



# Orchid Obscurity: Understanding Domestic Trade in Wild-Harvested Orchids in Viet Nam

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Unsustainable and illegal wildlife trade is a well-known conservation issue, but there are still large gaps in our understanding of how trade chains operate for the majority of over-exploited wildlife products. In particular, the large-scale global plant trade is under-reported and under-researched, and this is even more pronounced when the trade takes place within a country's borders. A clear example is the trade in orchids, all species of which are listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Although countries such as Viet Nam are known hotspots for the large-scale collection of wild orchids for the international horticultural trade, little is known about how plants move from the wild to the end-consumer, what role is played by domestic markets and the sustainability of this trade. We use a mixed-methods approach to determine the structure of trade chains for orchids in key trading areas of Northern Viet Nam, and use a thematic framework to identify five groups of actors trading wild-harvested orchids. Trade occurs both domestically and internationally, underpinned by demand for rare, wild plants. An important first step to address the illegal and unsustainable plant trade is to recognise it as a major and growing conservation issue, and develop diverse approaches that consider the complexity of the supply chains involved. It is imperative that the scale and process of domestic trade is understood, and its impact on long term conservation of these species assessed to make more informed decisions about effective interventions that take into account the full supply chain.

**Keywords:** non-timber forest products, sustainable use, Orchidaceae, plant trade, biodiversity loss, over harvesting

## INTRODUCTION

Unsustainable commercial wildlife trade is a rapidly expanding (Rosen and Smith, 2010), leading threat to biodiversity (Phelps and Webb, 2015). Whilst global efforts to address this practice are increasing, disproportionate amounts of attention are focused on a few charismatic animal species (Balding and Williams, 2016). Therefore, there are prevalent data gaps for the vast number of species over-exploited for commercial trade, particularly groups such as plants, fungi and invertebrates (Margulies et al., 2019). International trade in many species is monitored by the Convention on the International Trade of Endangered Species of Wild Fauna and Flora (CITES), however even trade in these species can be overlooked when it takes place on a domestic scale,

with data often coming only from enforcement seizures or media reports that are difficult to collate (Pistoni and Toledo, 2010; Siriwat and Nijman, 2018). Unchecked, unrecorded domestic markets can directly drive species declines (e.g., in elephants following international trade bans: Milliken, 2002), or channel wildlife products into larger international trade networks (e.g., seahorses in Viet Nam: Giles et al., 2006). Addressing these knowledge gaps is essential to improve interventions aimed at reducing illegal wildlife trade, which are often poorly targeted and based upon broad assumptions rather than specific knowledge of trade processes, likely limiting their potential success (Phelps et al., 2016).

One under-researched yet extensively traded group is orchids, which are traded globally for horticulture, medicine, food and other purposes (Hinsley et al., 2018). Only a small proportion of orchid species have been assessed by the IUCN Red List but still reveal alarming trends—84 out of 85 tropical Asian slipper orchids (*Paphiopedilum*) are threatened with extinction, and trade is listed as a threat for every species (IUCN, 2020). However, for most orchid species, little is known about trade networks, harvesting sustainability, drivers of trade, or potential significance of international trade. This is of major concern because their population sizes, restricted ranges, and natural sensitivity to a variety of threats, such as habitat and climate change, make orchids highly vulnerable to the added pressure of overharvesting (Koopowitz, 2001). Further, whilst legal trade is widespread and contributes to livelihoods in low-income countries its sustainability is undermined if illegal trade goes unchecked (Hinsley and Roberts, 2018).

Recognising the trade threat, every one of the ~29,000 species of the family Orchidaceae is included in the CITES Appendices (making up over 70% of all listed species: UNEP-WCMC, 2018), thus all international trade in these species and their derivatives is legally limited or prohibited, apart from in exceptional circumstances. Orchid trade is also prohibited to varying degrees under national legislation in numerous source countries including Viet Nam, where all wild orchid species are protected under Government decree No.32/2006/ND-CP, with *Paphiopedilum* species afforded the highest level of protection, banning all exploitation and commercial use.

Despite increasing awareness of the threats, effective interventions to reduce illegal orchid trade are hampered by a lack of data on supply chains and processes, and drivers of behaviour of actors within the supply chain (Hinsley and Roberts, 2018). Studies into domestic and regional trade are increasingly taking place (e.g., Gale et al., 2019; Ticktin et al., 2020), but trade in most orchid species is still relatively unknown. In Southeast Asia, a hotspot of orchid trade, studies have been conducted to understand the complexities of regional markets in Thailand, Myanmar and Lao People's Democratic Republic (Thomas, 2006; Phelps and Webb, 2015; Phelps et al., 2016). However, very little evidence exists concerning the nuances of trade in Viet Nam, despite its numerous orchid species (Teoh, 2005) and evidence of wild-collection for the international illegal trade leading to serious species declines (e.g., Averyanov et al., 2014). We attempt to address this knowledge gap by investigating the collection and trade of wild-harvested orchids in Viet Nam. Specifically, we aim

to (a) gather data on the extent of wild-orchid use and trade in our study areas; (b) identify the main actors involved in the wild orchid trade and how they interact; (c) identify some of the key drivers of trade. We then use these data on the structure and characteristics of the wild orchid trade to draw conclusions on the potential conservation implications of the trade.

## METHODS

We used a mixed-methods approach including key informant interviews ( $n = 24$ ) and structured surveys ( $n = 123$ ) conducted between May and June 2018 in three sites in Northern Viet Nam. These were selected following consultation with local experts at Fauna and Flora International (FFI) Viet Nam (pers. comm. Kempinski, 2018, personal communication). Selection was based on three criteria: presence of karst limestone habitat, due to their importance for several orchid species; evidence (often anecdotal) of orchid trading in these areas; and good relationships with the local Forest Protection Department (FPD) to facilitate the work. The sites comprised one urban site in Ha Noi (Dong La district), one rural site in Ha Nam province (Ba Sao), and one rural-urban-fringe area in Cao Bang province (Cao bang city).

### Key Informant Interviews

We used semi-structured key-informant interviews to explore informants' perspectives of, and involvement in, the orchid trade. This method is useful when investigating complex and potentially sensitive behaviours in a previously little-researched context (Young et al., 2018). We devised the initial interview guide from relevant orchid-trade literature (Phelps and Webb, 2015; Hinsley et al., 2018), which was translated into Vietnamese by a native speaker.

We selected initial key informants recommended by the local FPD in each field site, with further participants found through snowball sampling (Newing, 2010). The criteria for inclusion were: involvement in or specialist knowledge of the orchid trade, being over the age of 18, and residence in one of our study sites. We discontinued interviews in each field site when we reached saturation (Guest et al., 2006), or were unable to identify new informants. With permission from informants, all interviews were audio-recorded and, after completion, transcribed and translated into English. To minimise bias and ensure nuance was captured during translation, transcriptions were compared to the original audio recordings with a native Vietnamese speaker. We updated the interview guide to triangulate respondents' answers and to draw more robust conclusions. No informant refused to be interviewed.

### Surveys

We used surveys to gain a broader understanding of participants' attributes and behaviours in a wider context, to glean information about the scale of trade, and to understand demand for orchids. We asked about participants' use, harvest, trade and purchase of orchids, the frequency of these behaviours, and the purpose (e.g., personal or commercial use).

We translated the survey into Vietnamese, and back-translated it to English to check for accuracy.

We surveyed residential areas within each site, sampling residents in close geographical proximity to the processes of trading. In Ha Nam and Cao Bang, we sampled within 5 km of the forested areas reported by the local FPD to be a wild orchid source. In Ha Noi, residents of the Dong La district were sampled within a 5 km radius of specialist shops or farms selling mainly orchid species. We sampled every other house and (though this was not requested specifically) typically spoke to the head of the household, unless they were not present. If there was no answer, or participation was refused, the next house was sampled, before returning to the original sampling pattern.

We piloted the survey to ensure questions were culturally appropriate, understood as intended, and to test the clarity of concepts and language used. Following the pilot, no changes were required. A native Vietnamese interviewer read the survey aloud to participants in Vietnamese and data were recorded using Open Data Kit v.1.15.1 (Open Data Kit, 2018). The data were stored using Ona (Ona, 2018). After completion, survey responses were translated into English.

## Ethics

We obtained free prior informed consent from all participants, who were aware that participation was non-obligatory, and under assurance of anonymity and confidentiality. We ensured anonymity by excluding identifying information. The study was approved by the ethical procedure of the Department of Life Sciences, Imperial College London.

## Data Analysis

We used the Framework Method to systematically review the interview data to draw explanatory conclusions from identified themes, in an unambiguous and rigorous way (Ritchie and Spencer, 2002). We familiarised ourselves with each transcript, noting recurrent subject-matters. Then we identified a thematic framework, based on these subject-matters, or “themes.” We used this framework to code the data using QSR International’s NVivo 12 qualitative data analysis software (NVivo, 2018). Once coded, we identified a subset of themes based on our interpretation of their relevance to the research question. To increase the validity of our interpretation, we asked six people with no prior knowledge of the research topic (age range: 25–70), to apply our thematic framework to a subset of the interview data ( $n = 4$  interviews each), ensuring every interview was assessed by a second person. This review identified no new themes, though definitions of terms were discussed and clarified. The lead author analysed the data, and defined their observational standpoint using the framework outlined by Clark (2002) to account for any potential bias in interpretation.

We calculated descriptive statistics from the survey data, summarising the number of people who used, harvested, bought and sold any plants, specifically orchids. We applied chi-squared tests and Fisher’s exact tests in the “Mass” package in R (R Core Team, 2020) to determine the association between different behaviours (collecting, buying, trading, and using orchids) and key demographic variables (province of residence, gender, and

age). In answering how many orchids were collected from the mountain or forest, several respondents used kilograms rather than number of plants. To provide a minimum estimate of plants collected, we use Gale et al.’s (2019) database of orchid stems per kilogram for different orchid taxa, using the minimum (3.1 stems per kg) and median (62.3 stems per kg) estimate of all genera recorded in Viet Nam (identified using<sup>1</sup>) to estimate potential volumes of plants.

## RESULTS

We conducted 24 semi-structured interviews (13 interviews with singular respondents, and 11 with pairs of respondents. Each pair consisted of the same “category” of informant (see **Table 1**) living/working in the same establishment). In total, we interviewed 35 respondents across three field sites, covering four main types of key informant. We surveyed 123 households, with two refusing to participate (Ha Nam:  $n = 40$ ; Cao Bang:  $n = 50$ ; Ha Noi:  $n = 33$ ).

### Survey Results

Of the 123 survey participants, 52% identified as female, and 47% male. Fifty three per cent were between 18 and 44 years old, and 46% were 45 years and older. In the 12 months before the survey, 61.8% of participants ( $n = 76$ ) used wild plants (food:  $n = 54$ ; decoration:  $n = 41$ ; medicine:  $n = 15$ ; trading:  $n = 11$ ; building:  $n = 1$ ; shade:  $n = 8$ ; other:  $n = 7$ ). Most reported buying plants from a market, shop or the internet ( $n = 46$ ), with fewer sourcing plants directly from the wild themselves ( $n = 26$ ) or via somebody else ( $n = 8$ ). Fifteen reported “other” sources, including wild plants transplanted onto their own land some time ago ( $n = 4$ ), as a gift ( $n = 3$ ), and buying from people in ethnic minority groups ( $n = 1$ ).

Half of participants who used wild plants in the 12 months before the survey had used orchids within this same timeframe ( $n = 38$ , 30% of the sample). Nineteen% ( $n = 23$ ) reported buying orchids, 11% ( $n = 13$ ) selling them, and 14% ( $n = 17$ ) collecting wild orchids. People bought orchids for growing at home ( $n = 9$ ), re-selling ( $n = 8$ ), and decorating their house ( $n = 6$ ). Traders also bought from diverse sources (from people in minority groups:  $n = 6$ ; other provinces:  $n = 4$ ; door-to-door sellers:  $n = 3$ ; orchids farms:  $n = 2$ ).

The chi-squared and Fisher’s exact tests showed no evidence of significant association between any behaviours and gender or age, although slightly more men reported collecting orchids than women, and slightly more under 35-year-olds reported selling orchids than would be expected by chance (**Table 2**). There was a significant association between location and all behaviours, with more Ha Nam participants reporting that they had bought, used, and collected orchids than would be expected by chance, and more Cao Bang respondents reporting selling orchids than expected. Ha Noi respondents reported less participation in all behaviours than would be expected.

<sup>1</sup><https://wensp.science.kew.org>

**TABLE 1** | Participant quotes from interview data providing evidence for concepts identified through the thematic framework analysis.

a) Drivers of trade—Rarity	b) Process of trading—Buyer preferences	c) Drivers of trade—Conservation through Trading	d) Future of trading—Over-exploitation of orchids
1. “Foxtail orchids that have all white flowers, its rare and expensive, so many people want them. People would fight each other to buy one like that. Everyone would love to own it. But it’s hard, not just anyone is able to own it” <b>R16 Cao Bang</b>	2. “In my farm, I believe that people are more into orchids from the forest. Orchids from the forest are sellable. People love wild orchids because of the wild beauty and fragrant smell. . . they are just gorgeous” <b>R17 Cao Bang</b>	3. “I myself try to keep and preserve many species. . . I have many expensive orchids, I bought them no matter how expensive they are, thousands of dollars, to preserve the species. I have paid a lot of money to buy rare and endangered species” <b>R16 Cao Bang</b>	4. “There are large numbers of people who exploited the orchids in the forest. Back in the day, they took part of the orchids and still left some stems so they could keep on growing. But nowadays, people over exploit, they take out everything from the forest. Therefore, the number of orchids in the wild reduces and becomes rarer” <b>R6 Ha Nam</b>
5. “They are not special when they (orchids) are surrounded by many of them, they become hot when they are in places where there is only a few of them” <b>R9 Ha Nam</b>	6. “People always prefer natural orchids with origin from the forest. Orchids from the lab are unnatural, people don’t like them” <b>R6 Ha Nam</b>	7. “They (the government) need to develop and preserve orchids at once. Or it will be dangerous someday. There will be no more orchids. If the forest runs out of orchids, we need to preserve and breed them in farms” <b>R17 Cao Bang</b>	8. “Orchids nowadays is running out, people already took everything from the wild. In the past. . . we sold so many wild orchids from the forest, there were a couple of dozens of species of wild orchids being displayed in the shop. But now. . . we have none” <b>R9 Ha Nam</b>

Five people reported how many plants they collect in a single trip (1–2 plants:  $n = 3$ ; 3–4, and 25–30:  $n = 1$  each), and six reported the weight of plants collected (2–3 kg:  $n = 2$ : 7–8, 10, 15, and 20 kg:  $n = 1$  each). Using our minimum conversion estimate, this is between 6 and 62 stems per trip, and with the median conversion estimate at 125–1,246 stems per trip.

## Main Themes From Interviews

We identified four main themes from the interview data: drivers of trade, sources of orchids, the process of trading and the future of trading (Table 1). Drivers of trade included demand for rare plants and a desire to conserve them. Sources of orchids included wild or artificially propagated plants, as well as the places or people they were bought from. The process of trading included discussions of how orchids moved through the supply chain, who they are traded between and how the trade is facilitated. The final theme concerned data related to how respondents perceive the functioning of future trading. These themes were analysed to produce key concepts regarding orchid trade in Viet Nam, and present a fuller picture of trading in Northern Vietnam.

## Actors in the Supply Chain

We used data from the “process of trading” and “source of orchids” themes to identify five groups of actors that participate in the orchid trade (Table 3): (1) personal harvesters, (2) commercial harvesters, (3) intermediary wholesale vendor, (4) commercial vendor, and (5) orchid hobbyist. These groups are distinct but not mutually exclusive, with some respondents belonging to more than one group, or change groups in certain circumstances. For example, Respondent 5 is an orchid hobbyist but stated “I will see if there are orchids in the mountain, I will go get them if I see them with my binoculars” and so would also be a personal harvester in that circumstance.

Opportunistic harvest by orchid hobbyists is small scale. Most hobbyists obtain their orchids from commercial vendors or trade

amongst themselves, as Respondent 5 said “*In the community (of hobbyists) we only buy from farms, we don’t go to the forest to get orchids.*”

## Supply Chain Process

The orchid trade chain in our study sites constitutes a complex web of interactions of the five groups identified (Figure 1). Wild orchids can enter the trade chain via personal or commercial harvesters, or via opportunistic harvest by orchid hobbyists. Interviewees reported that once the orchids have entered the chain, the pathways through personal and commercial gardens can be cyclical, with the monetary value of the orchids increasing each time they pass through an actor. As Respondent 6 remarks “*he (commercial trader) sells to me for 10 million VND, I resell with a higher price.*”

The movement of orchids from harvesters, through commercial vendors and hobbyists is made more efficient by intermediaries, locally termed “wholesale traders.” These intermediaries travel to rural areas to buy wild orchids on behalf of commercial vendors, who order certain species or amounts of orchids (Table 3). The inclusion of these actors means that commercial traders or orchid hobbyists do not need to travel to source areas. Wholesale traders therefore serve to increase the volume of orchids available, whilst decreasing the time it takes buyers to access them by removing barriers, such as finding appropriate harvesters. Wholesale traders have become more widespread and numerous in more recent years, enabling those further down the supply chain to access large volumes of wild orchids more easily. Orchid hobbyists also engage in small scale trading amongst the orchid community, who interact regularly to trade or exchange knowledge. This inter-community trading ranges from local sales or swaps to national trading at orchid shows. Trading between members is regular, based on a shared passion rather than driven by profit and is facilitated by social media. Respondent 18 said,

**TABLE 2 |** The relationship between reporting one of four orchid-related behaviours (collecting, buying, using, or trading) and province, gender and age, determined using  $\chi^2$  or Fischer’s exact tests with standardised residual values.

Level		Behaviour											
		Collecting orchids			Buying orchids			Using orchid			Selling orchids		
		Not collected	Collected	$\chi^2$ or Fischer’s exact p-value	Not bought	Bought	$\chi^2$ or Fischer’s exact p-value	Not used	Used	$\chi^2$ or Fischer’s exact p-value	Not sold	Sold	$\chi^2$ or Fischer’s exact p-value
Location	Cao Bang	0	0	Fischer’s exact p < 0.00	0.4	-0.8	Fischer’s exact p < 0.00	0.6	-0.9	Fischer’s exact p < 0.00	-0.7	2	Fischer’s exact p < 0.00
	Ha Nam	-0.8	1.9		-1.1	2.4		-2	3.0		0.4	-1.1	
	Ha Noi	0.8	-2.1		0.8	-1.6		1.5	-2.2		0.5	-1.3	
Gender	Male	-0.4	1.1	$\chi^2 = 2.02, df = 1, p = 0.15$	-0.2	0.3	$\chi^2 = 0.08, df = 1, p = 0.77$	-0.4	0.5	$\chi^2 = 0.54, df = 1, p = 0.46$	-0.2	0.2	$\chi^2 = 0.21, df = 1, p = 0.64$
	Female	0.5	-1.1		0.2	-0.3		0.5	-0.6		0.5	-0.5	
Age category	<35	-0.1	0.2	Fischer’s exact p = 0.95	0	-0.1	$\chi^2 = 0.71, df = 2, p = 0.70$	-0.4	0.5	$\chi^2 = 0.77, df = 2, p = 0.68$	-0.5	1.3	Fischer’s exact p = 0.29
	35–54	0	0.1		-0.2	0.5		0	0		0.1	-0.4	
	>55	-0.1	-0.3		0.3	-0.6		0.3	-0.5		-0.3	-0.9	

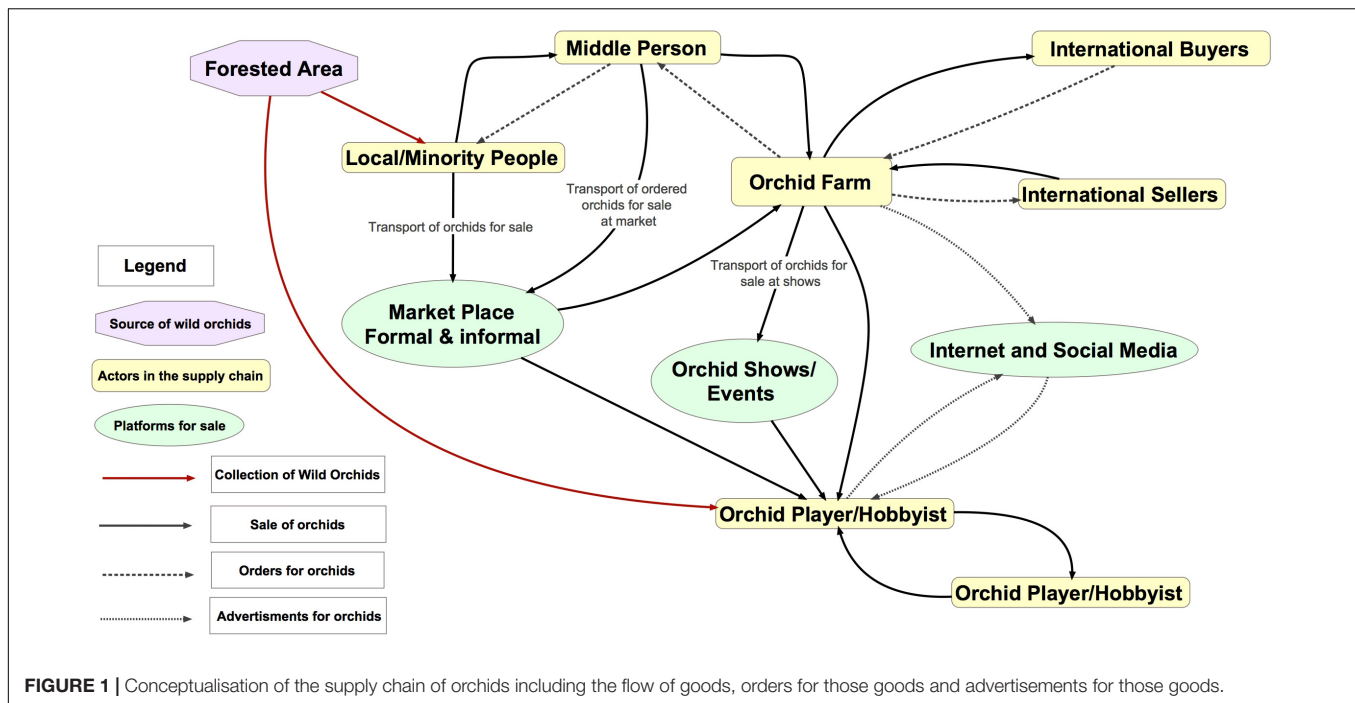
Positive residual values (green) indicate that this group reported this answer more than would be expected by chance, and negative values (red) indicating that this answer was reported less than would be expected. Lighter red and green shading denotes some difference to expected, while darker shading shows a large difference, and grey shading showing that the value is within the expected range. See SM for full results.

**TABLE 3 |** Descriptions of the roles and demographics of different actors in the supply chain.

Actor	Role	Demographic description	Respondent quotes about actor groups
Personal harvester	People who harvest wild orchids from the forest to grow at home	Usually local and/or people of ethnic minority who live close to forested areas in highland provinces. Occasionally includes those who would ordinarily purchase orchids, but opportunistically harvest orchids from the forest	“I got them in the forest while I went to the forest to raise my goats. I saw the orchids fell down from old big trees, I took them home to grow” <b>R14, Cao Bang</b>
Commercial harvesters	People who harvest wild orchids from the forest to sell to other people	Usually local and/or people of ethnic minority who live close to the forest in highland provinces. Occasionally people from outside the local area will travel to a forested area specifically to harvest orchids	“We buy from local people. There are people who will collect (wild) orchids. . . we buy from them” <b>R9, Ha Nam</b>
Intermediary wholesale traders	People who order certain orchid species from harvesters and buy them with the purpose of selling them onto other people	Usually people who live in the district containing the forested area, but not necessarily living in close proximity to the forest. They have the means to travel to other areas to sell orchids	“They buy from wholesale people, they will deliver just by one phone call. . . when there weren’t wholesale people, I had to go directly to forest. . .order minority and local people. . .to get orchids for me. . .but nowadays, there are wholesales people living in these provinces, so people don’t need to travel” <b>R23, Ha Noi</b>
Commercial vendors	People who buy orchids to grow them and sell them onto other people	Usually people with large commercial orchid farms that have the capability to buy and sell kilograms of orchids at a time. Situated in both highland and lowland provinces	“We get orchids from the local orchid farms. They breed and grow orchids at their farms and sell to people. . .their orchids are originally from the forest but (have been) tamed (grown) for years” <b>R3, Ha Nam</b>
Orchid hobbyist	People who buy orchids to grow them in their garden	Usually people with small personal orchid gardens, more often situated in lowland provinces	“I love them so much I don’t sell them, I just keep them in my garden” <b>R18, Cao Bang</b>

“I do sell. . .but not for money—just to keep the relationship with other people in the community. . .I sell on the internet, mainly Facebook.”

Commercial vendors, conversely, sell their orchids for profit as a business. Businesses vary in size, from home-based nurseries to others that spread over an acre or more. Vendors sold in different



locations to varying degrees. We identified three main locations of trade from the data: markets; orchid shows; and the internet and social media. Locations of trade are places where people either physically trade orchids, or advertise and agree sales. The internet and social media are an important platform for trade between commercial vendors and orchid hobbyists. It is used to advertise orchid species, agree on trade deals or induce face-to-face sales. Many respondents remarked that this platform plays an increasingly important role, simplifying and streamlining trade:—“Orchid farmers are using (the) internet a lot. . . (it is) the most effective platform for us to sell” (Respondent 22).

We found no evidence of export of orchid species directly by interviewees, although respondents did report in-person trading with international buyers, who transport orchids across international borders. As Respondent 20 states: “foreigners come here (Vietnam) and buy, they bring them (orchids) back to their countries by themselves.” It was commonly cited that language barriers made exporting internationally difficult, and thus was not typically engaged in. Most respondents were aware that it is illegal to trade certain orchid species internationally, as Respondent 23 summarises: “*slipper orchids, according to international law, are not allowed to be traded internationally—they can’t be exported.*”

## Drivers of Trade

Our interviewees reported that orchid trade is driven by the demand for beautiful, rare, wild-harvested plants. Strong preferences for wild plants were reported by 54.2% ( $n = 19$ ) of interviewees, for example, Respondent 22 stated they preferred wild orchids “*because it’s the natural beauty, the orchid is unique.*”

Rarity was also reported as an important factor, adding a desirability to collect orchids because they are “special”—“*special*

*beautiful orchids are the rare ones. . . hard to find*” (Respondent 3). Respondents also reported that rare orchids could be sold for higher prices, making it economically viable to invest in finding remaining specimens: “*they will be expensive if we have a hard time finding them in nature*” (Respondent 9).

We found that a common theme underpinning the drivers of trade is an authentic passion for orchids, as reported by 70.8% of interviewees ( $n = 25$ ). The depth of this passion is described by Respondent 7 who stated “*orchids and plants in general have souls. . . the more you know them, the more you realize.*” This is linked with a desire to conserve orchids, and recognition that wild orchids are becoming rarer. Some respondents even linked their rarity to over-exploitation—Respondent 7 states “*you should collect orchids to preserve the culture as well as the biodiversity,*” whilst Respondent 6 recognises “*there are a large number of people who exploited the orchids in the forest. the number of orchids in the wild reduces, becomes rarer.*”

## DISCUSSION

We show that wild-harvest and domestic trade in orchids takes place across our study sites, and is increasingly organised and efficient. Large-scale harvesting and trade of wild orchids in other areas has been shown to drive over-exploitation and lead to population declines (Hinsley et al., 2018), suggesting that the trade in Northern Viet Nam could be of conservation concern. This study is a vital first step in increasing the potential for effective, evidence-based conservation initiatives for traded orchid species, which has been highlighted as a priority (TRAFFIC, 2008; Hinsley et al., 2018). Our work demonstrates the need for further research into these trade chains, including to

quantify the level of wild collection, establish sustainable harvest levels for wild orchids, determine the contribution of wild orchid trade to livelihoods, and to investigate the role of cultivation in reducing wild orchid trade. It also reinforces the need for plant trade to be taken more seriously as a major, growing threat to biodiversity (Phelps and Webb, 2015; Williams et al., 2018; Margulies et al., 2019).

While our surveys found differences in orchid-related behaviours in different locations, our interviews showed that wild orchids are collected and traded in all of our study sites. The surveys were designed to investigate orchid trading in the broader community, and show that different locations likely play different roles in the supply chain. For example, more selling was found in the forested area of Cao Bang, while more buying and using orchids was found in Ha Nam. However, by triangulating data with our interviews, we show that, even in Ha Noi, where all orchid behaviours were less likely than would be expected amongst the wider community, trading does continue to occur at some level, with specialist vendors and hobbyists still present. Conceptualising this supply chain using Phelps et al. (2016), it is likely that the wild orchid trade in Viet Nam is a “redundant channel network”—where there are few barriers to participation in trade and low enforcement. Our results characterise the actors of this trade, and provide evidence toward understanding the network structure—both of which are key to implementing targeted interventions of this potentially unsustainable illegal trade (Phelps et al., 2016).

Our findings highlight the possibility that international trade chains are linked with domestic trade, and these linkages warrant further investigation. In contrast to the work of Phelps and Webb (2015) in Thailand, we did not find evidence for large scale international export of orchids, with most respondents reporting trading domestically. While this may be a result of social desirability biases amongst respondents concealing their involvement in illegal behaviour (Newing, 2010), most expressed a willingness to trade with international customers if the opportunity arose. Practical reasons cited for lack of international trade, such as language barriers, act as obstacles for some traders, but are likely not the case for all. A market for wild orchids clearly exists, and further study may reveal that commercial vendors or other intermediaries, possessing the relevant language skills, are tapping into this niche which will have implications for CITES enforcement. We found that commercial traders were willing to trade with international buyers despite knowledge that it was illegal to export these plants. This may be a strategy to avoid being caught themselves, but also supports earlier findings that awareness of CITES rules does not prevent trade actors from breaking them (Hinsley et al., 2017). Viet Nam is rated in the highest category for its national legislation that underpins CITES implementation<sup>2</sup>. However, CITES enforcement could be undermined if commercial vendors trade with international commercial greenhouses, laundering illegal wild plants as legally cultivated in international markets could undermine CITES rules in the country (Phelps and Webb, 2015). Without a better understanding of domestic wildlife trade chains, and formal

monitoring of the domestic trade, species extinction due to over-harvesting remains possible even if international trade is monitored and regulated through CITES.

We show that there are five key types of actors in the wild orchid supply chain in Northern Viet Nam, and that movement of orchids between them has become faster and easier in recent years. Only through understanding the complexity of actors' interactions can we design specific, targeted interventions to increase the sustainability of this trade (Mendelson et al., 2003). For the orchid trade in our study locations, a key focus should be new intermediary actors, who move more wild orchids from forested areas to a variety of consumers more quickly and efficiently than in previous years. Accessing orchids has become faster and easier, a trend that will likely continue as standards of living improve, access to forests is increased due to fragmentation and development, and online platforms are increasingly widely utilised. The negative impact of this rapidity from source population to trade has been documented in the case of wild *Paphiopedilum canthii* plants, approximately 99.5% of which were harvested within 6 months of being described (Averyanov et al., 2014). The combination of more efficient supply-chains and the high demand for rarity in the domestic trade could lead to rapid over-harvesting being replicated, even for yet undiscovered species (Vermeulen et al., 2014). This, combined with the complexity of the trade chain, the fluidity of the actors and the difficulty in enforcing legislation (Thomas, 2006) presents a significant challenge. Further understanding the interactions between commercial vendors and intermediary traders will allow an understanding of how high-volume, high-value species are moved from the wild to customers.

We provide evidence that the key drivers of wild orchid trade in Northern Viet Nam are likely to be the demand for rare, wild plants, combined with the ease of accessing these wild plants. We show preferences for wild-sourced orchids that reflect previous findings amongst both orchid consumers and traders (Hinsley et al., 2015; Williams et al., 2018). Preferences for wild plants likely links to consumer perception that rarity is desirable, which can drive harvest and precipitate species extinction (Courchamp et al., 2006). We note that preferences for wild products do not always translate directly into purchases due to barriers such as availability, legality and price—especially when legal alternatives exist (Hinsley and 't Sas-Rolfes, 2020). However, we show that in Northern Viet Nam, there are both preferences for wild orchids and the ability to collect or buy them easily, suggesting that fewer barriers between preferences and purchase exist in this market. This closely aligns with findings in China, where wild orchids were openly available and often cheaper than cultivated alternatives, meaning that even consumers without preferences for wild plants were likely to purchase them (Gale et al., 2019). While wildlife farming has been proposed as one approach to reducing wild harvest of traded species, certain conditions must be met for this to be successful (Phelps et al., 2016). However, our study echoes that of Gale et al. (2019) and Phelps et al. (2016) in demonstrating that introducing cultivated orchids into

<sup>2</sup>[https://cites.org/eng/legislation/National\\_Legislation\\_Project](https://cites.org/eng/legislation/National_Legislation_Project)

the supply chain may not be enough to prevent wild orchid trade, due to consumer preferences and ease of wild-harvesting. In addition, we show that the orchid trade clearly contributes to livelihoods in rural areas, such as Cao Bang. While cultivation can bring economic benefits, it may shift income from trade away from those who currently harvest in favour of wealthier landowners, and could lead to increased harvesting, as rural harvesters attempt to compensate for these losses (Williams et al., 2014). While further work is needed to investigate consumer preferences and market dynamics more broadly, it is likely that better enforcement of trade regulations, coupled with protection of orchids in their wild habitats, may provide some barriers to the harvesting of wild orchids.

Our results demonstrate that there is will amongst stakeholders in the orchid supply chain to conserve orchids, and that involvement of these stakeholders could be key to developing strategies for sustainable trade. We found high levels of concern for wild orchids amongst our respondents, with several explicitly stating that over-exploitation was leading to species loss. However, the level of concern regarding orchid conservation, coupled with the intense passion within the orchid community, support calls for greater engagement of orchid growers in tackling illegal trade (Williams et al., 2018). Our study suggests that conservation concern from orchid trade actors is currently misdirected into demand for wild orchids. Each actor who expressed a desire to conserve orchids felt that the orchids would be “safer” in their collection than in the wild, a phenomenon observed in other studies of the orchid trade (Mackenzie and Yates, 2016; Hinsley et al., 2017). Parallels are seen in trade chains of other species, such as amongst some exotic animal collectors, who justify their participation in illegal trade because they see owning these species as a valid conservation approach (Beetz, 2005; Slater, 2014).

It is clear that wild-collection and commercial trade of orchids is occurring in northern Viet Nam. Mirroring recommendations made by Phelps and Webb (2015), we call for greater recognition of domestic trade as a key threat to species and highlight the need for greater action at both national and international levels. Ultimately, bold, multi-dimensional strategies that go beyond enforcement must be adopted to address unsustainable trade (Challender and MacMillan, 2014; Phelps et al., 2014). Opportunity exists in Northern Viet Nam to work with commercial traders and hobbyists to develop more diverse approaches to addressing illegal trade. While stronger enforcement of existing regulations and *in situ* protection of wild orchids may help reduce commercial trade-driven over-exploitation in Viet Nam, this should be

accompanied by more comprehensive and multi-stakeholder interventions underpinned by improved understanding of orchid trade networks—including interactions between legal, illegal, domestic and international trade, consumer motivations and market dynamics.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Imperial College London. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

## AUTHOR CONTRIBUTIONS

L-AB and NN collected all the data. L-AB, NN, and AH analysed the data. L-AB wrote the manuscript with input from AH, RD, and NN. All authors contributed to the design of the survey and interview guide.

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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.2021.631795/full#supplementary-material>

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**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.

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