behavior (Cruwys et al., 2015). Descriptive norms which rely on situational factors through most of the other people's behavior influence consumer behavior (Kim et al., 2012), while injunctive norms by rules or sanctions placed on a person's behaviors by others (Kim and Seock, 2019), if their behavior violates injunctive norms, they will be punished (Jiang and Ma, 2014). Therefore, carrying out public education to guide the public to avoid consumption of pangolins, increased consumer penalties can reduce or eliminate the willingness of the public to flout the law and consume pangolins (Liu et al., 2017). Since the Chinese government has cracked down on the illegal trade and consumption of wildlife across the country, the consumption of wild animals has been significantly lower (Liu et al., 2017). In addition, with increasing public awareness of pangolin protection, some citizens have taken the initiative to report the behavior of those destroying pangolin resources to law enforcement authorities, and there is also a growing number of cases of the public reporting wild pangolin encounters to managers. For example, in June 2020, we recorded at least seven cases that were reported by the public in China, 5 cases were from news and another 2 cases were from personal communication (**Table 2**). Regarding the respondents' attitudes to the future consumption of pangolins, potential consumers still remain. Therefore, to protect pangolins more effectively, the penalties for pangolin consumption and media coverage of related cases should be increased to deter potential consumers. To increase public participation further in pangolin protection, we suggest the establishment of a standardized reporting reward system. Individuals would receive rewards for reporting cases of pangolin trafficking and consumption, once verified.

CONCLUSIONS

Although the public is generally aware that pangolins are protected animals, few are aware of their protection level in China or their critically endangered status. Only a small proportion of individuals in Guangdong have consumed pangolin, but among these, most knew that pangolin consumption was illegal, which indicates that they had a weak understanding of the Protection Law or were willing to flout the relevant law. Scales and meat were the primary items consumed, and scales were generally consumed for disease treatment and health care. Aside from accidental consumption, the primary motivation for eating pangolin meat was curiosity and "showing off." To reduce the consumption of pangolin, we suggest that it is necessary to simultaneously improve public knowledge of pangolin status, disease risks, and the Protection Law. Further necessary efforts include developing alternative drugs and ceasing the use of scales in Chinese patent medicine. We believe that these actions are fundamental to ensuring pangolin protection.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: protect the personal privacy of interviewees. Requests to access these datasets should be directed to Fuhua Zhang, zhangfuhuahbu@163.com.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee at South China Normal University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

FZ and SW: conceptualization, writing—review and editing, and funding acquisition. FZ, YY, and JY: methodology. FZ, YY, and YM: formal analysis and investigation. FZ, YY, and AM: writing—original draft preparation. FZ: resources. SW: supervision. All authors: contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fevo.2020.574161/full#supplementary-material

REFERENCES

Adeola, M. O. (1992). Importance of wild animals and their parts in the culture, religious festivals, and traditional medicine, of Nigeria. *Environ. Conserv.* 19, 125–134. doi: 10.1017/S0376892900030605

Anhui Forestry (2020a). *Huangshan District: Rescue and Release the Chinese Pangolin, a First-Class National Protected Wild Animal*. Available online at: https://mp.weixin.qq.com/s/EUM3OVwO-Zfrt0YebEZ3dA

Anhui Forestry (2020b). *A Wild Chinese Pangolin Has Again Been Found in Anhui With a Slight Injury to Its Forearm*. Available online at: http://www.ahwang.cn/newsflash/20200616/2090144.html

Bensky, D., Clavey, S., and Stoger, E. (2004). *Chinese Herbal Medicine, Materia Medica, 3rd Edn.* Washington: Eastland Press.

Boakye, M. K., Pietersen,D. W., Kotzé A, Dalton, D. L., and Jansen, R. (2014). Ethnomedicinal use of African pangolins by traditional medical practitioners in Sierra Leone. *J. Ethnobiol. Ethnomed.* 10:76. doi: 10.1186/1746-4269-10-76

Chaber, A. L., Allebone-Webb, S., Lignereux, Y., Cunningham, A. A., and Rowcliffe, J. M. (2010). The scale of illegal meat importation from Africa to Europe via Paris. *Cons. Lett.* 3, 317–321. doi: 10.1111/j.1755-263X.2010.00121.x

Challender, D., Willcox, D. H. A., Panjang, E., Lim, N., Nash, H., Heinrich, S., et al. (2019a). *Manis javanica. The IUCN Red List of Threatened Species 2019: e.T12763A123584856*. doi: 10.2305/IUCN.UK.2019-3.RLTS.T12763A123584856.en

Challender, D., Wu, S., Kaspal, P., Khatiwada, A., Ghose, A., Ching-Min Sun, N., et al. (2019b). *Manis pentadactyla. The IUCN Red List of Threatened Species 2019: e.T12764A168392151*. doi: 10.2305/IUCN.UK.2019-3.RLTS.T12764A168392151.en

Challender, D. W., Harrop, S. R., and MacMillan, D. C. (2015). Understanding markets to conserve trade-threatened species in CITES. *Biol. Conserv.* 187, 249–259. doi: 10.1016/j.biocon.2015.04.015

Challender, D. W. S., Wu, S. B., Nijman, V., and MacMillan, D. C. (2014). Changing behavior to tackle thewildlife trade. *Front. Ecol. Environ.* 12:203. doi: 10.1890/1540-9295-12.4.203

Chen, J. (2016). On situation of and countermeasures for the smuggling of endangered wild animals in China under the backdrop of economic globalization. *J. Cust. Trade* 37, 92–99.

Cheng, W., Xing, S., and Bonebrake, T. C. (2017). Recent pangolin seizures in China reveal priority areas for intervention. *Conserv. Lett.* 10, 757–764. doi: 10.1111/conl.12339

CITES (2017). *Convention on International Trade in Endangered Species of Wild Fauna and Flora*. Available online at: http://www.cites.org/eng/app/appendices.php

Cruwys, T., Bevelander, K. E., and Hermans, R. C. J. (2015). Social modeling of eating: a review of when and why social influence affects food intake and choice. *Appetite* 86, 3–18. doi: 10.1016/j.appet.2014.08.035

Guangdong Forestry (2020). *Come and Watch! Chaozhou Also Found the National First- Class Protected Animal-Pangolin!* Available online at: https://mp.weixin.qq.com/s/pQKRPdCjjLA-5mczoSIa1A

Guo, S., Peng, J., Liu, S., and Liu, P. (2019). An overview of wild pangolins status and the related illicit trade in China. *J. Chongqing Normal Univers.* 36, 48–54.

Heinrich, S., Wittmann, T. A., Prowse, T. A., Ross, J. V., Delean, S., Shepherd, C. R., et al. (2016). Where did all the pangolins go? International CITES trade in pangolin species. *Global Ecol. Cons.* 8, 241–253. doi: 10.1016/j.gecco.2016.09.007

Heinrich, S., Wittmann, T. A., Ross, J. V., Shepherd, C., Challender, D. W. S., and Cassey, P. (2017). *The Global Trafficking of Pangolins: A Comprehensive Summary of seizures and Trafficking Routes From 2010–2015*. Petaling Jaya: TRAFFIC, Southeast Asia Regional Office.

Hou, S., Zhao, J., Dong, X., and Cui, Y. (2000). Experimental comparison of pig nail and pangolin scale on the effect of stimulating lactation. *China J. Chin. Mater. Med.* 25, 44–46. doi: 10.3321/j.issn:1001-5302.2000.01.016

Hsieh, C. C. (2005). The lactation performance, immunomodulation and antitumor effects in the replacement drugs of Squama Manitis. *Yearb. Chin. Med.Pharm.* 23, 93–126.

Jiang, Z. G., and Ma, K. P. (2014). *Principles of Conservation Biology*. Beijing: Science Press.

Johnson, C. N. (2002). Determinants of loss of mammal species during the late quaternary 'megafauna' extinctions: life history and ecology, but not body size. *R. Soc. Proc. B* 269, 2221–2227. doi: 10.1098/rspb.2002.2130

Kim, H., Lee, E.-J., and Hur, W.-M. (2012). The normative social influence on eco-friendly consumer behavior: the moderating effect of environmental marketing claims. *Cloth. Textiles Res. J.* 30, 4–18. doi: 10.1177/0887302X12440875

Kim, S. H., and Seock, Y.-K. (2019). The roles of values and social norm on personal norms and pro-environmentally friendly apparel product purchasing behavior: the mediating role of personal norms. *J. Retail. Consumer Serv.* 51, 83–90. doi: 10.1016/j.jretconser.2019.05.023

Liu, P., Chen, W., and Chen, J.-P. (2019). Viral metagenomics revealed sendai virus and voronavirus infection of malayan pangolins (*Manis javanica*). *Viruses* 11:979. doi: 10.3390/v11110979

Liu, Z., Jiang, Z., and Yang, A. (2017). Research progress on trade and consumer behavior of wild animals. *Chin. J. Wildlife* 38, 712–719. doi: 10.19711/j.cnki.issn2310-1490.2017.04.035

Luo, J., Yan, D., Zhang, D., Feng, X., Yan, Y., Dong, X., et al. (2011). Substitutes for endangered medicinal animal horns and shells exposed by antithrombotic and anticoagulation effects. *J. Ethnopharmacol.* 136, 210–216. doi: 10.1016/j.jep.2011.04.053

MacMillan, D. C., and Nguyen, Q. A. (2014). Factors influencing the illegal harvest of wildlife by trapping and snaring among the Katu ethnic group in Vietnam. *Oryx* 48, 304–312. doi: 10.1017/S0030605312001445

Maxwell, S., Fuller, R. A., Brooks, T. M., and Watson, J. E. M. (2016). Biodiversity: the ravages of guns, nets and bulldozers. *Nature* 536, 143–145. doi: 10.1038/536143a

Nuwer, R., and Bell, D. (2014). Identifying and quantifying the threats to biodiversity in the U Minh peat swamp forests of the Mekong Delta, Vietnam. *Oryx* 48, 88–94. doi: 10.1017/S0030605312000865

Oldfield, S. (2014). *The Trade in Wildlife: Regulation for Conservation*. Abingdon, VA: Earthscan Publications.

Schneider, J. L. (2008). Reducing the illicit trade in endangered wildlife the market reduction approach. *J. Contemp. Crim. Justice* 24, 274–295. doi: 10.1177/1043986208318226

Schoppe, S., Katsis, L., and Lagrada, L. (2019). *Manis culionensis. The IUCN Red List of Threatened Species 2019: e.T136497A123586862*. doi: 10.2305/IUCN.UK.2019-3.RLTS.T136497A123586862.en

Shairp, R., Veríssimo, D., Fraser, I., Challender, D., and MacMillan, D. (2016). Understanding urban demand for wild meat in Vietnam: implications for conservation actions. *PLoS ONE* 11:e0134787. doi: 10.1371/journal.pone.0134787

SINA.COM (2007). *Xiamen: In a Pangolin Smuggling Case, Two Offenders Have Been Given a Suspended Death Sentence in First Trial.* Available online at: http://news.sina.com.cn/c/2007-11-07/105912861420s.shtml (accessed August 30, 2020).

Soewu, D. A., and Adekanola, T. A. (2011). Traditional-medical knowledge and perceptionof pangolins (Manis sps) among the Awori People, Southwestern Nigeria. *J. Ethnobiol. Ethnomed.* 7:25. doi: 10.1186/1746-4269-7-25

Statistics Bureau of Guangdong Province (2017). *An Analysis of Population Change in Guangdong Province in 2017*. Available online at: http://www.gdstats.gov.cn/tjzl/tjfx/201804/t20180418_386215.html (access August 30, 2019).

Still, J. (2003). Use of animal products in traditional Chinese medicine: environmental impact and health hazards. *Complement Ther. Med.* 11, 118–122. doi: 10.1016/S0965-2299(03)00055-4

t Sas-Rolfes, M., Challender, D. W. S., Hinsley, A., Veríssimo, D., and Milner-Gulland, E. J. (2019). Illegal wildlife trade: patterns, processes, and governance. *Ann. Rev. Environ. Resour.* 44, 201–228. doi: 10.1146/annurev-environ-101718-033253

Theng, M., Glikman, J. A., and Milner-Gulland, E. J. (2018). Exploring saiga horn consumption in Singapore. *Oryx* 52, 736–743. doi: 10.1017/S0030605317001624

Wang, G. B. (2008). "Pangolin conservation in Taiwan," in *2009 Proceedings of the Workshop on Trade and Conservation of Pangolins Native to South and Southeast Asia*, eds S. Pantel and C. S. Yun (Singapore: Singapore Zoo).

Wang, S. (1998). *China Red Data Book of Endangered Animals, Mammlia*. Beijing: Science Press.

Wang, Y., Zhang, G., and Ha, W. (2015). The research progress of application and preparation for endangered TCM Pangolins. *Modern Chin. Med.* 17, 280–284. doi: 10.13313/j.issn.1673-4890.2015.3.022

Williams, V. L., Balkwill, K., and Witkowski, E. T. F. (2007). Size-class prevalence of bulbous and perennial herbs sold in the Johannesburg medicinal plant markets between 1995 and 2001. *South Afr. J. Bot.* 73, 144–155. doi: 10.1016/j.sajb.2006.09.007

Wu, S. B., Ma, G. Z., Liao, G. Z., and Lu, K. H. (2005). *Biological Conservation of Chinese Pangolin*. Beijing: China Forestry Publishing House.

Wu, S. B., Ma, G. Z., Tang, M., Chen, H., and Liu, N. F. (2002). The status and conservation strategy of pangolin Resource in China. *J. Nat. Resourc.* 17, 174–180. doi: 10.11849/zrzyxb.2002.02.008

Xiao, K., Zhai, J., Feng, Y., Zhou, N., Zhang, X., Zou, J. J., et al. (2020). Isolation of SARS-CoV-2-related coronavirus from Malayan pangolins. *Nature* 583, 286–289. doi: 10.1038/s41586-020-2313-x

Xie, X., Zhang, X., Zhao, J., Gao, L., and Xu, G. (2001). Studies on the HL-60 cell apoptosis induced by pangolin extracts. *Zhejiang J. Integr. Tradition. Chin. Western Med.* 11, 477–479. doi: 10.3969/j.issn.1005-4561.2001.08.006

Yang, D., Dai, X., Deng, Y., Lu, W., and Jiang, Z. (2007). Changes in attitudes toward wildlife and wildlife meats in Hunan Provience, central China, before and after the severe acute respiratory syndrome outbreak. *Integr. Zool.* 1, 19–25. doi: 10.1111/j.1749-4877.2007.00043.x

Yin, F., Lu, L., Meng, M., and Liu, D. (2016). Trade and conservation of pangolin. *Chin. J. Wildlife* 37, 157–161. doi: 10.19711/j.cnki.issn2310-1490.2016.02.016

Zhang, F., Yu, J., Wu, S., Li, S., Zou, C., Wang, Q., et al. (2017b). Keeping and breeding the rescued Sunda pangolins (*Manis javanica*) in captivity. *Zoo Biol.* 36, 387–396. doi: 10.1002/zoo.21388

Zhang, G. F. (2019). Determination of sample size in complex sampling case. *Math. Study Res.* 10, 121–122.

Zhang, H. R., Miller, M. P., Yang, F., Chan, H. K., Gaubert, P., Ades, G., et al. (2015). Molecular tracing of confiscated pangolin scales for conservation and illegal trade monitoring in Southeast Asia. *Glob. Ecol. Conserv.* 4, 414–422. doi: 10.1016/j.gecco.2015.08.002

Zhang, L., Wu, S. B., and Bao, Y. X. (2008). "Current status of Chinese pangolin *Manis pentadactyla* in the wild: a rapid range wide population assessment," in *Proceeding of the Workshop on Trade and Conservation of Pangolins Native to South and Southeast Asia* (Singapore Zoo).

Zhang, L., Li, Q., Sun, G., and Luo, S. (2010). Population status and conservation of pangolins in China. *Bull. Biol.* 45, 1–4. doi: 10.3969/j.issn.0006-3193.2010.09.001

Zhang, M. X., Gouveia, A., Qin, T., Quan, R. C., and Nijman, V. (2017a). Illegal pangolin trade in northernmost Myanmar and its links to India and China. *Global Ecol. Cons.* 10, 23–31. doi: 10.1016/j.gecco.2017.01.006

Zhejiang Forest (2020). *Less Than a Year Later, Chun 'An Released the Chinese Pangolin, a National First-Class Protected Wild Animal.* Available online at: https://baijiahao.baidu.com/s?id=1670622798826397070&wfr=spider&for=pc

Zhejiang Forestry (2020). *A Farmer in Lishui Found Pangolins in his Fish Pond! National First- Class Protected Animal!* Available online at: https://www.sohu.com/a/400795839_203393

Zhou, J., Wan, C., Ma, L., and Li, Q. (2019). Review on the mechanism of pangolin on advanced hepatocellular carcinoma. *Guid. J. Tradition. Chin. Med. Pharmacol.* 25, 104–107. doi: 10.13862/j.cnki.cn43-1446/r.2019.18.030

Zhou, Z. M., Zhou, Y., Newman, C., and Macdonald, D. W. (2014). Scaling up pangolin protection in China. *Front. Ecol. Environ.* 12, 97–98. doi: 10.1890/14.WB.001

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.