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Using consumer preferences to characterize the trade of wild-collected ornamental orchids in China

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Abstract

Overexploitation of wildlife for trade threatens taxa globally. Interest in demand-side approaches to address this problem has grown but understanding of how consumer preferences shape demand remains limited. To quantify the role of consumer preferences for wild orchids in China's horticultural market, we used conjoint analysis to determine which attributes are preferred by orchid owners and nonowners in two socioeconomically contrasting areas of South China. Across all respondents, price was the most important attribute followed by flower color. While Xishuangbanna participants exhibited a slight preference for wild over cultivated plants, origin (wild/cultivated) was of minimal importance. We also measured awareness of orchid import regulations. Most did not recognize the CITES logo, and knowledge of import laws was significantly lower in Hong Kong than in Xishuangbanna. Our findings suggest that trade in wild ornamental orchids in South China is supply-driven, and strengthened regulations might be effective in reducing overexploitation.

KEYWORDS

behavioral change, demand reduction, orchidaceae, plant trade, regulation, wildlife trade

摘要

过度开采野生动植物进行贸易威胁着全球的生物类群。从需求的角度来解决这一问题的方法和兴趣与日俱增, 但对于消费者偏好如何影响需求的了解仍然很有限。为了量化消费者偏好对中国花卉市场上野生兰花所起的作用, 我们在中国南方两个社会经济截然不同的地区, 采用联合分析法来确定哪些属性是兰花业主和非业主的首选。在所有受访者中, 价格是最重要的属性, 其次是花色。虽然西双版纳地区的受访者对野生植物的偏好略高于栽培植物, 但来源 (野生或栽培) 的重要性微乎其微。我们还调查了受访者对兰花进口法规的意识, 大多数人并不认识CITES的标识, 有关进口法律的知识在香港显著低于西双版纳地区。我们的研究结果表明, 中国南方地区野生观赏兰花贸易是供给驱动的, 加强管制可能有效地减少过度开采。

1 | INTRODUCTION

Overexploitation of economically valuable species is a major threat to biodiversity (Ticktin, 2004), with customs seizures suggesting that at least 7,000 species are trafficked internationally (UNODC, 2016). Despite global targets, little progress has been made in reducing this threat (Brashares et al., 2014). Addressing overexploitation in the illegal wildlife trade has historically relied on regulation at both national and international levels, most notably through the Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES). However, the effectiveness of CITES and other regulations in preventing overexploitation can be limited where awareness of the rules is low, or where noncompliance is unlikely to result in negative consequences (Hinsley, Nuno, Ridout, St John & Roberts, 2017). Proposals to increase the protection of a CITES-listed species by moving it to a higher Appendix have on occasion been linked to increased trade (Rivalan et al., 2007).

Challenges in regulating illegal trade have led to increased interest in supply-side and demand-reduction approaches (Challender, Harrop, & MacMillan, 2015a). Supply-side approaches may involve introducing farmed substitutes to the market, assuming consumers will buy the new product. However, little is known about the conditions under which such interventions work (Phelps, Carrasco, & Webb, 2014). Equally, on the demand side, research on how consumer behavior can be modified is scant.

Understanding consumer behavior facilitates the development of approaches to address overexploitation and illegal trade (Nuno et al., 2017). For example, consumers may place higher value on wild-sourced medicinal products but would substitute them for synthetic alternatives given the right price, if they remained effective (Liu, Jiang, Fang, Li, & Meng, 2015a). Further, although scarcity caused by overexploitation may lead to increased harvesting costs and reduced net profit (Challender, Harrop, & MacMillan, 2015b), consumers may place higher value on rare species, thus maintaining incentives for traders (Hall, Milner-Gulland, & Courchamp, 2008; Zhang & Yin, 2014). This can lead to increased extinction risk for highly valued rare species (Courchamp et al., 2006). Evidence suggests that instilling rare species with higher value is widespread (Angulo, Deves, Saint Jalmes, & Courchamp, 2009), particularly among specialist or hobby collectors (Hall et al., 2008). In such cases, supply-side approaches may be difficult to implement. Where traders and/or consumers break rules in the knowledge that noncompliance is unlikely to be detected (Hinsley et al., 2017), better enforcement may be required. In reality, diverse species and markets probably necessitate a tailored approach: a 2016 CITES Resolution focused on demand-reduction noted that "*well-targeted, evidence-based, species-specific, country-specific*" interventions should be prioritized (CITES Res. Conf. 17.4).

Few studies have investigated the role of consumer behavior in driving overexploitation of rare, wild species in the lucrative horticultural trade (Goettsch et al., 2015; Winter & Botha, 1994). Here, we investigate consumer preferences for particular attributes of ornamental plants. We take a targeted approach, focusing on the Chinese market for orchids, a large taxonomic group included in its entirety by CITES, and accounting for >70% of all species listed by the Convention. Orchid cultivation in China is recorded as far back as the Wei Dynasty (220–265 AD: Hew, 2001), but purchasing of wild-harvested plants and their derivatives has become a symbol of elite status among the burgeoning middle class especially in the last two decades (Huang, 2011). As a result, overharvesting of wild orchids for the Chinese market has been recorded within China itself as well as in neighboring countries (Zhang & Yin, 2014). This situation is exacerbated by problems with CITES enforcement at border checkpoints (Chow, Cheung, & Yip, 2014; Gale, Bizid, Liu, & Chan, 2014). Moreover, whereas all wild plants (including orchids) on government land are protected under Hong Kong law (Barretto, Cribb, & Gale, 2011), legal protection for Mainland China's wild plants is relatively weak compared to that for animals, with the Regulations of the People's Republic of China on Wild Plants Protections (1996) stipulating only modest fines for violators (McBeath & McBeath, 2006). In addition, no orchids are listed among the 251 nationally protected plant species (State Council, 1999). While the conservation implications of wild orchid harvesting for medicinal use in China have received some research attention (Liu, Luo, Heien, Bhat, & Liu, 2014), the ornamental trade remains unexamined. Here, we assessed the relative importance of rarity and origin, among other attributes, in influencing consumer choice. We also sought to quantify consumer awareness of relevant environmental law. Our findings enable us to make recommendations for the most suitable approach to addressing unsustainable trade.

2 | METHODS

2.1 | Study sites

Our study focused on two demographically contrasting areas of South China: Xishuangbanna and Hong Kong. Xishuangbanna is a comparatively sparsely populated rural area in the Dai Autonomous Prefecture of Yunnan Province in southwest China, bordering Myanmar and Laos. Its status as a major domestic ecotourism destination meant there was potential to encounter respondents from many areas of Mainland China. In contrast, Hong Kong is a densely populated and economically developed free trade port; for CITES purposes, the border between Hong Kong and Mainland China is an international boundary. Both sites are known centers for

In the next 13 questions you will be asked to choose between two kinds of orchid based on five characteristics. Assuming that you can grow both equally well in your collection, which one would you buy? If you decide not to purchase either species, then select 'None'

Orchid A	Orchid B	
Red Common in the wild Wild 125 RMB Fragrant	Yellow Rare in the wild Cultivated 1000 RMB Fragrant	I would not choose either (None)

FIGURE 1 An example of a conjoint task. Respondents were required to indicate which of the orchids they would prefer to purchase, or if they would not purchase either

the international wildlife trade (Chow et al., 2014; Li & Wang, 1999), including plants (Lamxay, 2009; Lau, 2014; UNODC, 2016) and their characteristics have been linked to increased pressure for wild resource extraction and trade (Shepherd, Compton, & Warne, 2007). In addition, both sites are situated within the highly threatened Indo-Burma Biodiversity Hotspot and are rich in orchids (Barretto et al., 2011; Zhang, Yan, Tian, Li, He, & Tang, 2015).

In Xishuangbanna, data collection was carried out at Xishuangbanna Tropical Botanical Garden (XTBG; N21°55′33″ E101°15′23″), a large state-owned public garden, and popular visitor attraction, whereas in Hong Kong, data was collected at Mong Kok Flower Market (MKFM; N22°19′30″ E114°10′19″), the city's horticultural retail precinct.

2.2 | Conjoint analysis

We used conjoint analysis to investigate preferences for orchids in the Chinese horticultural trade. Conjoint analysis works under the premise that consumers evaluate the overall desirability of a product by weighing up the value of its separate attributes. By observing the choices made by purchasers when such attributes are systematically varied, the value of each attribute can be statistically deduced (Orme, 2006). Originally developed in the marketing industry, conjoint analysis has been used to investigate consumer preference for products as diverse as electric cars (Lebeau, Van Mierlo, Lebeau, Mairesse, & Macharis, 2012) and marine fish (Claret et al., 2012), as well as for nonmarket topics including environmental planning (Álvarez-Farizo & Hanley, 2002). We developed conjoint tasks to capture factors that growers commonly consider when buying orchids, namely flower color, price, rarity, scent, and origin (wild or cultivated) (Hinsley, Verissimo, & Roberts, 2015), to investigate how these attributes influence preferences.

TABLE 1 Orchid attributes and attribute levels included in the conjoint tasks. Equivalent prices were selected for the XTBG (in RMB) and MKFM (in HKD) questionnaires

Attribute	Attribute levels
Flower color	White Yellow Green Red
Rarity	Common in the wild Rare in the wild
Price	125 RMB/15 HKD 1,000 RMB/140 HKD 8,000 RMB/1,000 HKD
Origin	Wild Cultivated
Scent	Fragrant Not fragrant

2.3 | Questionnaire

We developed a questionnaire consisting of three sections: (i) a demographic section incorporating questions on respondents' relationship with orchids (owner/nonowner) and their orchid purchases in the preceding 12 months; (ii) 13 conjoint tasks; and (iii) knowledge of CITES as it pertains to orchids (see Supporting Information for questionnaire). We used 5 attributes and 13 levels (Table 1), which were combined using Sawtooth Software SSI Web 7 (Sawtooth Inc. 2010) into a $4 \times 2 \times 3 \times 2 \times 2$ factorial design measuring main effects. For each full-profile conjoint task, respondents indicated which of the two orchids they would purchase, or if they would not purchase either (Figure 1). We compared the relative importance of attributes favored by orchid owners and nonowners

to allow us to determine whether preferences were specific to current owners or common across the wider public.

The conjoint experiment estimated nine parameters (calculated as: number of levels – number of attributes + 1). The optimal range of conjoint tasks to be completed by each respondent is 1.5–3 times the number of parameters to be estimated (Sawtooth Inc. 2010). Following this guideline, each respondent should answer between 13 (9×1.5) and 27 (9×3) tasks. To avoid respondent fatigue, we presented 13 conjoint tasks; impacts of this decision on design efficiency were minimized by generating three different conjoint tasks sets (each containing 13 tasks), which were distributed to respondents in a random order in approximately equal quantities. This approach simultaneously minimizes potential bias introduced by question order.

We measured knowledge of laws relevant to the transporting of wild orchids internationally by presenting respondents with images of plants from the commonly traded genera *Dendrobium*, *Paphiopedilum*, and *Habenaria*. For each genus, respondents were asked to indicate whether they thought there were no restrictions on importing each into China/Hong Kong, whether importing requires a permit, whether no importing is allowed, or if they did not know.

Finally, we showed respondents the CITES logo and asked them whether they believed it represented (a) the organization that registers new orchid hybrids; (b) the law that restricts international trade in animals and plants; (c) the government body that tests the quality of medicinal orchids; or (d) a company that produces plastic orchids in China.

The questionnaire was first prepared in English before translation into Chinese (XTBG simplified characters; MKFM traditional characters), and back-translation into English to ensure accuracy. Prior to data collection the questionnaire was piloted at both sites. At XTBG, data collection took place from August to November 2014 by enumerators standing near the entrance of the garden. At MKFM, data collection took place from December 2014 to June 2015, with enumerators standing outside popular flower shops. Free prior informed consent was obtained from all respondents who were told that their participation was voluntary and that all data were anonymous. Ethics approval was granted by Bangor University Ethics Committee.

2.4 | Data analysis

We calculated the relative preference for attributes and levels within attributes using hierarchical Bayes analysis in Lighthouse Studio (Sawtooth Software Inc., 2016). This analysis estimates a hierarchical random coefficients model using a Monte Carlo Markov Chain algorithm. At the upper level of this hierarchical model, respondents are considered as a population of similar individuals, meaning that information can be "borrowed" between respondents when estimating parameters. At the lower level, each individual's part-worth estimates were assumed to be related to their overall rating of the product (orchids in this instance) by a linear regression model (Sawtooth Software Inc., 2016); full details of this model are available in Sawtooth Software Inc. (2009).

Data were checked for normality in SPSS (IBM SPSS Statistics 21.0) using the Kolmogorov–Smirnov test combined with visual assessment of Q–Q plots and stem and leaf plots. Where required, nonparametric tests were used to examine differences between groups.

3 | RESULTS

A total of 924 respondents completed the survey (224 and 200 orchid owners at XTBG and MKFM, respectively, plus 250 nonowners at each site). The median age was 37 (IQR 22, $n = 876$) and differed between respondent subgroups (Kruskal–Wallis $H = 152.16$, $P < 0.001$) with the median age of those at MKFM being greater (MKFM owners 47, IQR = 22; MKFM nonowners 41, IQR = 21) than those from XTBG (XTBG owners 34, IQR = 18; XTBG nonowners 28, IQR = 11). Subgroups also differed in the number of years' education they had completed ($H = 172.69$, $P < 0.001$); the median years of education was higher among XTBG respondents (XTBG owners 4, IQR = 1; XTBG nonowners 5, IQR = 1) than among MKFM respondents (MKFM owners 3, IQR = 2; MKFM nonowner 3, IQR = 2). Respondents sampled at XTBG came from 29 Mainland Chinese provinces plus Taiwan, whereas all MKFM respondents resided in Hong Kong.

Across all three orchid genera, knowledge of orchid import law was significantly lower in Hong Kong than in Mainland China (*Habenaria* X^2 124.6, $P \leq 0.001$, $n = 923$; *Paphiopedilum* X^2 103.5 $P \leq 0.001$, $n = 923$; *Dendrobium* X^2 124.0, $P \leq 0.001$, $n = 923$) (Table 2), and lowest among nonorchid owning respondents of Hong Kong (Table S1). When asked what the CITES logo represents, most (85.9%) did not know. MKFM respondents were significantly less likely to report that CITES regulates international trade in wild animals and plants (X^2 44.81, $P \leq 0.001$, $n = 923$).

We calculated mean utility values for orchid characteristics using hierarchical Bayes estimation (Figure 2). Price followed by color was the most important attributes across all respondents. While price preferences differed significantly among the four groups (Kruskal–Wallis $H = 55.78$, $P \leq 0.001$), there were no significant differences in the amount of importance placed on color ($H = 4.63$, $P = 0.201$) or origin ($H = 3.96$, $P = 0.266$). Importance of orchid rarity differed significantly (Kruskal–Wallis $H = 28.11$, $P \leq 0.001$), being least important for MKFM nonowners; scent was significantly more important for XTBG respondents ($H = 125.89$, $P \leq 0.001$).

TABLE 2 The percentage of respondents from XTBG (*n* = 474) and MKFM (*n* = 450) reporting their perception of import laws associated with different orchids. The correct answer for each of the three orchid groups, *Habenaria*, *Paphiopedilum*, and *Dendrobium*, is that they can be imported into mainland China, including Hong Kong, with a permit

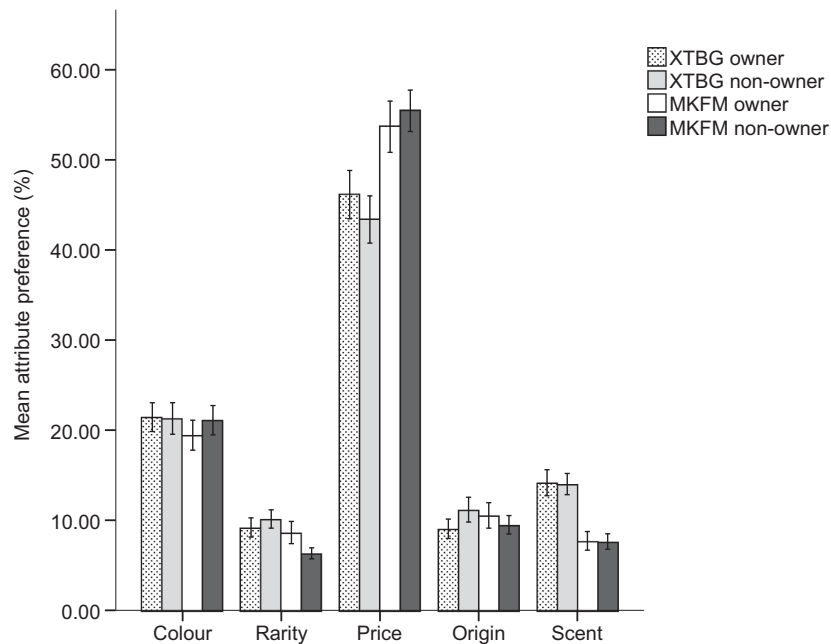| Response option	*Habenaria*		*Paphiopedilum*		*Dendrobium*	
	XTBG	**MKFM**	**XTBG**	**MKFM**	**XTBG**	**MKFM**
No import restrictions into Hong Kong/China	23.7	4.2	20.7	8.4	28.5	8.7
Importing into Hong Kong/China allowed with a permit	28.8	16.9	35.3	19.3	30.9	19.3
No importing allowed	7.4	4.9	7.0	2.2	6.6	2.7
Don't know	40.2	74.0	37.0	70.0	34.0	69.3

FIGURE 2 The relative importance of attributes of hypothetical orchids presented to study respondents. Error bars represent 95% confidence intervals

Analysis of the degree of preference respondents placed upon levels within an attribute revealed a more detailed picture (Figure 3). Within the most important attribute, price, there were significant differences between groups and their degree of preference for low ($H = 19.80$, $P \leq 0.001$), medium ($H = 231.97$, $P \leq 0.001$), and highly priced orchids ($H = 146.24$, $P \leq 0.001$). Participants also differed significantly in their preference for flower color (white $H = 49.26$, $P \leq 0.001$; yellow $H = 19.10$, $P \leq 0.001$; green $H = 8.88$, $P = 0.031$; and red $H = 44.96$, $P \leq 0.001$), with white being preferred by owners at XTBG and nonowners at MKFM; rarity (common $H = 57.72$, $P \leq 0.001$; rare $H = 57.72$, $P \leq 0.001$), with rare species being most important among XTBG nonowners; origin (wild $H = 100.84$, $P \leq 0.001$; cultivated $H = 100.84$, $P \leq 0.001$), with MKFM orchid owners opting for cultivated stock; and scent (scented $H = 68.45$, $P \leq 0.001$; nonscented $H = 68.45$, $P \leq 0.001$), with respondents at XTBG revealing greater preference for scented orchids compared to those at MKFM (see Table S2 for pairwise statistics).

4 | DISCUSSION

This study is the first to identify factors underpinning demand for horticultural orchids among consumers from widely different sociodemographic and economic backgrounds in China. Therefore, it represents an important step toward the development of practical conservation and policy interventions for overexploited and illegally traded plants in the region.

Price and color were found to be the most important attributes across both study sites. While a slight preference for wild plants was detected at Xishuangbanna, plant origin was the last, or second-to-last most important attribute among these participants. Other factors, primarily cost and flower color, took precedence in driving choice. A strong preference for flower color, specifically white, corroborates preferences reported by nonspecialist orchid growers in the international horticultural trade (Hinsley et al., 2015). However, our results contrast with distinct preferences for wild plants demonstrated in the Chinese medicinal orchid trade (Liu et al., 2014). Although cheap, colorful wild-sourced plants
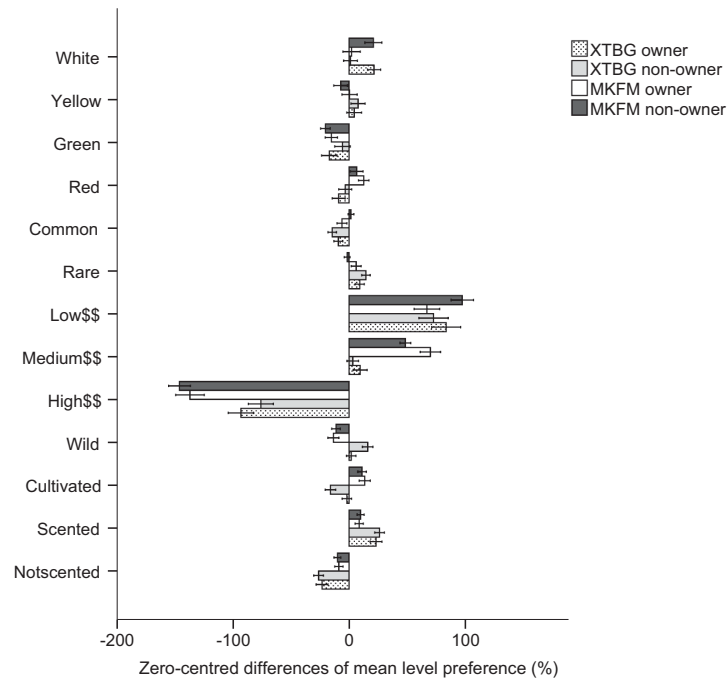
FIGURE 3 Mean relative importance of levels within attributes. Data are zero-centered so that, within each subgroup of respondents, the mean preference of levels within any one attribute sum to zero. Error bars show 95% confidence intervals

are widely available at both survey locations (Gale et al., 2014; Liu et al., 2015a,b; Zhang, Hua, & Sun, 2008), our results suggest that this trade is not consumer-driven. Rather, the provision of wild-collected orchids is supply-driven.

Although not detected in our study, previous work on international orchid consumers found small subsets with a strong preference for rare species (Hinsley et al., 2015). Indeed, collectors with in-depth taxonomic knowledge of their focal group are known to seek wild specimens of new species described in the scientific literature before they become available via legitimate sources (Guterman, 2006). While better enforcement of CITES and improvements to national legislation may therefore work for mass-market consumers, specialist growers may go out of their way to access valuable species, potentially moving to sourcing plants online where enforcement is more difficult (Hinsley et al., 2015). Further work in this area should focus on assessing the size of this specialist market and whether this demand is driving wild-collection. In addition, although our respondents came from across Mainland China, targeted work on consumer preferences in major cities may reveal further information about demand. Finally, there are likely to be illegal markets that our study of end-consumers did not capture. Further research, ideally supported by the Chinese Government, is needed to understand such actors.

Accurate differentiation of wild-sourced and artificially propagated plants is difficult for nonspecialists to achieve (CITES Secretariat, 2002). If the same is true of consumers at our study sites then it is unlikely that they know the origin

of the plants they buy, suggesting that preference for wild plants is unlikely to be the cause of the large numbers of wild-sourced plants on sale at street markets near XTBG or at MKFM. Although artificial propagation is not always successful in reducing wild plant trade (Phelps et al., 2014), our findings suggest that it could be effective in the supply-driven markets studied here, if cultivated orchids were competitively priced.

We propose that the Chinese horticultural orchid market can tolerate tighter regulation on the sale of wild-collected plants, since most consumer demand is likely to be satisfied with cultivated substitutes of equivalent price and color. We show that the majority of consumers in our sample do not know what CITES is, or how it applies to different orchid groups. This suggests that most people who purchase orchids at these sites may not be aware of the issues related to the illegal trade in wild plants, as has been demonstrated for other traded wildlife (Broad, Mulliken, & Roe, 2003; Zhang et al., 2008). A study of international orchid consumers found that those with more knowledge of CITES rules were more likely to transgress (Hinsley et al., 2017), suggesting that increasing awareness of CITES may not improve compliance. Our findings of a supply-driven trade with limited consumer preference for wild plants suggests that consumer awareness-raising about CITES may be obsolete in this case. While we acknowledge that better awareness of CITES rules may encourage some consumers to question sellers about the source of orchids, we suggest that better enforcement to prevent traders bringing wild plants into Mainland China

or Hong Kong may have greater impact than education campaigns. This is supported by evidence from both of our study sites that wild plants of nonnative species are being transported across CITES borders (Yang, Chen, Bai, Deng, & Liu, 2000; Gale et al., 2014; Liu et al., 2015b). This suggests that market vendors view wild orchids as an easy source of stock and that current levels of enforcement of CITES and other regulations are currently failing to generate meaningful compliance. Regulation of the trade must therefore involve the strengthening of customs controls to ensure CITES compliance for orchids. Beyond that, however, we contend that Mainland Chinese domestic law must also be enhanced to provide better protection for wild native orchids, the decline of which has been widely documented (Liu et al., 2014; Liu et al., 2015b), including for many species of horticultural value (e.g., Cai et al., 2011). Improving domestic protection in this way is likely to reduce the potential for the laundering of illegally imported wild plants.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.