INVESTIGATING CONSERVATION SOLUTIONS IN TRADITIONAL CHINESE MEDICINE

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Abstract

Exploring animal consumption in the context of traditional Chinese medicine (TCM) may be a valuable means for driving conservation solutions globally. As the demand for particular animal-based remedies in TCM gives rise to robust wildlife trade networks, both legal and otherwise, an understanding of TCM is pivotal to the preservation of those species. TCM covers a broad range of medical practices with varying degrees of conventionality, efficacy, and cost to global ecosystems. This paper seeks to analyze and contrast two animal case studies, seahorse and bear, highlighting connections between TCM and conservation and suggesting alternative plant-based remedies for each case.

Traditional Chinese Medicine

Traditional Chinese medicine (TCM),[1] as it is practiced today, is an amalgamation of cultural-medical traditions, including herbal remedies, acupuncture, cupping, *qigong*, and the consumption of health tonics. Plant and animal-based remedies are prescribed with the intention of rectifying the flow of *qi* (life force) and balancing one's *yin* (feminine energy) and *yang* (masculine energy), all of which is central to Daoist ideology. Each remedy has a recognized combination of medical properties that reflect its curative capacity, with room for overlap among remedies with similar attributes (Yuan et al., 2011). The TCM pharmacopeia has grown considerably, from around 250 remedies during the Han dynasty to over 5000 currently documented remedies, sourced both domestically and globally (Bensky & Gamble, 1989). Although its foundation lies in practices dating back to before

[1] Although other medical traditions in east Asia trace their lineage to Chinese medical practice (eg. Kanpo, Hanbang), this paper is focused on the modern iteration of herbal medicine in China

the Han dynasty (206 BCE – 220 CE), TCM emerged as a response to shifting political conditions in early communist China (1949 – present). The notion of TCM, as opposed to modern, Western-influenced medicine, is a novel concept with ancient roots (Croizier, 1965).

Western medicine first clashed with native Chinese medical practices in the 18th century, during the Qing dynasty (1644-1912 CE). However, the Republican era—following the fall of imperial China—marked the beginning of Western medicine as a strong competitor to traditional practices (Liu, 2019). From the 1910's to the 1940's, China saw an imperialistic shift in attitude towards 'scientific progress', with native Chinese medicine representing China's perceived backwardness in the eyes of both communists and nationalists, while Western medicine emerged as a strategy for modernization (Croizier, 1965; Hsu, 2008). Shortly after founding the People's Republic of China, Chairman Mao Zedong grappled with two central political concerns: the need to represent China as an autonomous power free of Western colonial influence and the strategic rejection of old, imperial Chinese values and cultural practices in favor of scientific 'modernity' (Hsu, 2008). In addition, he sought to supply medical care to peasants, who constituted his chief base of support during his rise to leadership (Taylor, 2011). In order to satisfy these conditions, Mao championed the generation of TCM, using traditional remedies combined with scientific principles to form a modern but distinctly Chinese form of medicine (Croizier, 1965; Farquhar, 1996).

Since then, Chinese politics and social issues have continued to shape TCM, reflecting nationalistic sentiment, as well as the emergent consumer culture of the Chinese upper middle class. Although Western medicine is prevalent in China today, TCM remains an important practice closely intertwined with the Chinese Communist Party. Today, government support for TCM is robust, often credited as a chief factor in the contemporary ubiquity of TCM in China, in contrast to the general pattern of modern evidence-based medicine supplanting traditional indigenous knowledge. Animal based TCM remedies and associated health tonics are also important status symbols reflecting personal wealth in contemporary China (Liu, 2019).

Case Study 1: Seahorses

Introduction

Seahorses of the genus *Hippocampus* are central to the discussion of conservation and ethnopharmacology, as they are threatened globally due to overexploitation serving international TCM markets (Convention on International Trade in Endangered Species of Wild Flora and Fauna, 2019). To a lesser degree, seahorses are also imperiled by habitat degradation and fragmentation caused by human activity, exacerbated by the unique life history traits they possess (Foster & Vincent, 2004). The entire genus *Hippocampus* has been classified in CITES Appendix II, which restricts international trade of all 46 recognized species of seahorse (Convention on International Trade in Endangered Species of Wild Flora and Fauna, 2019). Several seahorse species are subject to targeted poaching due to their use in TCM (Chen et al., 2015).

In TCM, seahorse is a sweet, salty, and warm substance that enters the body through the kidney and liver meridians. It is sold in dried whole or powdered form, and is used for several purposes, notably the treatment of impotence, urinary incontinence, poor blood circulation and wheezing (Bensky & Gamble, 1989; Chen et al., 2012). Seahorse (*Hai Ma*) was first described in the TCM text *Omissions from the (Classic of the) Materia Medica*, written by Chen Cangqi in the Tang Dynasty (618-907 CE) around the year 720 CE. This text was intended as an addendum or supplement to the existing literature of the time, rather than a stand-alone encyclopedic work (Bensky & Gamble, 1989). TCM materia medica texts do not specify a single species of seahorse necessary for medicinal effectiveness, but rather multiple, including the three-spot seahorse (*H. trimaculatus*), great seahorse (*H. kelloggi*), spiny seahorse (*H. histrix*), Japanese seahorse (*H. mohnikei*), and common seahorse (*H. kuda)* (Hou et al., 2016). Five of the 33 species of seahorse are harvested domestically in China: *H. trimaculatus*, *H. kuda*, *H. kelloggi*, *H. histrix*, and the hedgehog seahorse *H. spinosissimus* (Chen, et al., 2015).

Seahorses are an almost entirely benthic[2] genus of fish with a distinctive appearance and a global distribution stretching along temperate and tropical shallow coastal habitat patches, including seagrass beds, mangrove forests, and coral reefs. These nearshore ecosystems provide seahorses with holdfasts they can use to anchor themselves against strong currents, as well as a background for camouflage, a key predator avoidance tactic (Lourie et al., 2004; Scales, 2010). These factors are essential to seahorses' survival, since they are weak swimmers, using their anal fin to propel themselves forward in short, slow bursts. Their prehensile tail enables seahorses to remain stationary so as to avoid predation and feed on passing zooplankton (Freedman, 2021). One of the most exceptional features of seahorses is their reproductive strategy. Female seahorses deposit fertilized eggs into a male's brood pouch. Once the eggs have been transferred, the young develop within the brood pouch until they are self-sufficient, at which point they are expelled into

[2] There is only one potentially pelagic species, *H. fisheri*, found in Hawaii (Lourie et al., 2004)

the water column to disperse through ocean currents. Seahorses represent the only known instance of male pregnancy in the animal kingdom (Vincent, 1990; Foster & Vincent, 2004).

Conservation

The nearshore ecosystems seahorses inhabit are all susceptible to anthropogenic influence, including structural damage from trawling, chemical and sediment runoff, as well as other forms of habitat degradation (Short et al., 2011; Wear, 2016; Romañach et al., 2018). As a result, their populations tend to be highly fragmented, potentially worrisome in terms of their levels of genetic diversity (Lourie et al., 2004; Scales, 2010). Seahorses' patchy distributions, along with their preference for already threatened coastal habitats increase their risk of extinction, although the links between habitat loss and seahorse population decline remains understudied (Zhang & Vincent, 2018).

In addition to their unique morphology and dependence on specialized, already-threatened habitats, seahorses have several biological characteristics that intensify their risk of extinction from overfishing and habitat degradation. Unlike juveniles, adult seahorses are incapable of drifting or actively swimming to new habitat patches, and display high site fidelity (Foster & Vincent, 2004). This means once a seahorse population is extirpated from a specific area, the habitat is unlikely to be repopulated by new individuals. Seahorses also exhibit low sexual maturity and relatively low fecundity, depending on the species, which hinders the process of population recovery. In a breeding cycle, a pair of seahorses will produce as few as 5 to 2000 developed young (Vincent et al., 2011), paling in contrast to the most fecund fish yet recorded, the ocean sunfish, which can produce up to 300 million eggs (Pope et al., 2010). High fecundity effectively compensates for the intense predation ocean sunfish and other pelagic fish face as juveniles—an issue seahorses do not experience to the same degree. However, seahorses do not produce enough young to offset the number of adults harvested for use in TCM (Vincent et al., 2011). Some seahorse species are monogamous. In these cases, upon an individual's death, its partner will not breed until it finds another unpaired seahorse of the same species; other seahorse species that practice lifelong monogamy will not mate again after the death of their partner. Finding a replacement partner can be difficult due to low population densities and restricted mobility (Foster & Vincent, 2004; Lourie et al., 2004).

All of these factors have brought seahorses to the foreground of marine conservation efforts. Of the 46 species of seahorse recorded by the International Union for Conservation of Nature (IUCN), 9 are of least concern, 1 is near threatened, 12 are vulnerable, 2 are endangered, 18 are data deficient, and 4 are not evaluated (Stanton et al., 2021). In an effort to regulate the sale of seahorses, the Convention on International Trade in Endangered Species (CITES) established a minimum length of 10 cm for seahorses being traded internationally, from 2004 onward, with the exception of the great seahorse *H. kelloggi*. There are 183 governments currently beholden to CITES regulations, with failure to follow resulting in international trade bans (Convention on International Trade in Endangered Species of Wild Flora and Fauna, 2019; Koning & Hoeksma, 2021). However, the harvesting and trade of seahorses still pose the most acute threat to their populations worldwide, despite the lack of reliable information regarding the volume of poached and trafficked seahorses (Vincent et al., 2011).

In a sampling of three TCM markets in China, Hou et al. (2016) identified nine species of seahorse using DNA barcoding methods. Among these, three species—tiger tail seahorse (*H. comes*), Pacific seahorse (*H. ingens*) Barbour's seahorse (*H. barbourin*), and Queensland seahorse (*H. queenslandicus*)—were not native to Chinese coastal regions, and therefore not mentioned in materia medica texts. In another study of Taiwanese TCM stores, Chang et al. (2013) found eight species of seahorse, three of which (tiger tail seahorse (*H. comes*), *H. algericus*, and Cape seahorse (*H. capensis*)) do not have geographical ranges that include China. These two surveys suggest that some of the seahorses sold in TCM may not be verified remedies according to the conventional medical framework. As dried seahorses are often cut lengthwise before being sold, species can often be difficult to distinguish. This leaves room for exploitation of seahorses globally, not just in east Asia. The establishment of marine protected areas may be an appropriate initial strategy to preserve wild seahorse populations via restricted harvesting (Scales, 2010).

Alternative Remedies

Another strategy to conserve seahorses in the context of TCM is to establish and popularize plant-based alternative remedies with the same medical properties, thus decreasing and hopefully eliminating the demand for seahorse products. Astralagus seed (*Sha Yuan Zi*) is a similar remedy for impotence and urinary incontinence, entering the kidney and liver meridians with sweet and warm properties (Bensky & Gamble, 1989). It was first mentioned in Su Song's *Illustrated Classic of the Materia Medica*, also compiled during the Song dynasty in the year 1061 CE (Chen et al., 2012). Cooked Chinese foxglove root (*Shu Di Huang*), a sweet and slightly warm remedy entering through the kidney and liver meridians, aids in invigorating blood circulation and eliminating wheezing (Bensky & Gamble, 1989). *Shu Di Huang* was first mentioned in the Tang dynasty (690-705 CE) text

Thousand Golden Essential Perscriptions written by Sun Simiao (Chen et al., 2012). Although the discovery of seahorse predates that of Astralagus seed, it, as well as cooked Chinese foxglove root, remains a practicable alternative to seahorse products and fall within the scope of TCM.

Case Study 2: Bear

Introduction

Bears are another notable, globally distributed[3] animal used in TCM. There are eight species of bear: *Ursus americanus* (American black bear), *Tremarctos ornatus* (Andean bear or spectacled bear), *Ursus thibetinus* (Asiatic black bear), *Ursus arctos* (brown bear or grizzly bear), *Ailuropoda melanoleuca* (Giant panda), *Ursus maritimus* (polar bear), *Melursus ursinus* (Sloth bear), and *Helarctos malayanus* (Sun bear). However not all species are threatened due to their medicinal properties (Feng et al., 2009). In TCM, bile is traditionally extracted from the gallbladders of the Asiatic black bear and brown bear (Chen et al., 2012). Today, the American black bear and sun bear are also at risk of exploitation for their bile (Lin et al., 1997).

In addition to TCM-related poaching, the Asiatic black bear, American black bear, brown bear, and sun bear are threatened by illegal sport hunting, habitat loss due to logging and human proximity, and decrease in food availability, among other factors (Zedrosser et al., 2011; Scotson et al., 2019). Bear gallbladder (*Xiong Dan*) is a bitter and cold substance entering the body through the heart, gallbladder, and liver meridians. It is used to treat several conditions, including fever, jaundice, and swelling (Bensky & Gamble,

[3] Excluding Antarctica, Australia, and Africa (Feng et al., 2009).

1989; Chen et al., 2012). It was first recorded in the *Newly Revised Materia Medica*, written in 659 CE by Su Jintao during the Tang dynasty (Chen et al., 2012). The *Newly Revised Materia Medica* was an imperially commissioned text, considered to be the first national compendium of medicinal substances (Zhao et al., 2018).

Black bears (both American and Asiatic), brown bears, and sun bears are all forest dwelling, omnivorous animals crucial to the health of their respective ecosystems (Garshelis et al., 2016; McLellan et al., 2017; Scotson et al., 2017; Garshelis & Steinmetz, 2020).

The American black bear is widely distributed across North America's boreal and temperate forests, with a range extending patchily into Mexico. Its diet includes fish, mammals, insects, fruits, vegetation, nuts, and seeds, as well as human-cultivated crops and garbage. They are notable for their ecologically important roles as predators and seed dispersers. After reaching sexual maturity between 3 and 10 years of age, they produce, on average, 2.5 cubs every other year. American black bears hibernate up to 7 months of the year.[4] Known for their frequent dispersal and recolonization of previously depleted areas, American black bears are resilient, provided food is abundant and human interference is limited (Garshelis et al., 2016).

Asiatic black bears are found in a diverse array of forests, at various elevations (sea level to 4300m), as far west as Afghanistan and Pakistan, and as far east as Japan, with notable resident populations in southern China, Korea, and along the Himalayas. They share the southern portion of their range with sun bears. Like American black bears, Asiatic black bears' diet consists of vegetation, fruits, nuts, insects, and, in some places, meat (both

[4] Those living in southern latitudes may forgo hibernation altogether (Garshelis et al., 2016).

scavenged carcasses and fresh kills). However, they are less carnivorous than their American counterpart, and are sometimes preyed upon by tigers, brown bears, and other Asiatic black bears. Hibernation is latitude-dependent in this species. Asiatic black bears begin reproducing between 4 and 5 years of age, and usually produce a single cub (2 at the most) every other year. Due to their consumption of a wide variety of plants, especially in more southerly latitudes where they are largely frugivorous, Asiatic black bears disperse the seeds of a number of species of fleshy fruit. Populations are currently decreasing due to poaching, along with other anthropogenic and environmental threats, despite the alternative practice of bear bile farms (Garshelis & Steinmetz, 2020).

The brown bear has a wide range,[5] spanning North America, Russia, Europe, and western Asia (including parts of China). They occupy the most diverse habitats of any bear species, including temperate rainforests, steppes, and shrublands. More carnivorous than either species of black bear, brown bears have highly variable diets, depending on where they live. In coastal areas, salmon may make up a large part of a brown bear's food intake, while in arctic areas, ungulates may be more frequently eaten. Insects and plant material, such as nuts, berries and greens are more prevalent in other portions of their range. Brown bears hibernate in the winter when food supply is low, and are highly variable in their reproduction, depending on habitat and food availability, with a minimum of 1 cub every 5 years in northern Pakistan to a maximum of 4-5 cubs every other year in certain parts of Europe. Brown bears are among the bear species known as keystone species for their crucial role in regulating the ecosystems in which they reside. They control prey numbers, fertilize soil though their excrement (particularly after eating nutrient-rich food such as

[5] Brown bears may share their range with both American and Asiatic black bears (McLellan et al., 2017)

salmon), and disperse seeds, much like black bears do. The extirpation of brown bears in their range may drastically upset the balance of their habitat and the organisms around them (McLellan et al., 2017).

Sun bears are perhaps the least-known of the four main species of bears exploited for their bile. Once occupying an extensive range throughout Asia, they now occur patchily from southwest China to the Indonesian island of Sumatra, including Myanmar, Thailand, Malaysia, Vietnam, and Cambodia, among other nations. They inhabit montane deciduous forests, as well as both seasonal and aseasonal evergreen forests throughout their range (Scotson et al., 2017). The bulk of sun bears' diet is comprised of insects, including stingless bee larvae, beetle larvae, ants, and termites. Sun bears also eat honey, fruit (particularly figs), and have been known to engage in crop raiding of fields, orchards, and plantations (Guharajan et al., 2018). Since their habitat has year-round food sources, sun bears do not hibernate. They are estimated to produce one calf at a time and do not breed seasonally. Their behavior and ecology are otherwise little studied (Scotson et al., 2017).

Conservation

The American black bear and brown bear are listed as least concern per the IUCN, with more intensely threatened populations occurring periodically throughout their ranges. Despite both species having declined from their historical numbers, in line with the majority of wildlife, they are widespread and do not possess any risk of extinction currently. Brown bears populations are stable, while American black bears are experiencing an increasing population trend (Garshelis et al., 2016; McLellan et al., 2017).

The IUCN considers Asiatic black bears and sun bears vulnerable,[6] indicating a risk of human-caused extinction in the wild. Over the last 30 years, both species have experienced significant decreases in distribution as well as population density—trends that continue into the present (Scotson et al., 2017; Garshelis & Steinmetz, 2020).

The trade of all species of bear is regulated by CITES, with different degrees of restriction. Classification under Appendix II indicates legal trade with oversight or constraints, as with seahorses, and classification under Appendix I indicates all trade is illegal, save for exceptional circumstances (CITES, n.d.). American black bears are listed under Appendix II (CITES, 2021a). Brown bears are listed under both Appendix I and II, depending on the country of origin[7] (CITES, 2021c). Due to their threatened status, Asiatic black bears and sun bears are listed under Appendix I (CITES, 2021b, 2021d).

Asiatic black bears, American black bears, brown bears, and sun bears all face unique barriers to their conservation, with different factors affecting each species to a varying degree. In the case of brown bears and American black bears, the threat of commercial bile harvest is a lesser concern in comparison to factors like human-bear conflict and anthropogenic habitat degradation (Garshelis et al., 2016; McLellan et al., 2017). Sun bears and Asiatic black bears face the brunt of the demand for bear bile in TCM, which drives illegal poaching as well as international trafficking, both of which are severely underregulated. This fact, in combination with logging, local hunting for meat, and

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[6] The lowest of the three "threatened classifications used by the IUCN: vulnerable, endangered, and critically endangered

[7] Brown bear populations in China, Bhutan, Mongolia, and Mexico are subject to Appendix I; all other countries follow appendix II regulations

incidental snaring, makes sun bears and Asiatic black bears the primary focus of this case study (Scotson et al., 2017; Garshelis & Steinmetz, 2020)

In the case of the Asiatic black bear, there is an additional factor to consider in the context of its conservation—bear farms. In these facilities, bile is repeatedly taken from live captive bears that are either poached from the wild or bred in captivity. Developed with the intent to decrease the need for wild-harvested bile, farming practices are considered inhumane due to the poor condition bears are held in and the continuous-drip method used to obtain the bile from bears' gallbladders, which increases their susceptibility to cancer and infection (Feng et al., 2009; Garshelis & Steinmetz, 2020). In addition, farmed bile is less sought after by TCM practitioners and consumers, who perceive wild-harvested bile to be superior, and are willing to pay more for it (Dutton et al., 2011; Hinsley et al., 2021). There is a possibility that the availability of farmed bile may help bear bile reach new consumers, who may not otherwise be able to afford wild-harvested bile, but will make the switch when it is financially feasible for them to do so, thereby exacerbating the issue of wild bear poaching and trafficking. Farmed bear bile is also being used in non-medicinal capacities, including ingestible health tonics, cosmetics, and other personal care products aimed at promoting overall wellness, thus creating a new segment of the bear bile industry, which may further endanger bears globally (Garshelis & Steinmetz, 2020).

Since bears occur in variable environmental contexts, there are a wide range of strategies necessary to conserve bear populations. Both Asiatic black bears and sun bears would benefit from protection of the forest ecosystems in which they reside. Avoiding habitat degradation by instituting logging bans, as well as protecting the fruit trees they rely on for food, aids in stabilizing bear populations in the face of intense pressure from poaching and incidental kills (Scotson et al., 2017; Scotson et al., 2019; Garshelis & Steinmetz, 2020). Changes in Asiatic black bears' diet due to climate change may also have a significant effect on their range, reproductive behavior, and survival (Zahoor et al., 2021). Palm plantations are a widespread issue across the sun bear's range, as natural forests are cleared on a massive scale in favor of an economically advantageous monoculture. This reduces the number and diversity of fruiting trees available to sun bears. While sun bears have been able to adapt to palm plantations by climbing palm trees, eating palm fruit, and taking advantage of the shade the trees afford them, the altered landscape is ultimately detrimental to their conservation. Allowing palm plantations to be partially or fully rewilded may permit sun bears' long-term survival (Guharajan et al., 2018).

Alternative Remedies

Despite other factors in bear conservation, the demand for bear bile fuels the most imperative issue in bear conservation—poaching. In order to mitigate this concern, herbal alternatives to bear bile should be investigated. Because bear bile is used for so many different medicinal purposes, multiple alternatives may be necessary. For the equivalent treatment of fever and jaundice, Baikal skullcap root (*Huang Qin*) may be suitable. Like bear bile, Baikal skullcap root has bitter and cold properties, but enters through the gallbladder, lung, stomach, and large intestine meridians (Bensky & Gamble, 1989; Chen et al., 2012). It originates from the *Divine Husbandman's Classic of the Materia Medica* (Chen et al., 2012), which was written during the Eastern Han Dynasty (25-220 CE) and is considered the most ancient extant TCM text responsible for the discovery of at least 365 medicinal herbs still used in TCM (Zhao et al., 2018). In addition, Baikal skullcap root can be harvested domestically within China (Bensky & Gamble, 1989). A second potential substitute for bear bile is gardenia fruit (*Zhi Zi*), which is used to treat swelling and topical pain. It enters through the heart, lung, stomach, and triple burner, and acts on the body with bitter and cold properties. It was also first recorded in the *Divine Husbandman's Classic of the Materia Medica* (Bensky & Gamble, 1989; Chen et al., 2012). These proposed herbal remedies are similarly highlighted in Appiah et al.'s (2017) chemical study of bear bile substitutes. A table of the alternate remedies outlined in this paper is given below.

Table 1: Animal-based remedies and their alternatives

Animal Product	Use (Bensky & Gamble, 1989; Chen et al., 2012).	Alternative Remedy
Seahorse	Impotence, urinary incontinence	Astralagus seed
	Poor blood circulation, wheezing	Cooked Chinese foxglove root
Bear bile	Fever, jaundice	Baikal skullcap root
	Swelling, topical pain	Gardenia fruit

Conclusion

The conservation-related impacts of animal-based TCM remedies pose a critical, multifaceted issue for biologists, medical practitioners, policymakers, and social scientists alike. Consequently, any feasible solutions to the overexploitation of animals in this context require a multidisciplinary approach that is sensitive to the cultural heritage of TCM's consumer base, while looking to shift TCM away from unsustainable practices (Cheung et al., 2020). Since supply-based controls on illegal wildlife poaching and trafficking (including trade and sale bans) have proven to be largely unsuccessful, mitigating the demand for these animals is a solution worth exploring (Chang, 2017; Thomas-Walters et al., 2020).

Both case studies explored in this paper illustrate the role of TCM products beyond their perceived medicinal value. Crucially, seahorses and bear bile lend social cachet to those who use them. The efficacy of these remedies is less relevant to their consumers than the cultural value and sense of antiquity they possess, despite the fact that neither of them were described in medical texts until the mid-Tang dynasty (618 – 907 CE), four centuries after the first recorded standardization of traditional medical practices in China. This entanglement of science and culture yields several barriers to the successful implementation of the herbal alternatives discussed in this paper.

One complicating factor is the prevalence of heath tonics—chiefly animal-based delicacies sought after for their cultural, if not medical, significance (Bensky & Gamble, 1989; Chen et al., 2012). While health tonics are associated with TCM, their efficacy is often called into question, since they are not always listed in the official TCM pharmacopeia. Some tonics are in the form of a comestible, such as shark fin soup, which has come under international scrutiny for its role in endangering shark populations globally (Sadovy de Mitcheson et al., 2018), in addition to the high levels of monomethylmercury occurring in it (Nalluri et al., 2014). Other health tonics, like shampoos made with farmed bear bile, may be detrimental to conservation efforts due to the new niche markets they open. TCM does not support the non-pharmaceutical use of bear bile, and products like these may further jeopardize bears by increasing bear bile's consumer base beyond those pursuing medical treatment for certain ailments (Dutton et al., 2011). Since health tonics operate outside the scope of TCM texts, it is difficult to suggest potential substitutes. Further study of health tonics and consumers' willingness to stop purchasing them is needed in order to address this issue.

Another concern regarding the viability of alternative remedies is the degree of receptivity practitioners and consumers possess towards plant-based solutions. The attitudes of TCM consumers and practitioners should be gauged in order to provide a baseline for future initiatives like the WildAid PSA campaign against shark fin soup, which has aired on mainland Chinese national television since 2006 (Jeffreys, 2016). In one study of consumers in Beijing, Liu et al. (2017) evaluated their use and opinions of bear bile and bear farming. They found that consumer willingness to use bear bile increased with the age of participants and decreased with their degree of education. These results suggest that younger individuals with a higher level of education may be more amenable to the alternative remedies suggested in this paper.

Shifting public opinion is imperative in order to mitigate demand for seahorse, bear bile, and other luxury TCM products. However, government or NGO-led initiatives aimed at decreasing consumption of these remedies should focus on lowering their desirability and the social influence associated with these products, rather than delegitimizing TCM as a whole. While the narrative of TCM as a superstitious set of beliefs responsible for grave environmental harm is prevalent in Western conservation media, it has the potential to alienate TCM consumers and practitioners to the cause of wildlife conservation. Instead, TCM may be able to untwine itself from unsustainable practices by way of a partnership of wildlife conservation, medicine, anthropology, and environmental policy.

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