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Wild orchid tuber collection in Iran: a wake-up call for conservation

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Abstract Wild orchids are traditionally harvested as *Salep* and used in traditional medicine and ice-cream production in Iran. Recently however, illegal harvest of wild orchids for export appears to have grown. This study aimed to: (1) determine the diversity of harvested wild orchid species and their collection sites in Iran; and (2) study the current harvest status and trade chain and volume to estimate the total orchid plant extraction from natural populations. Field surveys of collectors and market surveys of traders were conducted to establish the diversity of collected species, to identify harvest hotspots, and to document harvesting and trade volumes. Sixteen species and subspecies from 7 genera of Orchidaceae are collected for their tubers. Based on estimates from the 2013 April to June harvest season more than 24.5 tons of fresh tubers were collected from three districts in Golestan province alone. It is estimated that this amount of tuber requires the lethal destructive harvesting of 5.5–6.1 million orchids, with a market value of 320,000 USD. In the Tehran Bazar *Salep* trade during May–July 2013 was 1.9 tons of dried tubers, with estimated retail value of 310,000 USD. Current orchid collection practices in Iran, which have soared in recent years due to international demand, do not seem sustainable as all

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tubers are collected destructively. To preserve orchid populations, in the longterm, establishment of specific Orchid Conservation Areas and introduction of sustainable production practices, could alleviate harvesting pressure. In the midterm, development of a DNA barcoding-based molecular identification system could help to monitor and control illegal trade. In the near term, effective implementation of collection bans in excessively harvested areas and strengthening of current regulations are necessary to avoid the catastrophic effects of harvesting on orchid populations, as has been observed in Turkey.

Keywords *Salep* · Orchidaceae · Anacamptis · Orchis · Dactylorhiza · Sustainability · CITES

Background

Orchids have a long history of use in many cultures around the world (Hossain 2011). Tubers of different species of terrestrial orchids have been used for treatment of diarrhea, dysentery, intestinal disorders, coughs, cold, and tuberculosis (Arditti 1992; Hossain 2011; Subedi et al. 2013). Many orchid species are used as dietary supplements for infants and children, and as an aphrodisiac for adults (Bulpitt 2005). In fact orchids are a significant source of nourishment for people in many places, where the starch-rich tubers or pseudobulbs are collected, processed and eaten (Arditti 1992). In Tanzania, Zambia and Malawi for example, ground and boiled tubers of terrestrial orchids are used in making a staple food called “*Chikanda*” (Davenport and Ndangalasi 2003; Kasulo et al. 2009; Challe and Price 2009).

In Asia Minor the dried tubers of terrestrial orchids are known as *Salep*. The word *Salep* comes from the Arabic *Sahlab*, and refers to dried tubers of terrestrial orchids, ground tuber powder and the beverage made from this powder. *Salep* is used in ice-cream production, confectionary and beverages (Kasperek and Grimm 1999; Sezik 2002; Tamer et al. 2006). In Turkey 38 different orchid species have been documented as sources of *salep* (Kasperek and Grimm 1999; Sezik 2002). In Greece, the beverage known as *Salepi* is still found in local markets, and is popular during the winter months as a warming drink (Starin 2012). Before the introduction of coffee to Europe *Salep* beverage was a common drink, but now it is mainly consumed in Turkey (Bulpitt 2005). In ice-cream production, synthetic alternatives to *Salep* such as cereal starch or carboxymethyl-cellulose (CMC) are currently more common than the original *Salep* (Tamer et al. 2006; Tekinşen and Güner 2010). However, the demand for orchid tubers has remained high for those seeking authentic *Salep* (Kasperek and Grimm 1999). There are no reliable estimates of the annual genuine *Salep* harvest in Turkey, but some have estimated up to 30 tons (Sezik 2002, 2006). It is not clear, however, whether this estimate includes orchid tubers imported to Turkey from neighboring countries. Depending on the harvested species and life stage, between 1,000 and 4,000 tubers, each representing an individual plant, are required for 1 kg of *Salep* (Kasperek and Grimm 1999). Based on these tuber numbers, estimates of the number of orchids harvested annually in Turkey are between 40 and 50 million plants (Sezik 2006). This huge exploitation of orchid plants in Turkey has led to a depletion of wild resources, which in turn has driven up prices, thus increasing the incentive for ever more intense harvesting. Currently many orchid species have become rare and some are near local extinction (Kasperek and Grimm 1999; Sezik 2002). It appears that a side effect of orchid resources scarcity in Turkey has been that traders there have started to tap into new resources of *Salep* abroad, especially in Iran.

In Iran, orchid tuber collection has been practiced for many years for local use in ice-cream production and folk medicine. As in Turkey, most people have shifted to synthetic alternatives for ice-cream production but a lively trade in orchid tubers has persisted nonetheless. The *Orchidaceae* family is represented by 46 species and subspecies in Iran, which are distributed mainly along the Alborz Mountains in the North, and the Zagros Mountains in the West (Renz 1978; Shahsavari 2008). Many of these species are exploited for their tubers (Amin 2005), but no information exists on the economic aspects and the ecological implications of wild orchid collection and trade. The retail market of Iranian-harvested orchid tubers remains unclear.

In this study we aimed to find out whether the constant demand, and diminishing supply of natural *Salep* in Turkey have accelerated tuber collection in Iran, and spurred a local orchid boom. More precisely, we aimed to find out: (1) which orchid species are commercially harvested; (2) where the harvesting hotspots are; (3) what the current volume and value are of the orchid tuber trade; (4) how the trade chain works; and (5) where the final destinations are, of orchid tubers harvested in Iran. Based on qualitative and quantitative data from markets, traders and collectors, the scale of harvesting is estimated and recommendations are given for sustainable harvesting and conservation of orchids in Iran.

Methods

Field survey

Information regarding orchid collection practices, collection sites, season, processing practices, history and volume of harvest and current uses of tubers was collected by interviewing local collectors and by direct observation in the field from March to July 2013. Interviews were conducted in Persian and Turkmen languages. The surveys were conducted in Golestan province (Kalaleh and Maraveh Tappe districts) and Western Azarbaijan province (Mahabaz and Piranshahr districts).

Market survey and ethnomedical data collection

The trade chain was studied by conducting interviews in herbal shops or herbal stalls on the markets of the towns of Kalaleh and Maraveh Tappe (Golestan province) at bazars in Urmieh, Mahabad and Sardasht (Western Azarbaijan province) the Kermanshah and Kerend (Kermanshah province), Ardabil (Ardabil province) and the Tehran Grand Bazar (Fig. 1). Information regarding prices along the trade chain, quality preferences, destination of tubers, history of trade and uses of tubers were recorded from *Salep* traders and herbal shop (*Attari*) owners. In addition, *attaris* were asked about medicinal uses and administration methods of tubers. To estimate the number of tubers equivalent with 1 kg fresh tuber, 5 samples of 100 g fresh tuber were purchased from the Maraveh Tappe, the number of tubers in each sample was counted and the average of the counts was extrapolated to 1 kg. To estimate the numbers of tubers in 1 kg dry *Salep*, samples of 50 g dried tubers were purchased from Tehran, Maraveh Tappe, Mahabad and Urmieh. The number of tubers in each sample was counted and the average number was extrapolated to 1 kg. These numbers were then used to estimate the total number of harvested orchids in a season, as calculated from the total weight of traded tubers.

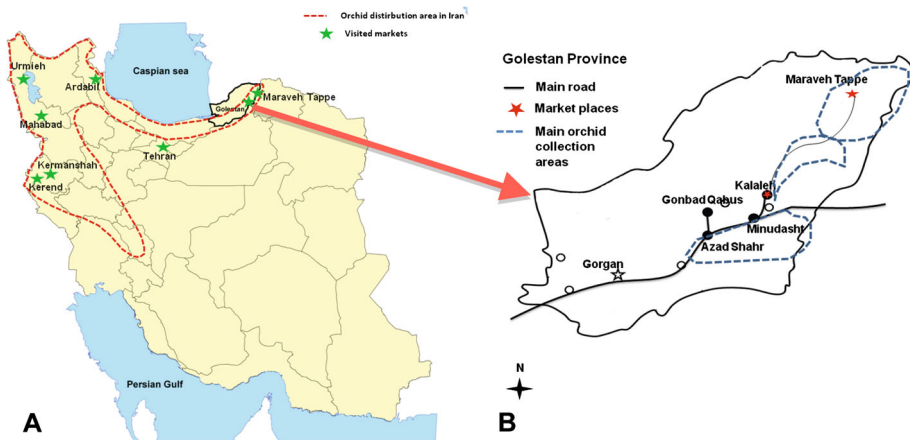


Fig. 1 **a** General distribution of *Orchidaceae* in Iran, with visited market denoted with *green stars*. **b** Main orchid collection areas in Golestan province, indicated with a *dashed blue line*, and visited markets indicated with *red stars*

Plant sample collection

Orchids were observed at collection sites, photographed, identified, and herbarium samples were collected. Identifications were made using the *Flora Iranica* vol. 126 (Renz 1978) and *Flora of Iran* vol. 57 (Shahsavari 2008), as well as in consultation with experts in specific genera. Herbarium vouchers were deposited at the herbarium of the Traditional Medicine and Materia Medica Research Center (HTMRC) and at the herbarium of Uppsala University (UPS) (Table 1). Species names were checked with The Plant List for the latest changes (<http://www.theplantlist.org>).

Results and discussion

Species diversity and major collection areas

Of the 46 species and subspecies of *Orchidaceae* in Iran, 30 species and subspecies produce tubers. We found that 16 species and subspecies of these tuber-producing orchids are collected for their tubers and these species are listed in Table 1. At the time of flowering each plant possesses one old tuber, which yielded this year's flowering plant and one new perennating and over-wintering tuber, which will yield next year's plant. The old tuber is scabrous and wrinkled, and locally known as the *mother* tuber, whereas the new one is fleshy and plump, and referred to as the *daughter* tuber. When harvesters locate the orchids they dig out the tubers, discard the old one and save the new one for *Salep*. *Dactylorhiza* species have a branched or palmate tuber, which after drying is known as *Panjeh-ey* (palmate) *Salep* (Fig. 2e). The other species collected for *Salep* have oval or circular tubers varying in size according to genus and species, and are known as *Qolveh-ey* (round or oval) *Salep* (Fig. 2f). In Turkey, which has higher orchid diversity, 38 species have been recorded for *Salep* production (Sezik 2002), and 11 of these species are also harvested in Iran.

Table 1 Orchid species harvested for *Salep* production in Iran

Genus	Species	Voucher number ^a
<i>Anacamptis</i>	<i>A. coriophora</i>	ABG 2633
	<i>A. morio</i> subsp. <i>picta</i>	ABG 2620
	<i>A. palustris</i>	ABG 2632
	<i>A. pyramidalis</i>	ABG 2592
<i>Dactylorhiza</i>	<i>D. incarnata</i>	ABG 2642
	<i>D. romana</i> subsp. <i>georgica</i>	ABG 2626
	<i>D. umbrosa</i>	ABG 2641
<i>Himantoglossum</i>	<i>H. affine</i>	ABG 2612
	<i>H. comperianum</i>	ABG 2611
<i>Ophrys</i>	<i>O. scolopax</i>	ABG 2590
	<i>O. sphegodes</i>	ABG 2586
	<i>O. sphegodes</i> subsp. <i>mammosa</i>	ABG 2595
<i>Orchis</i>	<i>O. adenocheila</i>	ABG 2589
	<i>O. mascula</i>	ABG 2621
	<i>O. simia</i>	ABG 2582
<i>Platanthera</i>	<i>P. bifolia</i>	ABG 2627
<i>Steveniella</i>	<i>S. satyrioides</i>	ABG 2581

^a Herbarium vouchers deposited at the Uppsala University herbarium (UPS) and the herbarium of the Traditional Medicine and Materia Medica Research Center (HTMRC)

Collection areas were visited in Namin district (Ardabil province), Maraveh Tappe, Kalaleh and Minoodasht districts (Golestan province), Kerend district (Kermanshah province), and Mahabad, Piranshahr and Sardasht districts (Western Azarbaijan province). These appear to be major orchid collection areas although orchid collection is not confined to them. In Kermanshah, collection focused mainly on *Himantoglossum comperianum*¹ and *H. affine*. The Kalaleh and Minoodasht districts (Golestan province) border Golestan National Park, but despite the park's protected status, illegal collection is rife inside the territory of the Golestan National Park. The main species collected in Golestan province include *Orchis simia*, *O. adenocheila*, *O. mascula*, *Anacamptis pyramidalis*, *Ophrys sphegodes*, *O. scolopax* and to some extent *Dactylorhiza romana* subsp. *georgica* (Table 1). All these species grow in temperate broadleaf forests and woodlands of *Paliurus spinachristi*, *Acer monspessulanum*, *Rhamnus* spp. and *Crataegus* spp. Main collection areas in eastern Golestan are woodlands between Maraveh Tappeh and Golidagh, especially around the village of Aq-Emam.

Harvest volume and estimated total numbers of harvested plants

The number of tubers in 1 kg of fresh or dry *Salep* depends on the composition of collected species and life stage of plants during harvest time. The latter depends on external factors such as the length of the winter, spring temperatures, and precipitation. Normally, collection of species is done indiscriminately and collected tubers are a mixture of different

¹ Names for all species are provided in Table 1. Species not included in Table 1 have author names included in the manuscript body.



Fig. 2 Orchid collection and drying in Iran. **a, b** Plants of *Orchis simia* thrown away after harvesting fresh tubers; **c, d** Fresh tubers are kept in water after the soil is washed away. Different sizes of the tubers represent different species; **e** Dried palmate *Salep* from *Dactylorhiza* tubers; **f** Dried ovoid *Salep*

species. In the Maraveh Tappe area (Golestan province) 1 kg of fresh tubers consists of 220–250 tubers, where each tuber is the perennating tuber of a whole, future orchid plant. In the same area, 1 kg of dried tubers consists of 1750 ± 93 tubers, which is thus the number of individual plants that must be harvested to produce 1 kg of ground dried *Salep*. In other regions these numbers differ slightly due to species composition in *Salep* and habitat conditions. Some genera such as *Himantoglossum* have larger and denser tubers than do other orchid genera such as *Ophrys*. In Western Azarbaijan, 1 kg of dried *Salep* from *Dactylorhiza* species (palmate *Salep*) can be produced from a mean number of 980 tubers, while 1 kg of dried ovoid *Salep* (from other species) requires a mean number of 1,380 tubers. Kasperek and Grimm (1999) reported different tuber counts per kg of dried *Salep* originating from different parts of Turkey ranging from 4,348 tubers per kg from Muğla region to 625 tubers per kg from Maraş region. They also reported a mean number of 595 tubers per kg of imported Iranian *Salep*. This is far less than the mean number of tubers per kg that we found in this study. This disparity implies that tubers weighed by Kasperek and Grimm in the 1990s in Tehran were heavier than the tubers we tested. Since *Salep* collection in Golestan Province is a recent activity, the Iranian *Salep* tested by Kasperek and Grimm might have originated from the Western provinces of Iran, such as the orchid districts in West Azarbaijan. Alternatively, the discrepancy may indicate a reduction in orchid tuber weight over time, which in turn could result from a shift in population stratification caused by harvesting pressure—but this needs to be tested.

During interviews with seven traders in Golestan province, it was reported that during the harvest season of April–June 2013 more than 24.5 tons of fresh tubers were collected from the Maraveh Tappe, Kalaleh and Minoodasht districts (Table 2). This trade volume would require destructive harvesting of 5.5–6.1 million individual orchids.

Based on interviews in Tehran Bazar with six medicinal plant wholesalers, it was estimated that 1920 kg of dried tubers with a price of 110–130 USD/kg were purchased from traders during May–July 2013 (Table 2). These tubers mainly originated from Mazandaran, Guilan and Golestan provinces, but included shipments from Kurdistan province. The estimated number of orchids destructively harvested for this volume is 3.1–3.5 million individuals (based on 1750 ± 93 tuber in 1 kg).

Orchid tuber trade and supply chain

Most of the harvest from Golestan Province finds its way to Western Azarbaijan province, to the cities of Urmieh and Mian-do-Ab, and from there is exported to Turkey. According to villagers in Golestan province merchants from Western Azarbaijan started coming to the area some 6 years ago (2006–2008), showing them pictures of orchids that they wanted to have collected. They created a system of middlemen by selecting trade representatives in some villages, who were tasked with purchasing fresh orchid tubers from collectors and shipping them onward to the merchants. These merchants did not give any information on orchids, their uses or even their Persian name to the local people, and to this day the trade continues with the local people referring to the plants and tubers as *mountain potatoes*.

Prices for fresh tubers vary from about 5 to 6 USD/kg at the beginning of the season to more than 22 USD/kg at the end of the season (Fig. 3). Prices also depend on the size of the tubers and the quantity ready for sale. The local middlemen resell the fresh tubers to merchants with 10–15 % profit. Merchants subsequently dry the tubers, and sell them on to either wholesalers or traders from Turkey, and to a lesser extent from India and Pakistan. Most of the *Salep* harvested in Western Azarbaijan and Kurdistan provinces is destined for export to Turkey, whereas the *Salep* in Tehran Bazar is also exported to India and Pakistan, with a minority exported to Turkey. The two types of tubers recognized by harvesters based on morphology—oval and a palmate type—are also recognized in the market. The oval is reputed to be of a superior quality and fetches a higher price.

Taking into account the volume of *Salep* trade in Golestan province and the average price of 13 USD/kg for fresh tubers, *Salep* trade in Golestan province alone was worth nearly 320,000 USD for the 2013 season. In Tehran Bazar dried *Salep* is traded for 160 USD/kg, and the estimated value of this trade for 2013 was nearly 310,000 USD.

Processing and substitution

Orchid tubers can be processed in different ways to preserve their quality between harvest and end user. Upon returning to their villages, harvesters wash the freshly collected tubers in cold water. The washing produces milky white, semitransparent, fragrant and bitter tubers. The local middlemen who buy the tubers directly from villagers keep the purchased tubers immersed in water until the tuber stock reaches a reasonable weight (200–300 kg) for transport (Fig. 2c, d). Water immersion is also a method of quality control by middlemen: old wrinkled *mother* tubers, which are not good for *Salep*, float on water. These old tubers are then removed from the purchased tubers and the collector fetches a lower price for the lot. When the tuber stock reaches the weight for economically feasible

Table 2 Interviewed traders in Golestan province and Tehran Bazar and their total trade volume in 2013 (1 USD = 24,700 Rials).

Middleman/ Trader M/T	Location	Years of <i>Salep</i> trade	Total trade (Kg) in 2013	Mode of traded tubers	Price 1,000 Rials/kg	Purchase price USD/kg	Origin of tuber material
M1	Maraveh Tappe	5	3,500	Fresh	160–550	6.4–22	Maraveh Tappe district
M2	Kalaleh	7	10,000	Fresh	160–550	6.4–22	Saleh Abad valley, Golidagh valley
M3	Maraveh Tappe	6	2,500	Fresh	160–350	6.4–14	Maraveh Tappe district
M4	Aq-Emam village	6	4,000	Fresh	200–500	8.0–20	Aq-Emam, Altı-Aqach
M5	Aq-Emam village	5	2,000	Fresh	160–500	6.4–20	Aq-Emam, Altı-Aqach
M6	Aq-Emam village	4	2,000	Fresh	160–500	6.4–20	Aq-Emam, Altı-Aqach
M7	Ramian	3	500	Fresh	2,500–3,000	10–12	Dasht shad, Loveh, Galikesh Minoodasht
T1	Tehran- bazar	35	800	Dry	3,100–3,200	129.5	Northern provinces mainly
T2	Tehran-bazar	30	200	Dry	2,800	113	NA
T3	Tehran-bazar	33	300	Dry	3,500	141.7	Northern provinces
T4	Tehran-bazar	3	500	Dry	3,000	121	Saqez, Kurdistan
T5	Tehran-bazar	NA	50	Dry	3,000	121	Kurdistan
T6	Tehran	NA	70	Dry	3,200	129.5	Northern provinces mainly

NA not available

transport, the soaked tubers are taken out of the water, packed into bags of 50–100 kg and sent to merchants in Western Azarbaijan or Tehran on long distance buses. None of the middlemen in Kalaleh and Maraveh Tappe districts mentioned drying the tubers themselves, and it seems that only the *Salep* wholesale merchants do the drying. In the early season each 8–10 kg of fresh tuber yields 1 kg of dried tuber but toward the end of the season and after flowering each 4–6 kg of fresh tuber yields 1 kg dried tuber.

Prior to drying, tubers are boiled in either water or milk for 10–15 min, sometimes with addition of one or two tablespoons of potassium sulfate (K_2SO_4). The process of boiling removes the bitterness, destroys the vitality of the tubers and facilitates drying. After boiling, the tubers are sieved and rinsed with fresh water, and subsequently dried in the sun or in a ventilated room. Kasperek and Grimm (1999) reported that in Turkey it is common to boil tubers in Ayran (thinned yogurt), and to thread the tubers on a string before hanging them up to dry. After drying, the tubers become hard and the color changes to yellow or yellowish gray (Fig. 2e, f). According to the merchants, the darker the color of the dried tubers the better the quality of the *Salep*.

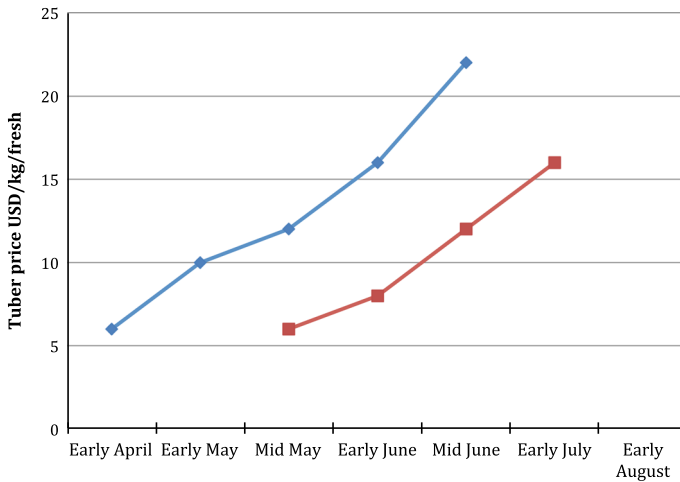


Fig. 3 Development of the market prices of fresh *Salep* tubers during a single harvest season in Golestan Province (blue line) and Western Azarbaijan Province (red line)

Substituting other monocot species with similar tubers for orchid tubers would seem to be a tempting opportunity to increase earnings. However, the only case of adulteration that was observed in this study was the mixing of tubers of *Fritillaria raddeana* with orchid tubers in Maraveh Tappe district. This was done to inflate the weight of the sold tubers. This isolated observation raises the question of whether substitution is common among harvesters, but it seems to be less common than expected.

Orchid tuber use in folk medicine and tuber harvest

Orchid tubers, *Salep*, play a significant role in Iranian folk and traditional medicine. The many herbal shops (*Attari*) visited during this study nearly all had *Salep* available in stock. In the *Attari* *Salep* was sold as a general stimulant, expectorant, and remedy for osteoporosis, joint pains, and breathing distress, e.g. asthma. *Attari* practitioners also reported to give it to infants and children who suffer from malnutrition. The main use of *Salep*, however, is to treat impotence, especially in men. To prepare an impotence cure, orchid tubers are ground and mixed with powdered ginseng, powdered nutmeg and honey, and administered orally, 3–4 tablespoons, 2 times a day. In Kurdistan province *Salep* is also used for producing yogurt by adding it to milk as a starter. However, among the Turkmen ethnic group in Golestan province, an important source of traded *Salep* today, no local uses of *Salep* were reported by the villagers, and the plants even lack a vernacular name in their language.

Sustainability of orchid tuber collection and conservation measures

Orchid harvesting in Iran is lethal to the individual plants. Although our study does not examine the impacts of the harvest on decline or recovery of the exploited populations, the current orchid collection practices do not seem to be sustainable. Vulnerability of a harvested plant population to overexploitation depends on the plant part being harvested, and the quantity, intensity and frequency of harvesting (Schippmann et al. 2006). Herbaceous

species whose roots or fruit/seeds are harvested are more susceptible to excessive collection than trees or shrubs (Schippmann et al. 2006).

Collectors identify orchids by their above-ground appearance and uproot the plants with a shovel, selecting the new tubers for collection and discarding the remainder (Fig. 2). The high prices of tubers have led to competition between collectors, and many commence harvesting before the plants bloom and develop seeds. Considering that orchids are herbaceous plants, whose tubers are harvested, that the plant is destroyed after harvest, and that the harvest mostly happens before seed production, current orchid collection practice is not sustainable. Unsustainable harvesting practices are a double-edged sword, destroying the existing plants and hampering regeneration by preventing seed development. Commercial harvesting of natural resources in most cases results in resource depletion if measures for sustainable harvesting are not properly put into place. In the Western provinces of Iran that have a longer history of orchid collection, people have reported a decline in orchid populations, and as a result try to replant the orchids after removing the new tubers. In the Northern provinces, however, where traders from outside the area introduced collection practices, villagers think of orchids as a gift of nature, provided to them as a resource to supplement their income.

In general, orchid collection areas overlap with areas of high orchid species diversity. The eastern part of Golestan province for example is one of the hot spots of orchid species diversity in Iran, yet wild orchid collection is booming there. Kasperek and Grimm (1999) also found a high correspondence between orchid collection areas with areas of high orchid diversity in Turkey, and this lends weight to concerns about the negative effects of collection on the conservation of orchid species diversity.

All orchid species are listed on either CITES Appendix I or II, and their international trade is regulated and requires both export and import permits. Iran has been a signatory to CITES since 1976, and in addition all Iranian orchid species are listed as protected and their collection and harvest is illegal. However none of the harvested orchid species has been assessed for conservation status according to the IUCN Red List of Threatened Species. A recent regulation that was passed from the Iranian Forests, Range and Watershed Management Organization (FRWO) to provincial offices on June 12, 2013 (number 92/1/15123) reiterated that all orchid collection is illegal and should be prevented and FRWO offices should not give collection, transport and export permission for orchid tubers (FRWO 2013). Unfortunately, enforcement of these regulations is not effective enough to prevent destructive collection because of limited tools and resources to monitor and control this trade. In addition, it is challenging to control orchid harvesting in open-access natural ecosystems with little patrolling and oversight.

Conclusions

Orchids are collected intensively and destructively in Iran despite official legislation banning all collection, trade, and export. Paradoxically, there are no official statistics about collection and export volume, precisely because these practices are illegal. The north-eastern provinces of Iran are experiencing an orchid collection boom caused by international demand and trade and the resultant high prices. This demand is not limited to export to Turkey, but also driven by demand from India and Pakistan. Excessive harvesting of orchid tubers in western Iran that has likely caused scarcity of resources has forced traders to tap into new natural resource areas in Golestan province to maintain a steady supply for export. Demand-driven commercial orchid harvesting brought to the area by

outside traders, has affected local perceptions in the northern provinces of a resource that had hitherto not been recognized. The dramatically increasing collection and trade is likely to cause resource scarcity in the near future as it has done in Turkey.

To protect orchid resources we recommend the implementation of collection bans in heavily collected areas, strengthening of the enforcement of current regulations, developing a DNA barcoding-based molecular identification system to monitor and track species diversity in trade, the establishment of specific Orchid Conservation Areas, and the training of local stakeholders for sustainable collection practices and small-scale cultivation. The Iranian Forests, Range & Watershed Management Organization (FRWO), as the responsible organization for conserving natural resources outside the territory of protected areas, should be provided with the necessary resources to enforce and strengthen the enforcement of regulations on the harvest of orchids through provincial offices. Forest rangers and environmental guards should be involved in orchid conservation by training them to identify orchids in the field, to map and record orchid population distributions, and to report new populations and significant finds to a central FRWO database. Village councils in densely harvested areas should be informed about collection regulations and the conservation status of orchids, with the aim of involving them in efforts to implement sustainable harvesting and production. Development of a DNA barcoding system would enable customs offices on the Iranian borders, but also in export destination countries, to identify dried orchid tubers easily and accurately and to control the mislabeling and illegal trade of processed product. Targeted establishment of Orchid Conservation Areas can mitigate the effects of illegal collection on orchid populations in hot-spot collection areas, but also attract tourism and associated benefits.

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