universität wien

MASTERARBEIT

Titel der Masterarbeit

"Review of the status, use, adulteration, cultivation, and trade of three threatened and intensively used medicinal plant taxa from the Himalayan region"

verfasst von

Kirsten Palme, BSc

angestrebter akademischer Grad

Master of Science (MSc)

Wien, 2015

Studienkennzahl Studienblatt:	lt.	A 066 879
Studienrichtung Studienblatt:	lt.	Masterstudium Naturschutz und Biodiversitätsmanagement
Betreut von:		ao. Univ.-Prof. Dr. Michael Kiehn

Table of Contents

Table of Figures

Abbreviations

AD: Anno Domini, counting years after 1 BC (Before Christ)

App.: Appendix, referring to the Appendices of CITES

Ann.: Annex, referring to the Annex of (EC) No 338/97

BArtSchV: Bundesartenschutzverordnung, Germany

BfN: Bundesamt für Naturschutz (German Federal Agency for Nature Conservation)

BTN: Ngultrum, currency of Bhutan, equal to the value of the Indian Rupee

CAMP: Conservation Assessment and Management Plan

CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora

cf.: compare to

CoP: Conference of the Parties (always refers to CITES)

e.g.: for example

EU: European Union

ICIMOD: International Centre for Integrated Mountain Development

IUCN: International Union for Conservation of Nature

INR: Indian Rupee

ha: hectare

MAP: Medicinal and Aromatic Plant

NR: Nepali Rupee

PC: Plants Committee

pers.comm.: personal communication

PKR: Pakistani Rupee

SA: Scientific Authority

syn.: synonym

t/ha: tonnes per hectare

t/y: tonnes per year

TCM: Traditional Chinese Medicine

TRAFFIC: Trade Records Analysis of Flora and Fauna in Commerce

UNEP: United Nations Environment Programme

USD: United States Dollar

WCMC: World Conservation Monitoring Centre

Definitions

A glossary of important terms concerning the trade with medicinal plants is given in CoP (Conference of Parties) 14 Prop.27 2007:

Extract: A complex, multi-component mixture obtained by using a solvent, in the form of a tincture, fluid, solid, or powder.
Finished product: A preparation processed, packaged, labelled and ready for retail trade.
Powder: A dry, solid substance in the form of fine or coarse particles.
Retail trade: Sale of merchandise to the general public, for household or personal consumption.
Rhizome: Underground stem posessing buds and/or nodes.
Root: Generally the underground portion of a plant.
Underground part: Any subterranean plant part, e.g. root, rhizome, bulb, tuber, corm or caudice.
Wood-chip: A small piece broken or cut from a woody part of a plant.

Foreword

This thesis was composed due to concerns on how trends in industrial countries for traditional medicines will affect wild plant populations, particularly in South East Asia. If a sustainable use of these wild plant populations cannot be guaranteed, especially with increasing demand, there is a need for action for CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) in order to secure sustainability of their trade. Several plant species are already listed in the Appendices of the Convention due to their medicinal properties.

Initially my aim was to identify potentially endangered plants from traditional health care systems, which were traded internationally and to analyse if they qualified for a listing in Ann. D of the Council Regulation (EC) No 338/97. This would have resulted in a better overview of the traded quantities of these species. The number of plant species used in Ayurveda, TCM and Unani was assessed to be several thousand, and information concerning these was very insufficient. Additionally, a project named "Yaocaodict" (http://yaocaodict.com, 30.04.2015) led by the German botanist Gerhard Höfer in Hamburg was already developing a database linking vernacular names of drugs used in TCM with the corresponding plant species and scientific information on these. As a consequence I first concentrated on a review of *Saussurea costus* because Austrian authorities are confronted with several import requests per year and there was insufficient knowledge about range states and supposed cultivation sites (M. Kiehn, Botanical Garden Univ. of Vienna – CITES plants expert, pers. information). Details on its cultivation were unexplained. Furthermore, questions arose if taxonomical clarity existed and if adulteration was a fact to consider. While reviewing I started questioning the listing of *Saussurea costus* in Appendix I and I also added *Nardostachys grandiflora*, listed in Appendix II and finally *Inula racemosa*, not listed in the CITES Appendices (all three taxa found in the Himalayan region and used in TCM, Unani and Ayurveda) to compare information availability and to try evaluating the best possible measures for the species conservation.

1. Introduction

1.1. CITES and Medicinal Plants

It is the mission of CITES to prevent the wild populations of species listed in the Appendices from being threatened due to unsustainable international trade (CITES Secretariat 2015a). This is the case for numerous species popular for their medicinal properties.

Only sixteen species have been listed in the CITES Appendices specifically because their use in medicine leads to a threat to their wild populations (Hamilton 2004). Others were included by listing whole families, for example orchids or tree ferns (Schippmann 2001). This is the reason why the exact number of listed medicinal plants in CITES is hard to quantify. Over 230 species were identified by Schippmann 2001 with the vast majority assigned to App. II. (Schippmann 2001).

When a species is included in one of the Appendices this listing comprises all parts and derivatives of this species unless it is annotated. Annotations are represented by a # and number and specify in detail which plant parts and products are controlled by CITES (CITES Appendices, Interpretation §7).

This is particularly important for medicinal plants because they may be traded in various forms: as crude drug, processed products, such as powder, oil, derivatives, extracts or packaged products for retail trade (Cameron et al. 2004).

The origin of plant products can be either artificially propagated or growing wild. This is an important factor, because it influences permit requirements, depending on the appendix the species is listed in.

For example, artificially propagated plants listed in App. I can be treated as species in App. II (Text of CITES Art.VII §4).

This study focused on several perennial herbs from the Himalayan region whose underground parts are used medicinally. The harvest of these plant parts is usually letal to the individual plant and therefore increases the risk of overexploitation.

The identification of these roots or rhizomes is difficult, especially for customs officers implementing the regulations (Cameron et al. 2004).

In traditional medical systems remedies that consist of only one plant species are very rare. Usually they are a mixture of several species (Stöger 2010). For example

PADMA 28, a traditional Tibetan formula produced in Switzerland, consists of parts from 20 different species. For four of these species, namely *Saussurea costus, Pterocarpus santalinus, Aconitum napellus* and *Centraria islandica* trade is already being controlled (CITES App.I/II, (EC) No 338/97 Ann. D, BArtSchV) (Saller et al. 1997). This increases the difficulty of trade monitoring because estimating the quantity of plant material contained in the product is virtually impossible if not documented well (Schippmann 2001).

1.2. Species included in the review

All three taxa included in this review are herbaceous, perennial plants growing in the Himalayan Region and facing some level of threat because their roots or rhizomes are overexploited and traded for medicinal use and incense. *Saussurea costus* is the only plant listed in Appendix I for its medicinal purposes and has the longest listing history. It was initially included in Appendix II when the convention came into force in 1975. Ten years later, in 1985, it was uplisted to Appendix I (PC 19 Inf.7 2011).

A short review of the whole genus *Saussurea* was added in order to investigate the taxonomic clarity and to identify other species of the genus, which are used medicinally.

During my research I came across several studies which mentioned *Inula racemosa* as an adulterant of *Saussurea costus* (Chen et al. 2008, Chaturvedi et al. 1995, Khare 2007, Sastry et al. 2013, Ved and Tandon 1998), so further information on this topic was gathered and evaluated. *Inula racemosa* is currently not subject to any international trade regulations.

Nardostachys sp. was included as *Nardostachys grandiflora* in CITES Appendix II in 1997 (CoP10 Prop.10.75). Former proposals in the years 1989 and 1994 had been withdrawn because information was insufficient (Mulliken and Crofton 2008). The listing was originally annotated to designate only "whole and sliced roots and parts of the roots". This lead to difficulties arising from the fact that the underground stems (botanically called "rhizomes") were actually the main commodities and that the trade with oil and derivatives remained concealed. Hence, the annotation was modified to #2: "All parts and derivatives except: a) seeds and pollen; and b) finished products packaged and ready for retail trade" and has become effective as of September 13th, 2007 (CoP14 Prop.27). The taxonomy of the genus *Nardostachys* is highly

controversial (cf. Mulliken and Crofton 2008, Weberling 1975). It is unresolved whether *Nardostachys* comprises several species with different geographical distributions or is monospecific with different morphological types.

1.3. Countries included in the review

Bhutan, China, India, Nepal and Pakistan are all part of the Himalayan region and are the five countries the review focused on. They did not become members of CITES at the same time. Bhutan joined in 2002 and is the newest member. The other four countries have been parties of CITES almost from the beginning (Nepal since 1975, India and Pakistan since 1976 and China since 1981) (CITES Secretariat 2015b).
Information from these countries was not equally available or accessible. India and Nepal stand out with a lot of open source scientific data, while information from Bhutan and Pakistan was rather scarce and Chinas data availability was inconsistent.

1.4. Important Publications

Some important publications of the past years have formed the foundation for this review. Particularly noteworthy are the "The Review of the Status, Harvest, Trade and Management of Seven Asian CITES-listed Medicinal and Aromatic Plant species" by Mulliken and Crofton (2008) and studies published by the German Federal Agency for Nature Conservation (BfN): "Medicinal Plants Significant Trade Study; CITES Project S-109; Plants Committee Document PC9.1.3 (rev.)" (Schippmann 2001) and the "Checklist of Medicinal and Aromatic Plants and their trade names covered by CITES and EU Regulation 2307/97. Version 3.0." (Lange and Schippmann 1999).
CAMP Workshops have provided essential threat assessments on national level for India (Molur and Walker 1998, Ved et al. 2005).
The following works gave important input regarding the particular genera and species:
Saussurea: "*Saussurea* species in Indian Himalayan Region: Diversity, Distribution and Indigenous Uses" (Butola and Samant 2010), "Genus *Saussurea* DC. (Compositae) of Pakistan" (Ahmad 2005)
Saussurea costus: "A Review of the Status of Saussurea costus"(PC 19 Inf.7 2011), "Medicinal Plants Significant Trade Study; CITES Project S-109; PC 9.1.3 (rev.)" (Schippmann 2001)

Nardostachys sp.: "The Review of the Status, Harvest, Trade and Management of Seven Asian CITES-listed Medicinal and Aromatic Plant species" (Mulliken and Crofton 2008)
Inula racemosa: "Reproductive Biology of *Inula racemosa* Hook. f." (Shabir 2012)

1.5. Research objectives

Main objectives of this study were to review three medicinal perennial plant taxa from the Himalayan region, namely *Saussurea* (mainly S, *costus*), *Inula racemosa* and *Nardostachys* (*N. grandiflora* and related taxa) to unveil taxonomic ambiguities, the risk of confusion of species and adulteration. Furthermore history, areas and trends of use were investigated.
Available information on harvest, processing and cultivation was summarized as well.
The complete genus *Saussurea* was examined in order to reveal if less popular species apart from *Saussurea costus* are used medicinally or as adulterants for *Saussurea costus*. Trade data from the WCMC trade data base was analysed to point out important trends in reported trade data concerning the two listed species *S. costus* and *N. grandiflora*.
Recommendations on how to improve international trade regulations for the three taxa were developed and discussed.

2. Methods

Data sources for this study included a great variety of different literature found through an extensive online search, at the university library and personal stock of Dr. Uwe Schippmann (Bundesamt für Naturschutz, Konstantinstr.110, 53179 Bonn). Although the Scientific Authorities of Bhutan (Dr. Sangay Wangchuk, sangaywangchuk33@yahoo.com), China (The Endangered Species Scientific Commission of the People's Republic of China, ccites@ioz.ac.cn and jiangzg@ioz.ac.cn), India (Director of the Wildlife Institute of India, dwii@wii.gov.in), Nepal (Natural History Museum, Kathmandu, online contact form) and Pakistan (Conservator Wildlife, umeed_khalid@yahoo.com) were asked for up to date information concerning population data, trade data and conservation issues via email only India provided information, which was included in the following study. Also two people involved in sustainable collection and cultivation of medicinal herbs, Ben Heron from Pukka Herbs and Prashanti De Jager from the Dunagiri Foundation, provided information after an email enquiry.

Species names were checked against The Plant List, Version 1.1 (http://www.theplantlist.org) concerning taxonomic issues.

Currencies were quoted as in the original source and if not given converted into est. USD value of the year the source was published in order to make the values comparable.

Trade data was gathered from the CITES trade database (UNEP WCMC 2015). The database contains valuable trade information about international transactions with listed species. Exporting and importing countries gather and provide their custom information to the UNEP WCMC annually which puts it on its website. Obligation for countries to report can be found in Art. VIII §7 of the Convention (CITES). The WCMC has provided a guide on how to use the trade database (UNEP WCMC 2013).

In this study comparative tables were used to evaluate this data, in order to avoid biases caused by non-matching data from importing and exporting countries. The gross/net tables usually lead to an overestimation of the general trade.

To receive net values the re-imports were excluded by deleting all entries with an “origin“ value. For the analyses in this study only the information provided by the exporting countries was considered.

3. Results

3.0 Saussurea DC.

Saussurea is a genus within the family Compositae/Asteraceae and was named after Theodore de Saussure (1767-1845). It consists mainly of spineless perennial herbs with imbricate involucral bracts and a feathery pappus. The species show a big variation in habit, size, indumentum, stem and leaf morphology (Ahmad 2005). They have a tendency for habitat specificity (Butola and Samant 2010).

The genus comprises around 400 species, which occur mostly in Asia, and is especially diverse in mountainous, temperate areas. The highest number of species, 264, is reported for China (Ahmad 2005). 61 species are claimed to be native to India (Hajra 1998 in Ahmad 2005), although this number is doubted by Ahmad (2005), who describes 23 species occurring in Pakistan. 37 species are native to the Himalayan Region (Butola and Samant 2010). 41 species of *Saussurea* are indigenous to Bhutan and described in the Flora of Bhutan (ICIMOD 2012). The only species in Europe is the type species of the genus: *Saussurea alpina L. (DC)* (Ahmad 2005).

Two studies suggest the exclusion of *S. costus* (Qureshi et al. 2006, Wang et al. 2006) and also *S. forestii* from the genus (Wang et al. 2006). A genetic analysis by Wang et al. (2006) concludes that *S. costus* has diverged from its sister clade around 13.6 – 12.2 Ma. The Flora of China currently refers to this species as *Aucklandia costus* Falconer (Flora of China Editorial Committee 2011a).

The genus *Saussurea* is known for a great number of uses, especially in medicine and for religious purposes. Essential oils of several species are used in high grade perfumery and as insecticides (Butola and Samant 2010).

The analysis of phytochemical and pharmacological characteristics started in the 1960s (Shi 2008 in Yang et al. 2010). A large number of secondary metabolites have been isolated. These have cell-protective, immunosuppressive, antifungal and antibacterial as well as anti-inflammatory effects (Shi 2008 in Yang et al. 2010).

The roots are the predominant plant parts used and cited for medicinal purposes (Butola and Samant 2010).

As a result of having so many medicinal properties, several *Saussurea* species have become rare or endangered due to exploitation and habitat degradation. This includes

S. costus, the most lucrative species (Butola and Samant 2010), which is popular in several traditional healthcare systems like Unani, Siddha, Ayurveda and TCM.

Five further species: *S. gossypiphora, S. obvallata, S. simpsoniana, S. laniceps* and *S. medusa* all have their habitats in the alpine zone of the Himalayas and were declared endangered. Besides being used for medicinal purposes *S. gossypiphora*, *S. obvallata* and *S. simpsoniana* are also very showy plants and face an ongoing rapid population decline because local people and tourists gather them. The cultivation of these species is very difficult and has presumably not been implemented anywhere (Molur and Walker 1998).

S. laniceps and *S. medusa* face an additional threat due to a lack of pollinators, which consist of only two bumblebee species. (Law et al. 2010)

3.1 *Saussurea costus* (Falc.) Lipsch.

Fig. 1: 8 -10 *Aucklandia costus* Falconer [*Saussurea costus* (Falconer) Lipschitz]. 8 lower portion of plant; 9 upper portion of plant; 10 root (Illustration: Liu Chunrong in Flora of China 1999; http://www.efloras.org/object_page.aspx?object_id=121498&flora_id=2, 02.05.2015)

3.1.1 Taxonomy (names, short description)

Saussurea costus is a member of the family Asteraceae/ Compositae and of the genus *Saussurea*.

However, there is an uncertainty of whether it should be excluded from the genus (Qureshi et al. 2006, Wang et al. 2006). A genetic analysis from Wang et al. (2006) concludes that *S. costus* has diverged from its sister clade around 13.6 – 12.2 Ma. The Flora of China currently refers to this species as *Aucklandia costus* Falconer (Flora of China Editorial Committee 2011a)

Synonyms:

Aplotaxis lappa Decne, *Aucklandia costus* Falc., *Aucklandia lappa* Decne., *Saussurea lappa* (Decne.) Sch.Bip., *Theodorea costus* Kuntze (The Plant List 2013)

Trade and Vernacular Names:

A total of 129 trade and vernacular names were compiled during the review (Annex1). These names can be misleading, because they vary between regions and are sometimes used for more than one species.

The name "Costus" may also refer to *Costus spicatus* (Jacq.) Sw. (Waly 2009) or *Costus speciosus* (J.Koenig) Sm. (Lange 1999), members of the Family Costaceae and not related at all to *Saussurea*.

For the latter also the vernacular names "kust", "kut" and "kushta" are ambiguous.

The roots of *Costus spicatus* can be differentiated by colour: *C. spicatus* has a whitish root while Saussurea *costus* has a dark root (Waly 2009).

Short Description:

Saussurea costus is an erect perennial herb with a height varying between 1m – 3m (Ahmad 2005, Flora of China Editorial Committee 2011a, Hajra 2000).

Basal leaves are 50-90 cm long and 30-40 cm wide (Ahmad et al. 2012, Hajra 2000). Flowers are dark purple to almost black, organized in 1 or 2-5 capitula usually 2.5 - 5 cm in diameter (Flora of China Editorial Committee 2011a, Hajra 2000). Involucre bracts are hairless and surround the capitulum (Hajra 2000).

The fruit is a brown achena with a black spot, apically wrinkled, with a feathery and straw coloured to brown pappus (Ahmad et al. 2012, Flora of China Editorial Committee 2011a, Hajra 2000, Sharma 2000).

It has an average weight of 25 mg (dry) to 27 mg (fresh), is of around 9mm in length and has a thickness of 1.6mm (Butola and Samant 2006).

The rhizome is up to 60 cm long and 30 cm thick, stout, spongy, and carrot-like. Its colour is greyish to brown and it has a very strong and unpleasant odour (Cameron et al. 2004, p.27, Hajra 2000). After 2 to 3 years 3 to 4 vegetative buds develop (Dar et al. 2006).

S. costus blooms during the summer months from June to August and fruits thereafter from August to September (Sharma 2000).

Description of Raw Drug**:**

The raw drug is generally described as transversely or longitudinally sliced pieces of dried rhizome or roots. These pieces are about 5 - 10 cm long and 0.5 – 6 cm thick. They are dull brown and have a very characteristic and pungent smell.

The surface is rough and wrinkled.

In transverse cut pieces three regions can be differentiated: an outer thin ring, which is the root bark, followed by a light brown layer with fine radial stripes and a dark brown central pith region, which is sometimes hollow in older roots (Cameron et al. 2004, Dutta and Jain 2000, Jamphel et al. 2009).

The Monograph on Medicinal Plants of Bhutan Volume II also describes the powder of the crude drug. It contains various crystals (e.g. calcium oxalate), different types of tracheids, fibres and vessels (Jamphel et al. 2009).

3.1.2 Geographical Distribution

Saussurea costus is native to the Himalayan region of India and Pakistan.

While reviewing, a reference reporting possible native occurrences in Nepal in the Manaslu Conservation Area was found. *S. costus* is described as one of the dominant herb species in one part of the area there, but no further information if these are wild specimen could be acquired (Gurung and Pyakurel 2006).

In India *S. costus* occurs mainly in the states of Himachal Pradesh, Jammu and Kashmir and Uttarakhand (Hajra 2000). However, there is an ongoing discussion whether the individuals from Uttarakhand are wild or have escaped from cultivation. (PC 19 Inf.7 2011).

Distribution varies according to different literature sources as can be seen in Fig. 2 and ranges mainly between 2500 – 3000 m.

An overview of countries cultivating *S. costus* is given in chapter 3.1.7.1: Cultivating countries.

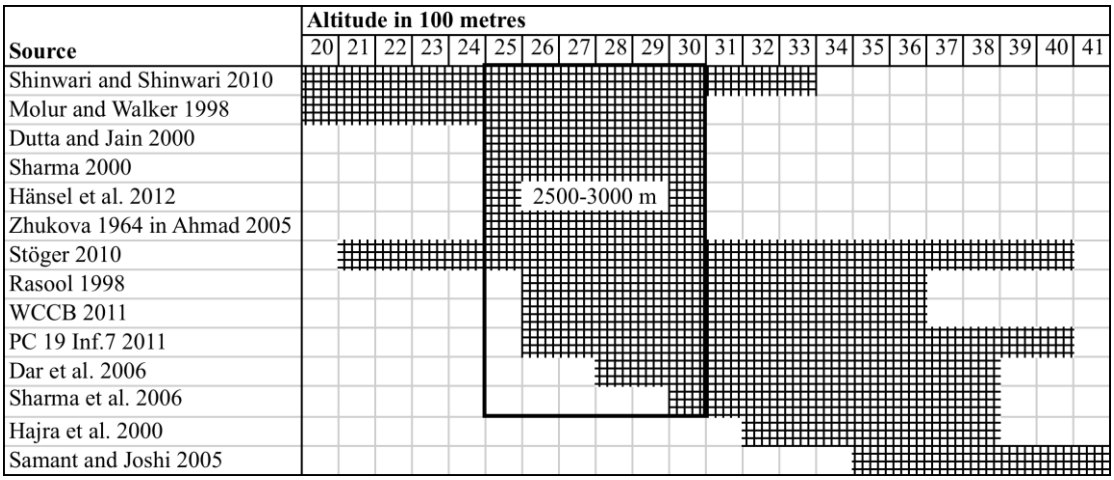


Fig. 2: Altitudinal distribution of *Saussurea costus* reported by different sources

3.1.3 Population status/trend

The 1997 IUCN Red List of Threatened Plants (Walter and Gillett 1998) classified *Saussurea costus* as endangered in India and Pakistan. The category 'critically endangered' did not exist at that time. Since these are the only described habitats, this status is also referred to as the global status. The Red Data Book of India agrees with the endangered status of *S. costus* (Hajra 2000).

As a result of rapid population decline of 70% in ten years and a very fragmented distribution *S. costus* was declared critically endangered in India at a CAMP workshop (Molur and Walker 1998).

A threat status assessment in the field in Kashmir found *S. costus* to be critically endangered due to extreme exploitation of rhizomes for medicinal purposes, illicit trade and grazing pressure, reduced and restricted populations and production of only few viable seeds (Dar et al. 2006). Sultan et al. (2013) found only few plants after long distances of trekking. This validates the view that most of the naturally occurring populations of the species are either overexploited or have been extirpated (Butola and Samant 2010).

The situation in Pakistan is very similar. Threats are excessive harvesting, unregulated grazing and land clearing for agriculture (Khan 2003). Furthermore the enforcement of regulations is insufficient (Khan 2003).

While Khan (2003) still estimated a population of >1000 individuals in managed forests in Pakistan in 2003, Sher et al. (2012) declared *S. costus* extinct in the

Pakistani valleys of the Hindu Kush and Himalayas based on their study and search for Important Plant Areas (IPAs) for Medicinal Plants.

3.1.4 Medicinal and other uses

Saussurea costus has been used since ancient to medieval times, where it was referred to as Costus arabicu, Costum or Cosstos (De Vos 2010). It is the most commercially used species of its genus and one of the most frequently traded CITES listed App. I species (PC 19 Inf.7 2011).

The dried rhizome of *S. costus* is used in several traditional medical systems particularly Unani, Siddha, Ayurveda and TCM and is therefore a remedy for a large variety of symptoms. It is one of the main ingredients in 71 of 175 formulations described in the Handbook of Traditional Tibetan Drugs (Tsarong 1986 in Butola and Samant 2006). The Monograph on Medicinal Plants of Bhutan Vol. II mentions over 30 important formulations containing *S. costus* (Jamphel et al. 2009) and around 90 products are listed in the Traditional Asian Medicine Identification Guide for Law Enforcers: Version II (Cameron et al. 2004).

Medicinally *S. costus* is used as an antiseptic (Hänsel et al. 2012a, Hajra 2000, Pandey et al. 2007) and to cure bacterial infections like cholera and leprosy (Dutta and Jain 2000, Adnan et al. 2006).
Additionally chronic respiratory diseases like asthma and bronchitis (Adnan et al. 2006, Hänsel et al. 2012a, Hajra 2000, Pandey et al. 2007), as well as chronic skin diseases (Hajra 2000), gastrointestinal problems (Adnan et al. 2006, Hänsel et al. 2012a, Hajra 2000), diabetes (Chaturvedi et al. 1995) and cancer (Madhuri et al. 2011, Pandey et al. 2007) are traditionally treated.
Furthermore *S. costus* is used as anticonvulsant (Hänsel et al. 2012a, Madhuri et al. 2011), antihypertensive (Hänsel et al. 2012a, Hajra 2000) and has antiarthritic (Butola and Samant 2010, Dutta and Jain 2000, Madhuri et al. 2011, Pandey et al. 2007) and anti-inflammatory effects (Madhuri et al. 2011, Pandey et al. 2007).
In China not only humans, but also livestock benefit from the treatment with medication composed of *S. costus* (Shen et al. 2010).

Other uses include the application as an insecticide (Bhatal et al. 1993, Hajra 2000, Kuniyal et al. 2005, Pandey et al. 2007, WCCB 2011) and as incense in religious ceremonies (ICIMOD 2012).
The leaves are used as fodder in winter and smoked as a substitute for tobacco (Butola and Samant 2010, Kuniyal et al. 2005)
Costus oil is used as hair oil and in high grade perfumery (Hajra 2000, Kuniyal et al. 2005, WCCB 2011).

3.1.5 Adulteration

Twelve different plant species used as substitutes and adulterants for *Saussurea costus* were recorded during the review. These are in alphabetical order: *Aristolochia contorta* Bunge (Chen et al. 2008), *Aristolochia debilis* Siebold & Zucc. (American Herbal Products Association (AHPA) 2012, Chen et al. 2008), *Carduus nutans* L. (Ved and Tandon 1998), *Inula helenium* L. (Chen et al. 2008, WCCB 2011), *Inula racemosa* Hook. f. (Chen u. a. 2008, Chaturvedi et al. 1995, Khare 2007a, Sastry et al. 2013, Ved and Tandon 1998), *Inula royleana* DC. (Ved and Tandon 1998), *Salvia lanata* Roxb. (accepted name: *Salvia mukerjeei* Bennet & Raizada) (Khare 2007a), *Saussurea auriculata* (DC.) Sch.Bip. (Butola and Samant 2010), *Senecio jacquemontianus* (Decne.) Benth. ex Hook.f. (syn. *Ligularia jacquemontiana* (Decne.) M.A.Rau) (Khare 2007a), *Vetiveria zizanioides* (L.) Nash (syn. *Chrysopogon zizanioides* (L.) Roberty (Sharma 2000, WCCB 2011), *Vladimiria berardioidea* (Franch.) Ling (syn. *Dolomiaea berardioidea* (Franch.) C.Shih) (Chen et al. 2008) and *Vladimiria souliei* (Franch.) Ling. (syn. *Dolomiaea souliei* (Franch.) C.Shih (Chen et al. 2008).
Furthermore *Saussurea costus* is mistaken for *Costus speciosus* (J.Koenig) due to identical trade names (Costus, Kushta, Kust, Kut) (Hänsel et al. 2012a).
Dolomiaea berardioidea, *Dolomiaea souliei*, *Inula helenium and Inula racemosa* also share their Chinese trade name „muxiang" with *S. costus* (Chen et al. 2008).

Inula racemosa and *Saussurea costus* are officially substitutes in Ayurvedan literature if one of them is not available (Chaturvedi et al. 1995, Sastry et al. 2014). Studies verified their similar medicinal properties for the treatment of asthma and diabetes (Chaturvedi et al. 1995, Sastry et al. 2013). Another study illustrated the morphological similarities (Sastry et al. 2014).

An adulteration with *Aristolochia sp.* or *Aconitum sp.* can be discovered microscopically (Hänsel et al. 2012a) and *Chrysopogon zizanioides* in oil can be distinguished by smell (Sharma 2000, WCCB 2011).
Chen et al. (2008) suggest DNA markers such as the internal transcribed spacer (ITS) region and 5S rRNA intergenic spacer to tell *S. costus* from its adulterants.

3.1.6 Harvest and processing

The rhizomes are generally ready for harvesting after 3 years (Kuniyal et al. 2005, Sharma 2000) and are harvested between September and November (ICIMOD 2012, Schmelzer 2001, Sharma 2000), because the essential oil content is highest at this time (Hänsel et al. 2012a).
It is crucial to harvest them before the plant starts flowering, because although the plant continues to grow, the quantity and quality of the root decreases (Sharma 2000, Schmelzer 2001).

Further handling involves rinsing the roots thoroughly with water, while avoiding letting them sit in water too long to prevent washing out useful active principles. (ICIMOD 2012). Thereafter they are dried, as a whole or in pieces, either under shady conditions or dried in the sun (ICIMOD 2012, Sharma 2000). Splitting the roots lengthwise or with hot air shortens the drying period but also reduces the quality (Schmelzer 2001). Finally the dried product is preferably stored in a moisture-proof container (ICIMOD 2012).

Moreover, the crude drug can be ground to powder. A viscous extract can be produced thereof by macerating the powder four times with ethyl acetate overnight (Julianti et al. 2011). In order to produce 1 g of extract 22.5 g of the powdered crude drug is needed (Julianti et al. 2011).
Essential oil is commonly isolated by hydro distillation yielding 1 – 1.5 % of oil (Hänsel et al. 2012a, Schmelzer 2001). A higher percentage of 3.3 – 6.6% of oil can be extracted using organic solvents (Hänsel et al. 2012a).

3.1.7. Cultivation and Artificial Propagation

Saussurea costus was collected from its wild, natural habitats in India until the 1920s. At this time farmers from Himachal Pradesh and Uttarakhand began to cultivate this species and made it one of the oldest cash crops in the cold desert area (Butola and Samant 2010, Kuniyal et al. 2005). Until the 1960s India was an important exporter (Anonymous 1976 in Kuniyal et al. 2005) and the area under cultivation was about 400 – 600 ha (Thakur et al. 1998 in Kuniyal et al. 2005). Later on the cultivation of *Saussurea costus* became unattractive, because of the long cultivation cycle with low income security and complicated permit formalities. This led to a decline of the cultivated area to 80 ha in the late 1990s (Thakur et al. 1998 in Kuniyal et al. 2005). It was replaced by more profitable cash crops and has only regained interest of farmers because of becoming declared an endangered medicinal plant (Kuniyal et al. 2005).

The cultivation of *S. costus* is possible in forests under seminatural conditions or in agricultural areas (Schmelzer 2001) and is therefore rated as only moderately difficult (Molur and Walker 1998). Where sufficient irrigation can be provided it can be also grown in cold desert areas (Kuniyal et al. 2005)

A protocol for rapid propagation for *S. costus* was already standardized in 1994, restricted only by the shortage of plant material to start with (Chandel and Sharma 1996). A plantation can yield between 2.5 - 3.5 t/ha dried roots per year (Negi et al. 2010, Schmelzer 2001, Sharma 2000).

Mainly there a two ways to propagate *Saussurea costus*, either by seed or by vegetative multiplication. Additionally, in vitro trials with tissue cultures have been successfully conducted (Chandel and Sharma 1996, Verma et al. 2012).

Seeds should be stored at cool temperatures to improve germination and sown before they are 18 months old (Butola and Samant 2006, Sharma et al. 2006). An average of 70% seed germination under on-farm conditions is reported by Butola and Samant (2006). In contradiction to this Dar et al. (2006) found most seeds to be nonviable and concluded that *S. costus* depended on vegetative propagation by underground plant parts. They explained this phenomenon by longlasting overexploitation, pollinator deficiency and unfavourable habitat for seedlings.

Several techniques can be applied to propagate *S. costus* vegetatively. Specifically, carefully separating buds from the main rhizome and planting them is is very time- and cost-efficient (Dar et al. 2006).

Replanting 2 - 3 cm long root pieces of the root collar zone (Kuniyal et al. 2005, Schmelzer 2001) and rooting runner cuttings (Parmar et al. 2012) are further methods. In addition "multiple shoot cultures" can be developed by culturing shoot tips of two week old seedlings (Johnson et al. 1997).

3.1.7.1. Cultivating countries

Bhutan:

Even though *S. costus* is not native to Bhutan, it is cultivated in the districts Bumthang, Haa, Gasa, Mongar and Trongsa (FAO 1996 p.22, ICIMOD 2012, Jamphel et al. 2009). A five year project conducted by ICIMOD instructed 250 farmers in cultivation techniques and around a hundred began cultivation on their land (ICIMOD 2012)

China:

Cultivation of *S. costus* takes place in the Chinese provinces Anhui, Fujian, Guangxi, Guizhou, Shaanxi, Sichuan, Yunnan and Zhejiang (Flora of China Editorial Committee 2011a)

India:

S. costus is cultivated by high altitudinal farmers in Himachal Pradesh and in some villages in Uttarakhand (pers. comm. G.S.Rawat, 11.09.2014)

412 farms in Uttarakhand were registered in the years 2008 and 2009 (PC 19 Inf.7 2011). Currently, 91 nurseries growing *S. costus* in India are registered with CITES (http://www.cites.org/eng/cms/index.php/component/cp/country/IN/cites-registers/Nurseries, 05.03.2015).

Natural regeneration in the proximity of plantations was documented in forests and pastures at Nanda Devi Biosphere Reserve in Uttarakhand and is occasionally used as planting material by farmers (Nautiyal et al. 2001).

Fig. 3: Terms and units as used by exporting countries

Term	Unit	count by exporter
derivatives	bags	3
	bottles	27
	boxes	22
	cartons	52
	g	46
	kg	258
	ml	4
	shipments	1
	(blank)	333
roots	boxes	1
	cartons	1
	g	15
	kg	284
	(blank)	23
extract	bottles	1
	cartons	1
	g	64
	kg	156
	l	2
	mg	1
	(blank)	20
powder	bottles	2
	g	7
	kg	68
	(blank)	2
dried plants	g	5
	kg	49
	(blank)	12
medicine	g	4
	kg	41
	(blank)	20
stems	g	12
	kg	31
specimens	g	1
	kg	10
	(blank)	1
live	kg	4
	(blank)	7
oil	kg	7
chips	kg	1
leaves	kg	1
carvings	(blank)	1
unspecified	(blank)	1

Source: Annual report data provided by WCMC

Pakistan:

One farm in the Punjab province conducted by "Qarshi Industries", an herbal medicine producer, is mentioned by Ahmad (2005).

Nepal:

No references found.

Vietnam:

S. costus has been cultivated in Vietnam. However, the total area of cultivation is decreasing due to cheap imports from China (Nguyen Dao Ngoc Van and Nguyen Tap 2008).

3.1.8 Trade

The trade of a species has two important levels: national and international trade. Analyzing trade is difficult because data is hardly available. Therefore the latest information obtainable was taken into consideration for the following overview.

3.1.8.1 National Trade

India's national demand is estimated at 1,826 t/y (Anonymous 2001). Kulu, a city in the state of Himachal Pradesh, is cited as the main trading centre for *S. costus* within India (WCCB 2011). A trend analysis from Uttarakhand assessed an average of 2.76 t/y of marketed, cultivated material at an average price of 85 INR/kg (≈1.60 USD/kg) in the years 2007 to 2010 (Kuniyal et al. 2013).

Valid national trade restrictions also apply to cultivated material and require certification (PC 19 Inf.7 2011).

The only reference found concerning trade within Pakistan reports a national consumption of 50 t/y with an estimated value of 150,000 PKR (≈ 6000 USD) (Khan 1991 in Williams and Ahmad 1999).

1,470 kg of dried *S. costus* roots were produced and sold by the Bhutanese cooperative at a price of 200 BTN/kg in 2012 (=4 USD/kg) (ICIMOD 2012).

The Inventory of Non Timber Forest Products (NTFPs) of the Manaslu Conservation Area in Nepal includes *S. costus.* However, it is not considered among the most valuable or vulnerable species, and no national trade is indicated (Gurung and Pyakurel 2006).

3.1.8.2 International Trade

Following the analysis of commodities in trade of Schippmann (2001), Fig. 3 shows all terms and units used by the exporters in their annual reports from 1997 – 2012. During these 15 years, the number of different terms doubled from 7 to 14.

New occurring terms since 1997 are: “powder”, “dried plants”, “medicine”, “stems”, “chips”, “leaves” and “carvings”.

Four terms were only used once: “leaves”, “chips”, “carvings”, and “unspecified” are therefore negligible. Especially the terms, “carvings“, “leaves“ (rhizome is the part usually in trade), “chips“, “live“, “stems“ (underground stem = rhizome) are misleading. Most likely these are all rhizomes or parts thereof, indicated by their trade in kg.

The term “medicine“ is also very questionable, because only the amount of *S. costus* in a medicinal product is supposed to be declared and not the weight of the product as a whole (cf. WCMC Guide).

A positive trend for the units used in the reports of the exporters was identified. The use of indeterminable units like shipments”, boxes, bottles or bags decreased significantly after 2001 and has been reduced to only metric units (kg/g) in 2010 (Fig.4).

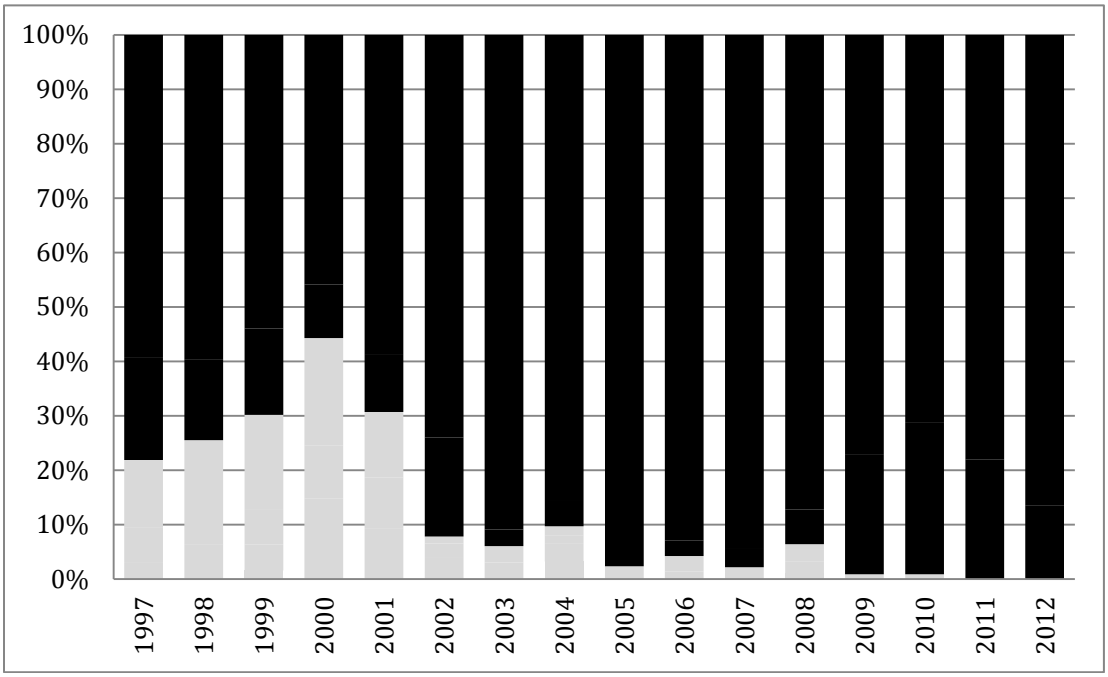


Fig. 4: Units used by the exporters in their reports in percent of the total count of reported trades per year. black = kg/g, grey = "other" units than kg/g

3.2. *Inula racemosa* Hook. f.

Fig. 5: 1-2 *Inula racemosa* J. D. Hooker. 1 portion of upper plant showing upper leaves; 2 flowering branch (Illustration: Liu Chunrong and Wu Zhanghua in Flora of China 1979; http://www.efloras.org/object_page.aspx?object_id=120769&flora_id=2, 02.05.2015)

3.2.1 Taxonomy (names, short description)

Inula racemosa Hook. F. is a member of the family Asteraceae/ Compositae and of the genus *Inula.*

Synonyms:

Inula royleana C.B. Clarke (Flora of China Editorial Committee 2011b).

Inula royleana DC. is a different medicinal plant from the Himalayan region called "Gugi Phool" in vernacular (Amin et al. 2014). It looks similar and is used as an adulterant of *Inula racemosa* Hook f. (Ved and Tandon 1998). In literature the two plants can only be distinguished if the authors name is quoted.

Trade and Vernacular Names:

A total of 35 vernacular names were compiled during the review (Annex 2)

These names can be misleading, because they vary between regions and are sometimes used for more than one species.

Short Description:

Inula racemosa is a perennial herb with a height between 140 cm – 210 cm. It has a very distinctive phenotypic variability. Plants growing in high altitudes are smaller, have fewer leaves and inflorescences and grow bigger rhizomes compared to plants from lower altitudes (Shabir 2012).

The leaves have a leathery texture, are 20-50 cm long and 10-20 cm wide (Flora of China Editorial Committee 2011b)

Flowers are yellow, arranged in racemes with 5-30 capitula per stem and have a diameter of 5 - 10 cm (Flora of China Editorial Committee 2011b, Kumar et al. 1997, Shabir 2012).

The main pollinators are two species of bumblebee and the Indian honeybee (*Apis indica)* (Shabir 2012, Wani et al. 2006).

The fruit is an achaena around 4mm long with a white to reddish pappus (Flora of China Editorial Committee 2011b, Shabir 2012) which develops after a flowering period in July - September throughout September (Flora of China Editorial Committee 2011b, Shabir 2012, Wani et al. 2006).

Description of Raw Drug:

The raw drug consists of dried pieces of rhizome which are about 6 - 9 cm long and 1-2 cm in diameter (Flora of China Editorial Committee 2011, Jamphel et al. 2009, Sastry et al. 2014). Their taste is bitter and their odour is sweet and camphor-like (Mangathayaru 2009, Jamphel et al. 2009, Sastry et al. 2014).

The outer surface is rough, longitudinally wrinkled and shows marks of lateral rootlets (Mangathayaru 2009). A greyish brown external area can be differentiated from a more yellow internal area and a sometimes hollow centre (Mangathayaru 2009).

The powdered crude drug contains microscopically visible parenchyma cells, bark cell fragments, fibres, tracheids, calcium oxalate crystals and occasionally starch grains (Jamphel et al. 2009).

3.2.2 Geographical Distribution

I. racemosa is native to the Hindu Kush Himalayan region in Afghanistan, Pakistan, India and Nepal (Anonymous 1998 in Shabir 2012, Flora of China Editorial Committee 2011b)

Distribution varies according to different literature sources as can be seen in Table 3 and ranges mainly between 2100 – 3100 m.

3.2.3. Population status

The 1997 IUCN Red List of Threatened Plants (Walter and Gillett 1998) classified *Inula racemosa* as vulnerable in India (Jammu & Kashmir).

A CAMP Workshop assessed a "CR – critically endangered" status for India due to an 80% wild population decline within 10 years. Data for a global status is deficient (Molur and Walker 1998). The main threats are overexploitation, commercial trade and habitat destruction (Molur and Walker 1998). These also influence the reproductive success of the species because isolated plants have a very low seed set (Shabir 2012).

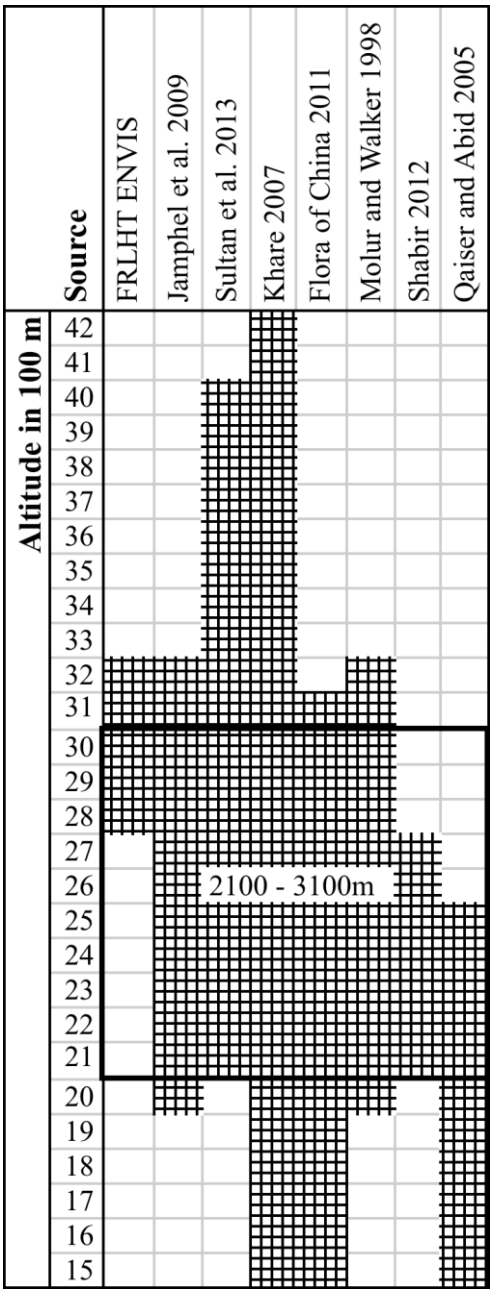


Fig. 6: Altitudinal distribution of *Inula racemosa* reported by different sources

Kala (2006) found *I. racemosa* only on culivated areas in Jammu and Kashmir and Himachal Pradesh during his study and and none in the wild.

3.2.4. Medicinal use

The dried rhizome of *Inula racemosa* is used in several Asian traditional medical systems like Ayurveda, Unani and TCM (Shabir 2012). Furthermore it has a history as a folk medicine in Europe and has been used by Native Americans to treat tuberculosis (Shabir 2012).

The Monograph on Medicinal Plants of Bhutan Vol. II mentions 23 important formulations containing *I. racemosa* (Jamphel et al. 2009). It is referred to as one of the fifty most commonly used medicinal plants in Jammu & Kashmir, India (Gairola et al. 2014)

Medication containing *I. racemosa* has antimicrobial and anti-inflammatory properties in people and animals (Gupta et al. 2013). It is used as antipyretic (Gupta et al. 2013), anti-hypertensive (Jamphel et al. 2009, Khare 2007a), against asthma, other pulmonary diseases (Gupta et al. 2013, Jamphel et al. 2009, Khare 2007a) and to treat stomach-aches and nausea (IUCN Nepal 2000, Jamphel et al. 2009, Khare 2007a).

Formulas comprised of *I. racemosa* may help to control diabetes (Chaturvedi et al. 1995) and to promote weight loss (Banarejee et al. 2014). According to the Supplement Guide of Men's Fitness most weight-loss pills in the United States of America contain between 20 and 100 mg of *I. racemosa* (Men's Fitness, Supplement Guide).

Apart from this the roots are applied as an insecticide (Bhatal et al. 1993).

3.2.5. Adulteration

Ayurvedan literature mentions two substitutes for *I. racemosa:* roots of *Saussurea costus* and *Ricinus communis* (Sastry et al. 2014). This recommendation dates back to AD 16, respectively AD 17 (Sastry et al. 2014). A study validated the substitution with *S. costus* for the treatment of diabetes (Chaturvedi et al. 1995). Several other sources declare *S. costus* as an adulterant (Khare 2007, Kumar et al. 1997, Molur and Walker 1998). The only other adulterant referred to is *Inula royleana* DC., especially in the Kashmir region (Ved and Tandon 1998).

3.2.6. Harvest and processing

I. racemosa is generally harvested after two or three years (Rawat and Everson 2011). In order to facilitate the harvesting the fields are often watered to loosen the soil. Thereafter the entire plant is uprooted (Kumar et al. 1997). The main harvesting season is from July to September (Jamphel et al. 2009).

For further processing the fresh roots are cleaned, cut into pieces and dried (Rawat and Everson 2011). 1 to 4 % of essential oil can be obtained by hydro-distillation (Khare 2007a).

3.2.7. Cultivation

Inula racemosa itself propagates both sexually and vegetatively. Therefore it can also be cultivated by both means (Shabir 2012). Additionally, methods for in vitro propagation were developed and standardized successfully by Jabeen et al. (2007) and Kaur et al. (2010).

The rate of 50 – 60 % seed germination in the field (Rawat and Everson 2011) can be improved by chilling (Sharma et al. 2006) or scarification (Shabir 2012).

Cultivation through rhizomes is more common (Rawat and Everson 2011). The rhizomes of 2 – 3 year old plants produce 3 - 5 vegetative shoots at the end of each growing season which can be separated and then used for cultivation (Shabir 2012).

The cultivation of *I. racemosa* is very labour intensive and can yield around 4 t/ha of roots (Rawat and Everson 2011). Loamy and sandy soils are preferable (Rawat and Everson 2011).

3.2.7.1 Cultivating Countries

Bhutan:

I. racemosa is cultivated in the districts Bumthang, Haa and Paro (Jamphel et al. 2009).

India:

The cultivation of *I. racemosa* was at its peak in Himachal Pradesh in the 1960s. The cultivated area added up to around 25 ha at this time. A crucial decline between 1980 and 2000 led to a remaining area of only 2 ha. According to the local farmers the main reasons for this is the long cultivation cycle, small land holdings and low and

fluctuating prices. It was therefore often replaced by cash crops like pea, potato and hops (Rawat and Everson 2011).

Nowadays, *I. racemosa* is planted quite commonly again by high altitudinal farmers in Himachal Pradesh and Jammu and Kashmir (Rana et al. 2014, G.S. Rawat pers. comm.11.09.2014). Occasionally, escapees from these fields are found in Lahaul, Himachal Pradesch (Ved and Tandon 1998).

China:

Cultivation of *Inula racemosa* exists in the autonomous region Xinjiang (Flora of China Editorial Committee 2011b)

3.2.8. Trade

The trade of a species has two important levels: national and international trade. Analyzing trade is difficult because data is hardly available. Therefore the latest information obtainable was taken into consideration for the following overview.

3.2.8.1 National Trade

Inula racemosa is used largely within India (G.S. Rawat pers. comm. 11.09.2014). The annual trade is estimated at 200 – 500 t at a price of around 150 INR/kg (≈3,5 USD/kg) (Ved and Goraya 2008).

No national trade data for any other countries could be obtained.

3.2.8.2. International Trade

Inula racemosa is currently not listed in any of the CITES Appendices. For this reason no international trade data was available.

Nevertheless, a patent from Unilever on an edible composition comprising theanine and an extract of *Inula racemosa*, e.g. for stimulating adiponectin release in humans (Banarejee et al. 2014) and the reference in the Men's Health Supplement Guide indicate international trade.

3.3 *Nardostachys sp.*

Fig. 7: 1-7 *Nardostachys jatamansi* (D. Don) Candolle. 1, 2 plants; 3, 4 fruits; 5, 6 flowers; 7 stamen (Illustration: Zhang Rongsheng in Flora of China 1986; http://www.efloras.org/object_page.aspx?object_id=119651&flora_id=2, 01.05.2015)

A very in-depth review of *Nardostachys grandiflora* DC. was done by Mulliken and Crofton in 2008. For this reason only essential and new information is summarized below.

3.3.1Taxonomy (names, short description)

The taxonomy of the genus *Nardostachys* is very intransparent and has therefore been the issue of many discussions (cf. Mulliken and Crofton 2008, Weberling 1975). The main aspect of these is whether *Nardostachys* comprises several species with different geographical distributions or is monospecific with different morphological types. This review follows the view of a monospecific genus and refers to this species as *Nardostachys sp.* in order to avoid further confusion.

The accepted name for the species is currently *Nardostachys jatamansi* (D.Don) DC. (Flora of China 2011c, The Plant List 2013). Therefore *N. grandiflora* DC. as well as *N. chinensis* Batalin are now considered synonyms.

Nardostachys sp. is a member of the family Valerianaceae (Flora of China Editorial Committee 2011c), now subsumed under the family Caprifoliaceae (The Plant List 2013).

3.3.2 Geographical Distribution

According to Mulliken and Crofton (2008) *Nardostachys sp.* occurs in Bhutan, China, India and Nepal. It remains uncertain whether Afghanistan, Myanmar and Pakistan are range states (Mulliken and Crofton 2008).

More detailed information on the distribution within Bhutan was found. *Nardostachys sp.* grows in scattered locations in the districts Haa, Paro, Timphu and Bhumtang (FAO 1996, p.25).

According to Shah (2007) information reporting the occurrence of *Nardostachys sp*. from Himachal Pradesh, India and Pakistan is wrong and the only states with natural occurring populations in India are Uttarakhand, Sikkim and Arunachal Pradesh.

3.3.3 Population status

Former threat assessments are outdated and there are still no reliable population data or estimates from any of the range states. A global status of the species has never been evaluated.

3.3.4 History of use

Nardostachys sp. has a long history of use. It was used from ancient to medieval times, where it was referred to as Spica or Spica nardi (De Vos 2010).

It has been one of the main ingredients in precious ointments perhaps already since Hammurabi in 2000 BC (Weberling 1975).

The price of *Nardostachys sp*. was regulated by the Diocletian Price Edict from the early 4th century AD (Naumann and Naumann 1973 in Kiehn 2012) and Pliny the Younger gave prices of different plant parts in "Naturalis Historia" book XII: 42 ff. Additionally, the high value of nard oil was mentioned in the bible by Mark (14:3-14:5) (Kiehn 2012).

Ancient trade is recorded from ca. AD 150. A customs declaration (P. Vindob. G 40822) on a papyrus mentions a ship from India carrying 60 containers of "Gangitian nard" parts. This reference shows that the species had been traded at a high trade volume for a very long time and has been able to survive until the present (Kiehn 2012).

3.3.5 Adulteration

Two *Selinum* species are used as an adulterant and a substitute for *Nardostachys sp.* These are *Selinum vaginatum* and *Selinum wallichianum* (Khare 2007b, Mulliken and Crofton 2008, WCCB 2011) The latter is also referred to by its synonyms: *Selinum tenuifolium* or *Selinum candollei*. These rhizomes can be told apart by looking at the fibres surrounding the rhizome: *Nardostachys* has reddish brown fibres with a sweet aroma and the *Selinum* species bristly, dirty brown fibres with a pungent and unpleasant odour (Shah 2007). The crude drug is also often adulterated with the roots and rhizomes of *Cymbopogon schoenanthus* (WCCB 2011).

Further substitutes are Seseli sibiricum and Corydalis govaniana (Khare 2007b).

Vetiveria zizanioides, now *Chrysopogon zizanoides* (The Plant List 2013) is referred to as 'Indische Nardenwurzel' or 'Indische Spikenardwurzel' in German and may therefore be mistaken for *Nardostachys sp.* (Hänsel et al. 2012b).

3.3.6 Harvest and processing

The Government of Nepal has presented strict regulations which quantify the wild collection. Sustainability is ensured by selective collection of 50% of the mature rhizomes harvested on one out of four blocks per year. Additionally, younger plants shall be replanted (Government of Nepal 2013).

Bhutan also published Harvesting Guidelines: The rhizome is to be dug up with a sharp knife. Thereby the mother plant shall be left intact with a small part of the rhizome left in the soil. It is also advised to harvest only in designated areas and on a small scale (Social Forestry Division et al. 2011).

3.3.7 Cultivation

Nardostachys sp. is difficult to cultivate and there is no known company doing so on a commercial scale (Ben Heron pers. comm. 24.11.2014, Prasahanti De Jager pers.comm. 23.03.2015)

In India, a project in Uttaranchal tried to promote the cultivation of *Nardostachys sp.* Farmers were provided with training and a booklet describing techniques. In 2003, 2,200 seedlings were planted by five farmers, but died due to the lack of irrigation (Jain 2004).

Small scale cultivation is reported from the bordering zones and agricultural land of the Govind Pashu Vihar Wildlife Sanctuary (Negi et al. 2010) and the buffer zone of the Nanda Devi Biosphere Reserve where a 0.15 ha nursery plantation for future propagation existed (Silori and Badola 2000).

The Dunagiri Foundation has supported some herb growers to cultivate a small quantity of *Nardostachys sp.* (Prashanti De Jager pers.comm. 23.03.2015)

The only institution successfully cultivating *Nardostachys sp.* appears to be the High Altitude Plant Physiology Research Centre (HAPPRC), HNB Garwhal University Srinagar at their experimental farm at Tungnath, Uttarakhand (Jain 2004, Ben Heron pers. comm. 24.11.2014, Prasahanti De Jager pers.comm. 23.03.2015).

From Nepal there is only one reference from 1979 to a farm named “Doti” at 3,134m that cultivated *Nardostachys sp.* (Singh et al. 1979)

A project in Western Nepal attempted to cultivate on former harvesting grounds, but was not very successful. (pers.comm. Prashanti De Jager 23.03.2015)

3.3.8 Trade

The trade of a species has two important levels: national and international trade. Analyzing trade is difficult because data is hardly available. Therefore the latest information obtainable was taken into consideration for the following overview.

3.3.8.1 National Trade

India has an estimated annual consumption of 286 t of *Nardostachys* sp., all provided from wild sources (Ved and Goraya 2008).

A monthly price information bulletin for major NTFPs in Nepal and India has existed since 2001 and is published by the Asia Network for Sustainable Agriculture and Bio Resources (ANSAB). In February 2015 it states the price of "Jatamansi" in Nepal at: Kathmandu: 700 NR/kg (≈ 9 USD/kg), Nepalgunj: 650 Nr/kg (≈ 8 USD/kg) and in India at: Delhi: 1,360 NR/kg (≈ 17 USD/kg), Tanakpur = 1,264 NR/kg (≈ 12 USD/kg), Lucknow = 1,376 (≈ 17 USD/kg), Kolkata = 1,440 NR/kg (≈ 18 USD/kg) (ANSAB 2015).

3.3.8.2 International Trade

The trade data from the UNEP-WCMC database was analyzed up to the year 2004 in Mulliken and Crofton (2008).

A follow-up interpretation was carried out in this study. There is still comparably little information reported. Modifying the annotation of the listing of *Nardostachys sp.* in 2007 to: "Designates all parts and derivatives except: a) seeds and pollen; and b) finished products packaged and ready for retail sale" improved this situation.

Fig. 8 shows that this was an important step to make the significant international trade volumes of oil and derivatives visible. Up to the year 2007 only whole or sliced roots or parts of roots were covered by the CITES listing.

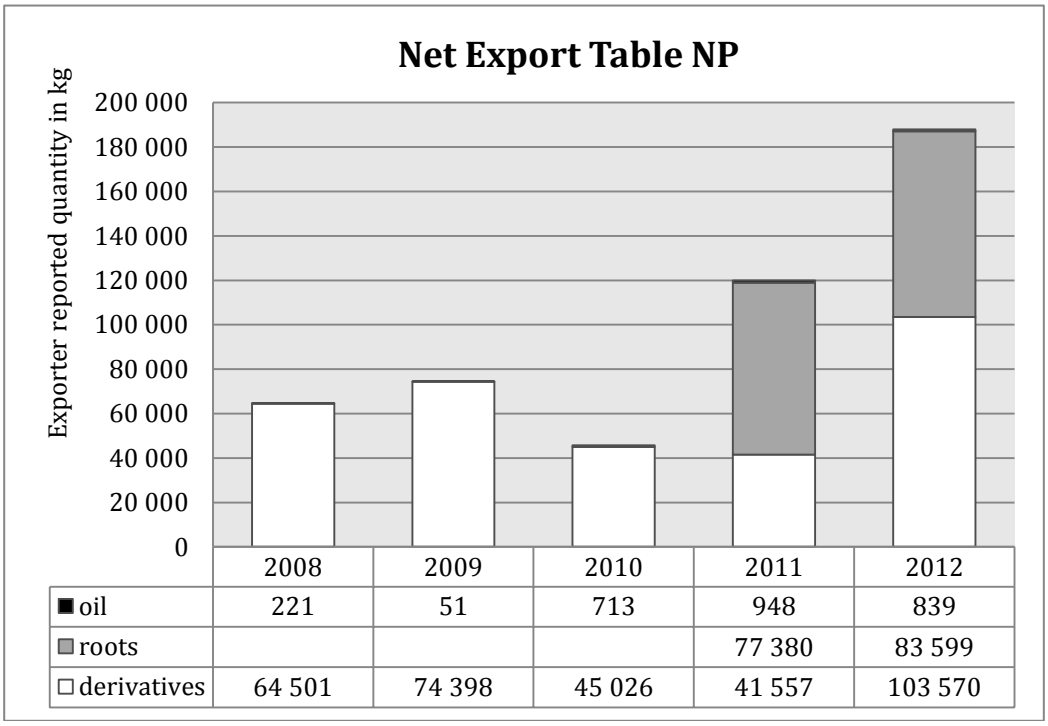
China reported an export of 12,500 kg of roots in 2001 and has thereafter never reported any trade again.

Nepal is the only range state of *Nardostachys sp.* reporting any trade in the years 2006 – 2012 (Fig. 8). It should be pointed out positively that only three terms: oil, derivatives and roots and only kg was used as a unit. The main commodity is derivatives.

The export of 77 t of roots in 2011 and 83 t of roots in 2012 to India raises the question if there was a special authorization, because otherwise the export of unprocessed roots from Nepal is prohibited by national legislation.

A different explanation might be the trade with "Jatamansi marc", the remains of the rhizomes after oil extraction (Mulliken and Crofton 2008), a slightly processed product.

The vast amount of plant material recorded in trade here gets more comprehensible by a simple calculation. The trade values of oil may appear misleadingly low, but the yield of oil on a commercial scale is on average 2 – 2.5 % of the weight of the dried rhizomes (Government of Nepal 2013). Therefore 948 kg of oil traded in 2011 require around 38t of crude drug (dried rhizome). Furthermore, if you apply the value of 420 plants uprooted per 1 kg of dried rhizomes (Rai et al. 2000) to convert these 38 t of dried rhizomes to plants uprooted the result is 15.9 million. If it were to be confirmed, that the trade of "roots" is actually trade of "marc", this amount would have to be subtracted from the amount of crude drug used for oil, to avoid misinterpretation. Moreover, the use of this trade term would have to be questioned.



	2008	2009	2010	2011	2012
oil	221	51	713	948	839
roots				77 380	83 599
derivatives	64 501	74 398	45 026	41 557	103 570

Fig. 8: Net export table of *Nardostachys sp.* from Nepal in kg by year, NP = Nepal

4. Discussion

Saussurea DC.:

The review of the complete genus *Saussurea* revealed that it consists of several species used in medicine, perfumery and as insecticides for which the underground plant parts are used most commonly (Butola and Samant 2010).

Additionally, the different species tend to show high habitat specifity (Butola and Samant 2010), which increases conservational concerns.

The species *S. gossypiphora*, *S. laniceps*, *S. medusa*, *S. obvallata*, and *S. simpsoniana* are endangered and have their habitat in the alpine zone of the Himalayans (Molur and Walker 1998).

Trade records refer most likely to *S. costus* and are mainly from confiscations (source: I). In 2009, Australia (AU) and The Republic of Korea (KR) used this name in their import records. But there is some likelihood that other *Saussurea* species are also traded internationally as there have been reports in the WCMC database reporting the trade with "*Saussurea spp*." since 1995. If this indicates difficulties of the authorities to identify the species, a listing of the whole genus as *Saussurea spp.* should be considered according to Res. Conf. 9. 24 (Rev. COP 16), Annex 2B.

Saussurea costus:

The Inventory of Non Timber Forest Products (NTFPs) of the Manaslu Conservation Area, Nepal (Gurung and Pyakurel 2006) reports the occurrence of potentially wild *Saussurea costus* from the area. So far *S. costus* was claimed endemic to India and Pakistan. It is therefore of particular importance to verify this record.

A total of 129 trade and vernacular names used for *Saussurea costus* were compiled during the review (Annex 1), reflecting its popularity among different nations and traditional systems of medicine.

The list of adulterants of *S. costus* was extended and includes twelve different plant species.

Although some of the adulterations can be detected with a microscope (Hänsel et al. 2012a) or by smell (Sharma 2000), it is hard to rule out completely. Detailed crude drug characteristics, acquired and described above, may assist in identification. Chen et al. (2008) suggest genetic analyses, which could resolve the problem.

Restrictions of this method are that they are not yet advanced enough to be used at the borders and could only be applied randomly. Furthermore the use is limited to the crude drug excluding powders or derivatives, which account for a big share of the total trade.

The analysis of the UNEP WCMC trade data from 1997 – 2012, following the trade data analysis of Schippmann (2001), showed that the variety and of different terms used in trade records increased immensely. Some of these terms, e.g. "live", "stems" and "chips" seem to describe the same commodity and probably actually describe rhizome parts, especially because they are traded in kg.

Vague terms like "medicines" should be avoided, because the amount of plant material used in this product is very hard to determine if not documented precisely and therefore often the weight of the whole commodity is reported, leading to falsifications in the database.

It is to be noted positively that efforts to harmonise the units used in the reports have been very successful as all export-reporting countries have only used the metric weight units g and kg since 2010.

If trade recorded under *Saussurea spp*. refers to *S. costus*, a solution needs to be found to harmonize these reports, because otherwise significant trade volumes might be overlooked.

A previous review published as PC 19 Inf.7 2011 has adressed and described the concern before, that the listing of *S. costus* on Appendix I might not be adequate anymore for several reasons. It is the only highly used and traded medicinal plant included in App. I. This by itself is already questionable. Since trade from wild sources is forbidden due to its listing, all products in trade have to be of artificially propagated origin, indicating successful and large volume cultivation is taking place. All these products are therefore already treated as those of a species in App. II. As the results of my review show a quite common cultivation of the species, and the species is very rare in the wild, these are good reasons to doubt that any commercially viable wild collection is still taking place. The main problem is that there is still no reliable population data to underpin this hypothesis.

So far there has been no evidence that the uplisting of *S. costus* to App. I has improved the situation of the wild populations in any way. On the contrary, there is reason to presume that it is actually hampering cultivation efforts, especially in its

range states rendering these not competitive to non-range states like China (PC 19 Inf.7 2011).
I agree with the suggestions of PC 19 Inf.7 (2011) that cultivation should be promoted further and linked to a registration of cultivators and periodic non-detriment-findings (NDFs).
Although the MA of India has declared the need for a comprehensive study on this topic in order to consider a downlisting in 2011 (PC 19 Inf.7 2011), so far no further efforts have been undertaken.

Inula racemosa:
The information available for *Inula racemosa* was significantly lower compared to the other two species. This may be due to the scientific community concentrating on other more popular species or to the fact that *Inula racemosa* up to now is not restricted or controlled in international trade.

Nevertheless, some findings compiled here on *I. racemosa* might be relevant to other species sharing the same habitat as well.
These include the very distinctive phenotypic variability of the species, with high altitudinal plants being smaller and having bigger rhizomes (Shabir 2012) and that higher population densities have a direct effect on the reproductive success of the species (Shabir 2012, Wani et al. 2006).

The fact that *I. racemosa* has been reported as one of the main adulterants for *S. costus* by several studies (Chen u. a. 2008, Chaturvedi et al. 1995, Khare 2007, Sastry et al. 2013, Ved and Tandon 1998) and has been historically described and verified as a substitute for *S. costus* (Chaturvedi et al. 1995, Sastry et al. 2014) could pose a potential risk to the species.

The review revealed that *I. racemosa* has a long history in use for medicinal purposes in several traditional medical systems, not only in Asia. A patent held by Unilever (Banarejee et al. 2014) and the reference to several weight loss pills containing *I. racemosa* in the supplement guide of Men's Health imply an ongoing international trade. The demand for *I. racemosa* might even be growing as diseases like obesity and diabetes increase. Some cultivation is taking place in Bhutan (Jamphel et al. 2009),

India (Rana et al. 2014, G.S. Rawat pers. comm. 11.09.2014) and China (Flora of China Editorial Committee 2011b). If this cultivation is able to meet the demand or if wild collection on a commercial scale is taking place remains unclear.
Unfortunately, no comprehensive trade or population data are available up to now. In order to oversee international trade, which may have an impact on the wild populations, a listing in Annex D of the Council Regulation (EC) No. 338/97 could be considered. The range states may also critically analyse all their available data on the species or request such from their authorities and compile these in order to assess if criteria are met for a listing in App. II.

Nardostachys sp.:
Apart from adulteration due to taxonomic confusion five additional adulterants of *Nardostachys sp*. were unveiled. The two *Selinum* species can presumably be recognised by fibres surrounding the rhizomes, but further distinguishing marks have to be identified.
Cultivation of *Nardostachys sp.* seems to be rather difficult and has not been implemented anywhere on a commercial scale until now. Therefore techniques for sustainable harvest should be enforced and certified by FairWild at best.

Reported trade data is quite fragmentary, with Nepal being the only export reporting country, apart from China which reported a onetime export of 12.5 t of roots in 2001. The amendment of the annotation to include processed forms in 2007 has improved the situation very much and has made significant trade volumes of oils and derivatives visible (Fig. 8).
It is, however, still very doubtful that no further international trade is taking place from any other range state. Bhutan has addressed concerns of long term sustainability and the capability to meet the demand of the state owned pharmaceutical company in 2012 (Dorji 2012). Has the international trade from China really stopped or is it just not recorded anymore? There is also greater clarity needed whether the term "roots" is also used for "marc", the remnants of the roots after oil extraction, which can lead to confusion.

The taxonomic ambiguities concerning *Nardostachys sp*. remain and cause problems in the CITES implementation, a concern already addressed by Mulliken (2000).

No synonyms for *Nardostachys grandiflora* are officially listed in the Appendices, none appear in CITES+ or the most recent "Checklist of CITES Species" (UNEP_WCMC 2014) although the proposal from 1997 mentions, among others, *Nardostachys jatamansi* DC as a scientific synonym (CoP (Conference of Parties) 10 Prop.75 1997).

The lack of synonyms appearing officially very likely leads to a falsification of the trade data, especially because "*Nardostachys jatamansi*" seems to be the more popular used name for the species in trade.

This is demonstrated, for example, by Rathnayake and Peiris (2012), who mention *Nardostachys jatamansi* in their list of medicinal plant species used in Sri Lanka, but exclude it later on in their presentation from the list of CITES listed species of Sri Lanka.

A proposal to list *Nardostachys* as a genus (*Nardostachys spp*.) should be considered, because no matter whether regarding the genus to be monospecific or not the advantages outweigh the disadvantages: When considering *Nardostachys* as monospecific, the listing of the whole genus automatically covers most synonyms. If disagreeing with this opinion, the rhizomes of the subspecies of *Nardostachys sp*. still qualify for inclusion in App. II as lookalikes, because custom officials are incapable of distinguishing their rhizomes (cf. Res. Conf. 9. 24 (Rev. COP 16), Annex 2B).

Conclusions:

Information availability remains best from India and Nepal (Mulliken and Crofton 2008).

Although Bhutan joined CITES as a member in 2002 it has so far not reported any trade to the WCMC trade database. This should be changed as soon as possible.

Numerous adulterants were found for all three species. Future investigations will have to find methods to recognise them. Maybe a DNA method can be promising (c.f. Chen 2008).

No recent population data or threat assessment on any of the three species was available for the range states or globally.

Identification of rhizomes on the species level is difficult. It is so far only possible if morphological traits are recognisable. When dealing with powders or derivatives correct labelling is crucial.

Whether the product in trade originated from the wild or was cultivated is indistinguishable for the customs official on the basis of the crude drug or even the processed products.

Therefore it is essential that the originating countries have clear documentation and certification. Possibilities include the transparent registration of nurseries with CITES, including estimated yield quantities. Member states should be asked to update or provide this information in the future.

A further option would be to mention countries cultivating a listed species on CITES+ to provide a good foundation for decision-making to management authorities. Especially, because it can be very time consuming to obtain this information

The UNEP WCMC Trade database is a powerful tool to analyse trends in trade. This should be done on a regular basis. Positive changes like the harmonisation of units in the reporting of *S. costus* have to be pursued further. As soon as the suspicion arises that important trade factors could have been left out, special awareness has to be implemented to avoid drawing the wrong conclusions (cf. *Nardostachys sp*.).

The listing of a species in one of the Appendices has to be chosen very carefully. Special attention has to be given to the history of use and possibilities for sustainable harvest regimes and successful cultivation.

Bibliography

Abid, R., and Qaiser, M. (2006): Numerical analysis of *Inula* L.(s. str.) and its allied genera from Pakistan and Kashmir. Pakistan Journal of Botany 38(3):521-526. http://pakbs.org/pjbot/PDFs/38(3)/PJB38(3)521.pdf accessed:08/05/2014

Adnan, S., Khan, A.A., and Shiwari, Z.K. (2006): Threats to the Sustainability of ethno-medicinal uses in Northern Pakistan (A case study of Miandam Valley, District Swat, NWFP Province, Pakistan). http://www.lyonia.org/downloadPDF.php?pdfID=2.494.1, accessed: 25.2.2015).

Ahmad, S. (2005): Genus *Saussurea* DC. (Compositae) of Pakistan. univ. Diss. Department of Biological Sciences, Quaid-i-Azam University, Islamabad, Pakistan. 153 pp. published online. http://prr.hec.gov.pk/thesis/2259.pdf accessed:02/03/2015

Ahmad, K.S., Qureshi, R., Hameed, M., Ahmad, F., and Nawaz, T. (2012): Conservation Assessment and Medicinal Importance of Some Plants Resources from Sharda, Neelum Valley, Azad Jammu and Kashmir, Pakistan. International Journal of Agriculture and Biology 14(6): 997–1000. http://www.fspublishers.org/published_papers/11263_..pdf accessed: 14/02/2014

American Herbal Products Association (AHPA) (2012): Guidance Policies - Known Adulterants. http://www.ahpa.org/Portals/0/pdfs/AHPA_GuidancePolicies.pdf accessed: 11/26/2013

Amin, S., Kaloo, Z.A., and Singh, S. (2014): Rapid in vitro propagation of *Inula royleana* DC. through embryo culture. Journal of Scientific and Innovative Research 3(2): 203 – 206. http://www.jsirjournal.com/Vol3_Issue2_14.pdf accessed:03/01/2015

Anonymous (2001): Study for Selected Medicinal Plants Vol II (Plant Profile). ANSAB. http://www.ansab.org/wp-content/uploads/2015/03/ANSAB_MIS_Price-List_February-2015.pdf accessed: 16/03/2015

Banarejee, G., Kadamkode, V., Kalathil, R., and Majumder, S. (2014): Patent WO2014079665A1 - Composition Comprising Theanine and an Extract of *Inula racemosa*. http://www.google.com/patents/WO2014079665A1?cl=en accessed:08/05/2014

Bhatal, S.S., Singh, D., Singh, S., and Dhillon, R.S. (1993): Effect of crude root oils of *Inula racemosa* and *Saussurea lappa* on feeding, survival and development of *Spodoptera litura* (Lepidoptera: Noctuidae) larvae. European Journal of Entomology 90: 239–240. http://www.eje.cz/pdfs/eje/1993/02/16.pdf accessed:08/05/2014

Butola, J.S., and Samant, S.S. (2006): Seed Viability of *Saussurea costus*. Journal of Tropical Medicinal Plants 7(2): 197–203. http://www.researchgate.net/profile/Jitendra_Butola/publication/257991081_Seed_viability_of_Saussurea_costus/file/e0b495268fa4764890.pdf accessed:03/04/2014

Butola, J.S., and Samant, S.S. (2010): *Saussurea* Species in Indian Himalayan Region: Diversity, Distribution and Indigenous Uses. International Journal of Plant Biology 1(1): 43–51. http://www.pagepress.org/journals/index.php/pb/article/view/1652 accessed:09/13/2013

Cameron, G., Pendry, S., Allan, C., and Wu, J. (2004): Traditional Asian Medicine Identification Guide for Law Enforcers: Version II. Her Majesty's Customs and Excise, London and TRAFFIC International, Cambridge, UK. 332 pp. http://www.traffic.org/medicinal-reports/traffic_pub_medicinal5.pdf accessed:12/02/2013

Chandel, K.P.S. and Sharma, N. (1996): In Vitro Conservation of Diversity in Medicinal Plants of North-West Himalaya. In: Supplement to cultivation and utilization of medicinal plants, 741– 751. Regional Research Laboratory, Jammu-Tawi.

Chaturvedi, P., Shukla, S., Tripathi, P., Chaurasia, S., Singh, S.K. et al. (1995): Comparative Study of *Inula racemosa* and *Saussurea lappa* on the Glucose Level in Albino Rats. Ancient Science of Life 15(1): 62–70. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3331181/pdf/ASL-15-62.pdf accessed:07/09/2014

Chen, F., Chan, H.Y., Wong, K.L., Wang, J., Yu, M.T. et al. (2008): Authentication of *Saussurea lappa*, an Endangered Medicinal Material, by ITS DNA and 5S rRNA Sequencing. Planta Medica 74(8): 889–892. http://www.thieme-connect.de/DOI/DOI?10.1055/s-2008-1074551 accessed:05/16/2014

CITES Appendices I, II and III valid from February 5th 2015. http://www.cites.org/sites/default/files/eng/app/2015/E-Appendices-2015-02-05.pdf accessed: 04/30/2015

CITES Secretariat (2015a): What is CITES? http://cites.org/eng/disc/what.php accessed: 04/30/2015

CITES Secretariat (2015b): List of Contracting Parties. http://cites.org/eng/disc/parties/chronolo.php accessed: 04/30/2015

CoP (Conference of Parties) 10 Prop.75 (1997): Consideration of Proposals for Amendment of Appendices I and II. *Nardostachys grandiflora*. http://cites.org/sites/default/files/eng/cop/10/prop/E-CoP10-P-75.pdf accessed:05/05/2014

CoP (Conference of Parties) 14 Prop.27 (2007): Consideration of Proposals for Amendment of Appendices I and II. http://cites.org/sites/default/files/eng/cop/14/prop/E14-P27.pdf accessed:05/05/2014

CoP (Conference of Parties) 16 Res.Conf. 9.24 rev. (2013): Criteria for Amendment of Appendices I and II - E-Res-09-24R16. http://cites.org/sites/default/files/eng/res/09/E-Res-09-24R16.pdf accessed:08/05/2014

Dar, A.R., Dar, G., and Reshi, Z. (2006): Recovery and Restoration of some critically endangered endemic Angiosperms of the Kashmir Himalaya. Journal of Biological Sciences 6(6):985–991.

Dorji, U. (2012): *Nardostachys grandiflora* - Status report. CITES Asia Regional Workshop on Medicinal Plants "Ensuring Legal, Sustainable and Traceable Trade", 24-26 May 2012, Thimphu Bhutan, Proceedings, 158. Department of Forest and Park Services, Wildlife Conservation Division, Royal Government of Bhutan, Thimphu. http://www.cites.org/sites/default/files/eng/cop/16/inf/E-CoP16i-49.pdf accessed:04/07/2015

Dutta, R. and Jain, P. (2000): CITES Listed Medicinal Plants of India - An Identification Manual, TRAFFIC-India/WWF-India, New Delhi, India http://www.traffic.org/species-reports/traffic_species_plants11.pdf accessed:12/02/2013

ENVIS - FRLHT Trade Search - *Saussurea*. http://envis.frlht.org/trade_search.php?txtpart=ROOTS&lst_part=ROOTS&txttrade=kutki&lst_trade=KUTKI&emailid=&Join=Join accessed:08/05/2014a

ENVIS - FRLHT Trade Search - *Nardostachys*. http://envis.frlht.org/trade_search.php?txtpart=ROOTS&lst_part=ROOTS&txttrade=JESHTIMADH+%28MULETHI%29+No.1&lst_trade=JATAMANSI&emailid= accessed:08/05/2014b

ENVIS - FRLHT Trade Search - *Inula racemosa.* http://envis.frlht.org/trade_search.php?txtpart=ROOTS&lst_part=ROOTS&txttrade=pushkarmool+asli&lst_trade=PUSHKARMOOL+ASLI&emailid=&Join=Join accessed:08/05/2014

FAO (1996): Non-wood Forest Products of Bhutan. Rap Publication 1996/6, Food and Agriculture Organization of the United Nations, Bangkok, Thailand. 108 pp. http://www.fao.org/docrep/x5335e/x5335e05.htm# accessed:05/03/2015

Flora of China Editorial Committee (2011a): Asteraceae. *Aucklandia. Aucklandia costus* Falconer. Flora of China Vol. 20 -21: 55. http://www.efloras.org/florataxon.aspx?flora_id=2&taxon_id=250097338 accessed:02/17/2014

Flora of China Editorial Committee (2011b): Asteraceae. *Inula. Inula racemosa* J.D. Hooker. Flora of China Vol 20-21: 839. http://www.efloras.org/florataxon.aspx?flora_id=2&taxon_id=200024063 accessed:12/15/2014

Flora of China Editorial Committee (2011c): Valerianaceae. *Nardostachys. Nardostachys jatamansi* (D. Don) Candolle. Flora of China Vol. 19: 661. http://www.efloras.org/florataxon.aspx?flora_id=2&taxon_id=200022534 accessed:12/15/2014

Gairola, S., Sharma, J., and Bedi, Y.S. (2014): A cross-cultural analysis of Jammu, Kashmir and Ladakh (India) medicinal plant use. Journal of Ethnopharmacology 155(2): 925–986.

Government of Nepal, Ministry of Forests and Soil Conservation, Department of Forests (2013): Status of Impact on the Natural Population of *Nardostachys grandiflora* due to current level of Trade in Nepal. submitted to: European Commission, EnV.E.2 - Multilateral Environtmental Agreements, Processes and Trade Issues .

Gupta, S., Sharma, O., Raina, N., and Sehgal, S. (2013): Ethno-botanical study of medicinal plants of Paddar Valley of Jammu and Kashmir, India. African Journal of Traditional, Complementary and Alternative Medicines 10(4): 59 – 65. http://www.ajol.info/index.php/ajtcam/article/view/89712 accessed:08/05/2014

Gurung, K. and Pyakurel, D. (2006): Identification and Inventory of Non Timber Forest Products (NTFPs) of Manaslu Conservation Area. A report submitted to: Mansaslu Conservation Area Project (MCAP) and National Trust for Nature Conservation (NTNC)

Hajra, P.K. (2000): *Saussurea costus* (Falc.) Lipschitz. In: Red Data Book of Indian Plants Vol II repr. : 69. Botanical Survey of India, Calcutta.

Hamilton, A.C. (2004): Medicinal plants, conservation and livelihoods. Biodiversity and Conservation 13(8): 1477–1517.

Hänsel, R., Keller, K., Rimpler, H., and Schneider, G. (eds) (2012a): Hagers Handbuch der Pharmazeutischen Praxis 6: Drogen P-Z: 620-626, Springer Berlin Heidelberg
Hänsel, R., Keller, K., Rimpler, H., and Schneider, G. (eds) (2012b): Hagers Handbuch der Pharmazeutischen Praxis 5: Drogen E—O: 912 -915, Springer Berlin Heidelberg

ICIMOD (2012): Medicinal Plants and Herbal Products in the Eastern Himalayas: Developing Sustainable Supply Chain and Enhancing Rural Livelihoods. Project Code: FISGTF/16. April 2007 - Oct 2012, Kathmandu, Nepal. 62 pp. http://www.common-fund.org/fileadmin/user_upload/Projects/FISGTF/FISGTF_16/PROJECT_COMPLETION_REPORT_FISGTF_16.pdf accessed:12/09/2014

IUCN Nepal (2000): National Register of Medicinal Plants, IUCN Nepal, Kathmandu, Nepal. 161pp. https://portals.iucn.org/library/efiles/edocs/2000-058.pdf accessed:05/21/2014

Jabeen, N., Shawl, A.S., Dar, G.H., Jan, A., and Sultan, P. (2007): Micropropagation of *Inula racemosa* Hook.f. a valuable medicinal plant. International Journal of Botany 3(3): 296–301. http://198.170.104.138/ijb/2007/296-301.pdf accessed:08/05/2014

Jain, P. (2004): Facilitating Cultivation Trials of Medicinal Plants in Uttaranchal State of India. Medplant Network News 4(4): 23–24.

Jamphel, K., Tenzin, S., Tashi, and Dorji, D.Y. (eds) (2009): Monograph on Medicinal Plants of Bhutan Volume II, Ministry of Health, Institute of Traditional Medicine Services, Pharmaceutical and Research Unit, Thimphu, Bhutan. *Inula racemosa*. p.51-54. *Saussurea lappa*. p.72-75. *Nardostachys grandiflora*. p.80-83. http://herbalnet.healthrepository.org/handle/123456789/2054 accessed:03/22/2015

Johnson, T.S., Narayan, S.B., and Narayana, D.B.A. (1997): Rapid in vitro propagation of *Saussurea lappa*, an endangered Medicinal Plant, through multiple shoot cultures. In Vitro Cellular & Developmental Biology-Plant 33(2):128–130.
Julianti, T., Hata, Y., Zimmermann, S., Kaiser, M., Hamburger, M. et al. (2011): Antitrypanosomal Sesquiterpene Lactones from *Saussurea costus*. Fitoterapia 82(7): 955–959.

Kala, C.P. (2006): Medicinal plants of the high altitude cold desert in India: Diversity, distribution and traditional uses. International Journal of Biodiversity Science, Ecosystems Services & Management 2(1): 43–56.

Kaur, R., Kashyap, A., Majeed, S., Chauhan, N.S., and Bhardwaj, S.B. (2010): In vitro propagation and conservation of *Inula racemosa* Hook. f. An endangered medicinal plant of temperate origin. J. Adv. Lab. Res. Biol 1(1): 88–91

Khan, S.R. (2003): Status of forest genetic resources conservation and management in Pakistan. Forest Genetic Resources Working Papers, Working Paper FGR/67E. Forest Resources Development Service, Forest Resources Division, FAO, Rome. http://www.fao.org/docrep/007/ad873e/ad873e00.htm accessed:03/10/2014

Khare, C.P. (ed) (2007a): *Inula racemosa* Hook. f.. In: Indian Medicinal Plants: An Illustrated Dictionary, 329. Springer, Berlin/Heidelberg.

Khare, C.P. (ed) (2007b): *Nardostachys jatamansi* DC.. In: Indian Medicinal Plants: An Illustrated Dictionary, Springer, 433-434. Berlin/Heidelberg.

Kiehn, M. (2012): Plant Introductions: Historical Sketches. Pacific Science 66(2): 119–125. http://www.bioone.org/doi/abs/10.2984/66.2.2 accessed:03/17/2015

Kumar, S., Singh, J., Shah, N.C., and Ranjan, V. (1997): Indian medicinal and aromatic plants facing genetic erosion. *Inula racemosa* p.131-137. *Saussurea costus* p. 189-191. Central Institute of Medicinal and Aromatic Plants, Lucknow.

Kuniyal, C.P., Rawat, Y.S., Oinam, S.S., Kuniyal, J.C., and Vishvakarma, S.C.R. (2005): Kuth (*Saussurea lappa*) Cultivation in the cold desert environment of the Lahaul Valley, Northwestern Himalaya, India: Arising threats and need to revive socio-economic values. Biodiversity and Conservation 14(5):1035–1045.
Kuniyal, C.P., Kuniyal, P.C., Butola, J.S., and Sundriyal, R.C. (2013): Trends in the marketing of some important medicinal plants in Uttarakhand, India. International Journal of Biodiversity Science, Ecosystem Services & Management 9(4):324–329. http://www.tandfonline.com/doi/abs/10.1080/21513732.2013.819531 accessed:12/10/2014

Lange, D. (1999): Identification training for medicinal and aromatic plants covered by CITES and EU Regulation 2307/ 97. Lecture script. Version 2-En. 25.5.99., Bundesamt für Naturschutz, Bonn (BfNSkripten 11)

Lange, D. and Schippmann, U. (1999): Checklist of Medicinal and Aromatic Plants and Their Trade Names Covered by CITES and EU Regulation 2307/97. Version 3.0. BfN-Skripten 8, German Federal Agency for Nature Conservation, Bonn

Law, W., Salick, J., and Knight, T.M. (2010): The effects of pollen limitation on population dynamics of snow lotus (*Saussurea medusa* and *S. laniceps*, Asteraceae): Threatened Tibetan medicinal plants of the Eastern Himalayas. Plant Ecology 210(2):343–357.

Madhuri, K., Elango, K., and Ponnusankar, S. (2011): *Saussurea lappa* (Kuth root): review of its traditional uses, phytochemistry and pharmacology. Oriental Pharmacy and Experimental Medicine 12(1):1–9.

Mangathayaru, K. (2009): Pharmacognostic studies of *Inula racemosa* Hook.f and *Erythrina variegata* Linn. on experimental atherosclerosis. Thesis. Sri Ramachandra Medical College And Research Institute Sri Ramachandra University, Porur, Chennai. http://shodhganga.inflibnet.ac.in/bitstream/10603/4584/1/01_title.pdf accessed:07/09/2014

Men's Fitness, Supplement Guide: *Inula racemosa*. http://www.mensfitness.com/nutrition/supplements/supplement-guide-inula-racemosa accessed:07/11/2014

Molur, S. and Walker, S. (eds) (1998): Report of the Workshop Conservation Assessment and Management Plan for Selected Medicinal Plant Species of Northern, Northeastern and Central India (BCCP-Endangered Species Project). 62. Zoo Outreach Organisation, Conservation Breeding Specialist Group, Coimbatore, India. http://zooreach.org/downloads/ZOO_CAMP_PHVA_reports/1998%20BCPP%20C.A.M.P.%20Report%20-%20Selected%20Medicinal%20plants%20of%20N,NE%20and%20Central%20India.pdf accessed:01/30/2015

Mulliken, T.A. (2000): Implementing CITES for Himalayan Medicinal Plants *Nardostachys grandiflora* and *Picrorhiza kurrooa*. 63–72. http://www.traffic.org/traffic-bulletin/traffic_pub_bulletin_18_2.pdf accessed:03/26/2014

Mulliken, T. and Crofton, P. (2008): Review of the status, harvest, trade and management of seven Asian CITES-listed medicinal and aromatic plant species. BfN-Skripten 227, Federal Agency for Natural Conservation, Bonn, Germany. http://www.neobiota.bfn.de/fileadmin/MDB/documents/service/skript227.pdf accessed:12/02/2013

Nautiyal, S., Maikhuri, R.K., Rao, K.S., and Saxena, K.G. (2001): Medicinal Plant Resources in Nanda Devi Biosphere Reserve in the Central Himalayas. Journal of Herbs, Spices & Medicinal Plants 8(4): 47–64. http://www.tandfonline.com/doi/abs/10.1300/J044v08n04_06 accessed:05/07/2014

Negi, V.S., Maikhuri, R.K., Phondani, P.C., and Rawat, L.S. (2010): An Inventory of Indigenous Knowledge and Cultivation Practices of Medicinal Plants in Govind Pashu Vihar Wildlife Sanctuary, Central Himalaya, India. International Journal of Biodiversity Science, Ecosystem Services & Management 6(3-4): 96–105. http://dx.doi.org/10.1080/21513732.2011.575385 accessed:09/13/2013

Nguyen Dao Ngoc Van and Nguyen Tap (2008): An Overview of the Use of Plants and Animals in Traditional Medicine Systems in Viet Nam Compiled by Nguyen Dao Ngoc Van and Nguyen Tap. TRAFFIC Southeast Asia, Greater Mekong Programme, Hanoi, Viet Nam. http://www.worldwildlife.org/who/media/press/2008/wwfbinaryitem9483.pdf accessed:12/02/2013

Pandey, M.M., Rastogi, S., and Rawat, A.K.S. (2007): *Saussurea costus*: Botanical, chemical and pharmacological review of an ayurvedic medicinal plant. Journal of Ethnopharmacology 110(3): 379–390.

Parmar, M.P.S., Negi, L.S., and Ramola, S. (2012): Seeds germination and seedlings analysis of *Saussurea costus* Royle Ex Benth. in high and low altitudinal villages of District Uttarkashi (Uttarakhand). IOSR Journal of Pharmacy 2(6):25–30. http://www.iosrphr.org/papers/v2i6/Part_4/D02642530.pdf accessed:02/06/2014

PC (Plant Committee Meeting) 19 Inf.7 (2011): A review of the status of *Saussurea costus*. http://www.cites.org/common/com/pc/19/E19i-07.pdf accessed:12/12/2013

Qureshi, R.A., Ahmad, S., and Khan, A.G. (2006): Hierarchial Cluster Analysis of *Saussurea* DC. (Compositae) of Pakistan based on morphological characters. International Journal of Botany 2(3):319–323. http://198.170.104.138/ijb/2006/319-323.pdf accessed:03/19/2014

Rai, L.K., Prasad, P., and Sharma, E. (2000): Conservation threats to some important medicinal plants of the Sikkim Himalaya. Biological Conservation 93(1):27–33.

Rana, P.K., Kumar, P., Singhal, V.K., and Rana, J.C. (2014): Uses of Local Plant Biodiversity among the Tribal Communities of Pangi Valley of District Chamba in Cold Desert Himalaya, India. The Scientific World Journal 2014: 1–15. http://www.hindawi.com/journals/tswj/2014/753289/ accessed:08/05/2014

Rasool, G. (1998): Saving the Plants That Save Us. Medicinal Plants of the Northern Areas of Pakistan, BASDO, Gilgit.

Rathnayake, H.D. and Peiris, L. (2012): Medicinal Plants of Sri Lanka. CoP (Conference of Parties) 16 Prop.49: 5 CITES Asia Regional Workshop on Medicinal Plants "Ensuring Legal, Sustainable and Traceable Trade", 24-26 May 2012, Thimphu Bhutan, Proceedings, 158. Department of Forest and Park Services,Wildlife Conservation Division, Royal Government of Bhutan, Thimphu. http://www.cites.org/sites/default/files/eng/cop/16/inf/E-CoP16i-49.pdf accessed:04/07/2015

Rawat, Y.S. and Everson, C.S. (2011): *Inula racemosa* Hook. f: A potential medicinal crop in the cold desert agro-ecosystem of North Western Himalaya, India. Journal of Medicinal Plants Research 5(26): 6218–6223. http://www.academicjournals.org/article/article1380706882_Rawat%20and%20Everson.pdf accessed:03/22/2015

Saller, R., Kristof, O., and Reichling, J. (1997): Padma 28. Ein traditionelles und modernes Phytotherapeutikum. Zeitschrift für Phytotherapie 18: 323–331.

Samant and Joshi (2005): Plant diversity and conservation status of Nanda Devi National Park and comparison with highland National Parks of the Indian Himalayan Region. International Journal of Biodiversity Science, Ecosystems Services & Management 1(1):65–73. http://www.tandfonline.com/doi/abs/10.1080/17451590509618081 accessed:02/12/2014

Sastry, J.L.N., Nesari, T.M., and Rajendra, H. (2013): Comparative study on the substitutes used in Ayurveda with special reference to substitutes for Pushkaramula (*Inula racemosa* Hook.f.) Viz., Kushta (*Saussurea lappa* Decne.) and Erandamula (*Ricinus communis* L.): A clinical study. International Research Journal of Pharmacy 4(5): 92–100

Sastry, J.L.N., Nesari, T.M., and Rajendra, H. (2014): Pharmacognostic studies on the substitutes of Pushkaramula (*Inula racemosa*). International Journal of Pharmacotherapy 4(1): 1–5. http://www.ijopjournal.com/File_Folder/1-5.pdf accessed:08/05/2014

Schippmann, U. (2001): Medicinal Plants Significant Trade Study; Cites Project S-109; Plants Commitee Document PC9.1.3 (rev.). BfN-Skripten 39, German Federal Agency for Nature Conservation, Bonn

Schmelzer, G.H. (2001): *Saussurea costus* (Falc.) S.J. Lipschitz. In: Valkenburg, JLC. van., and Bunyapraphatsara, N. (eds): Plants Resources of South-East Asia 12 (2). Medicinal and poisonous plants 2, 488–491. Backhuys, Leiden.

Shabir, P.A. (2012): Reproductive biology of *Inula racemosa* Hook. f. univ. Diss. Department of Zoology Post Graduat Department of Zoology Faculty of Biological Science, University of Kashmir. 180 pp. published online. http://ojs.uok.edu.in/jspui/handle/1/1357 accessed:08/05/2014

Shah, N.C.S. (2007): On the history, botany, distribution, uses and conservation aspects of *Nardostachys jatamansi* in India. Medicinal Plant Conservation 13: 8–11. http://cmsdata.iucn.org/downloads/mpc13.pdf accessed:05/05/2014

Sharma, R. (2000): Vulnerable and threatened plants of economic value. S*aussurea costus*. MFP News 10(2): 17–18.

Sharma, R.K., Sharma, S., and Sharma, S.S. (2006): Seed germination behaviour of some medicinal plants of Lahaul and Spiti Cold Desert (Himachal Pradesh): Implications for conservation and cultivation. Current Science 90(8):1113 –1118. http://www.iisc.ernet.in/currsci/apr252006/1113.pdf accessed:05/16/2014

Shen, S., Qian, J., and Ren, J. (2010): Ethnoveterinary plant remedies used by Nu people in NW Yunnan of China. J Ethnobiol Ethnomed 6(1): 1–24. http://www.biomedcentral.com/content/pdf/1746-4269-6-24.pdf accessed:11/26/2013

Sher, H., Ali, H., and Rehman, S. (2012): Identification and conservation of important plant areas (IPAS) for the distribution of medicinal, aromatic and economic plants in the Hindukush-Himalaya mountain range. Pakistan Journal of Botany 44: 187–194. http://www.pakbs.org/pjbot/PDFs/44(SI2)/26.pdf accessed:02/14/2014

Shinwari, M.I., and Shinwari, M.I. (2010): Botanical diversity in Pakistan; Past, present and future. Pakistan Engineering Congress, World Environment Day 2010 85–104. http://pecongress.org.pk/images/upload/books/Botanical%20Diversity%20in%20Pakistan%20Past,%20Present%20and%20Future%20(7).pdf accessed:02/19/2014

Silori, C.S. and Badola, R. (2000): Medicinal plant cultivation and sustainable development: A case study in the buffer zone of the Nanda Devi Biosphere Reserve, Western Himalaya, India. Mountain Research and Development 20(3): 272–279. http://www.bioone.org/doi/abs/10.1659/0276-4741(2000)020%5B0272:MPCASD%5D2.0.CO%3B2 accessed:11/26/2013

Singh, M.P., Malla, S.B., Rajbhandari, S.B., and Manandhar, A. (1979): Medicinal Plants of Nepal—Retrospects and Prospects. Economic Botany 33(2):185–198. http://link.springer.com/article/10.1007/BF02858287 accessed:04/28/2014

Social Forestry Division, Department of Forests & Park Services, and Ministry of Agriculture & Forests (2011): Interim Framework for Management and Marketing of Non-Wood Forest Products. http://www.snvworld.org/sites/www.snvworld.org/files/images/interim_framework_for_management_and_marketing_of_non-wood_forest_products_-_2011.pdf accessed:12/09/2013

Stöger, E.A. (2010): Drogen der Traditionellen Chinesischen Medizin in westlichen Ländern. Pharmakognosie—Phytopharmazie, 385–414.

Sultan, R., Wani, M.A., and Nawchoo, I.A. (2013): Unabated loss of medicinal plant diversity in Himalaya: a serious socio-economic concern and urgency to salvage whatever is left. Global Advanced Research Journal of Medicinal Plants (GARJMP) (2)1: 12-21. http://www.garj.org/full-articles/unabated-loss-of-medicinal-plant-diversity-in-himalaya-a-serious-socio-economic-concern-and-urgency-to-salvage-whatever-is-left.pdf?view=download accessed:02/19/2015

Text of the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Signed at Washington, D.C., on March 3rd 1973, amended at Bonn, on June 22nd 1979, amended at Gaborone, on April 30th 1983. http://www.cites.org/sites/default/files/eng/disc/CITES-Convention-EN.pdf accessed: 04/30/2015

The Plant List (2013): http://www.theplantlist.org/ accessed:11/26/2014
UNEP-WCMC (Comps.) (2014): Checklist of CITES Species. CITES Secretariat, Geneva, Switzerland, and UNEP-WCMC, Cambridge, United Kingdom. http://http://checklist.cites.org/ accessed:04/07/2015

UNEP-WCMC (2013): A guide to using the CITES Trade Database, Version 8 October 2013. Cambridge, UK. http://trade.cites.org/cites_trade_guidelines/en-CITES_Trade_Database_Guide.pdf accessed: 04/30/2015

UNEP-WCMC (2015): CITES Trade Database. UNEP World Conservation Monitoring Centre, Cambridge, UK. http://trade.cites.org/ accessed: 04/30/2015

Ved, D.K., Kinhal, G.A., Ravikumar, K., Sankar, R.V., and Haridasan, K. (2005): Conservation Assessment and Management Prioritisation (CAMP) for wild medicinal plants of North-East India. Medicinal Plant Conservation 11: 40–44. http://cmsdata.iucn.org/downloads/mpc11.pdf accessed:05/16/2014

Ved, D.K. and Goraya, G.S. (2008): Demand and supply of medicinal plants in India, NMPB, New Delhi & FRLHT, Bangalore, India, Dehra Dun .

Ved, D.K. and Tandon, V. (eds) (1998): Conservation Assessment and Management Plan Workshop for High Altitude Medicinal Plants of Jammu-Kashmir and Himachal Pradesh, Kullu, Himachal Pradesh, 16-18 April 1998. 75 pp. FRLHT, Bangalore.

Verma, P., Mathur, A.K., Jain, S.P., and Mathur, A. (2012): In vitro conservation of twenty-three overexploited medicinal plants belonging to the Indian sub continent. The Scientific World Journal 2012, Article ID: 929650, 10 pp. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3349164/ accessed:03/21/2013

De Vos, P. (2010): European materia medica in historical texts: Longevity of a tradition and implications for future use. Journal of Ethnopharmacology 132(1): 28–47. accessed:11/26/2013

Walter, K.S. and Gillett, H.J. (eds) (1998): 1997 IUCN Red List of Threatened Plants. Compiled by the World Conservation Monitoring Centre, IUCN, Gland, Switzerland and Cambridge, UK.

Waly, N.M. (2009): Verifying the scientific name of Costus [*Saussurea lappa* ((Decne.) CB Clarke.)–Asteraceae]. JKAU Sci 21327–334. http://amohorjy.kau.edu.sa/Files/320/Researches/53959_24476.pdf accessed:02/21/2014

Wang, Y.J., Liu, J.Q., and Miehe, G. (2006): Phylogenetic origins of the Himalayan endemic Dolomiaea, Diplazoptilon and Xanthopappus (Asteraceae: Cardueae) Based on three DNA Regions. Annals of Botany 99(2): 311–322. http://aob.oxfordjournals.org/cgi/doi/10.1093/aob/mcl259 accessed:06/11/2014

Wani, P.A., Ganaie, K.A., Nawchoo, I.A., and Wafai, B.A. (2006): Phenological episodes and reproductive strategies of *Inula racemosa* (Asteraceae)- a critically endangered medicinal herb of North West Himalaya. International Journal of Botany 2(4): 388–394. http://docsdrive.com/pdfs/ansinet/ijb/2006/388-394.pdf accessed:07/09/2014

WCCB (2011): Manual on Medicinal Plants. A Manual on Wildlife Species in Trade, 411–426. Wildlife Crime Control Bureau, Ministry of Envrionment and Forests, Government of India, New Delhi, India. http://wccb.gov.in/WriteReadData/userfiles/file/A%20Manual%20on%20Wildlife%20Species%20in%20trade.pdf accessed:04/05/2015

Weberling, F. (1975): On the Systematics of *Nardostachys* (Valerianaceae). Taxon 24(4): 443.

Williams, J.T. and Ahmad, Z. (1999): Priorities for Medicinal Plants Research and Development in Pakistan, Medicinal & Aromatic Plants Program in Asia (MAPPA) ID RC/SARO, New Delhi, India http://idl-bnc.idrc.ca/dspace/bitstream/10625/22721/1/110243.pdf accessed:03/14/2014

Yang, J.L., Wang, R., Liu, L-L., and Shi, Y-P. (2010): Phytochemicals and biological activities of *Saussurea* species. 12(2):162–175. http://www.tandfonline.com/doi/pdf/10.1080/10286020903496455 accessed: 03/19/2014

Acknowledgements

First and foremost my sincere gratitude goes to my supervisor, Prof. Michael Kiehn, for providing me with this interesting topic and for supporting me throughout my thesis with great enthusiasm, patience and knowledge whilst allowing me the room to work in my own way.

Furthermore I would like to thank the German Federal Agency for Nature Conservation (BfN) for having me on their premises, especially Dr. Uwe Schippmann for giving me access to his valuable collection of literature, as well as Dr. Daniel Wolf.

I whish to thank Ben Heron from Pukka Herbs and Prashanti de Jager from the Dunagiri Foundation for sharing their precious insight on the cultivation of the species covered in this thesis.

The evaluations and recent information provided by G.S.Rawat, Scientific Authority of India, enhanced this study and deserve credit.

A special thanks goes to Martin Rose for his constant information update, his assistance with the trade data evaluation, and for comments that greatly improved the manuscript.

I would like to express my heart-felt gratitude to my family, who made it possible for me to study and always supported me in my interests. A special thanks goes to my mother for fine-tuning my English and proofreading.

Finally, I would also like to thank my fellow students, who have become dear friends, for a wonderful time with many encouragements and fruitful discussions.

Annex

Annex 1: Trade and vernacular names of *Saussurea costus*

Annex 2: Trade and vernacular names of *Inula racemosa*

Annex 3: Abstract

Annex 4: Zusammenfassung

Annex 5: Curriculum Vitae

Annex 1: Trade and vernacular names of *Saussurea costus*

Name	Language	Source
Agada	san	FRLHT 2013
Amaya	san	FRLHT 2013
Apya	san	FRLHT 2013
Aucklandia	eng	Lange and Schippmann 1999
Aucklandia radix	pha	Lange and Schippmann 1999
Bhasura	san	FRLHT 2013
Cengala	tel	FRLHT 2013
Chagal koshtam	tam	FRLHT 2013
Changala	tel	FRLHT 2013, Lange and Schippmann 1999
Chengulva	tel	FRLHT 2013
Chob-i-qut	kas	Lange and Schippmann 1999
Chuan mu xiang	chi	Lange and Schippmann 1999
Costi amari radix	pha	Stöger 2010
Costus	eng, mal	Schmelzer 2001, WCCB 2011
Costus root	eng	FRLHT 2013, Lange and Schippmann 1999
Costuswurzel	ger	Lange and Schippmann 1999
Dushta	san	FRLHT 2013
Gada	san	FRLHT 2013
Gadakhya	san	FRLHT 2013
Gadavha	san	FRLHT 2013
Gadavhaya	san	FRLHT 2013
Goshtam	tam	FRLHT 2013, Lange and Schippmann 1999
Gostan	tam	FRLHT 2013
Guang mu xiang	chi	Lange and Schippmann 1999
Haribhadraka	san	FRLHT 2013
Himalayaschartenwurzel	ger	Lange and Schippmann 1999
Indische Kostuswurzel	ger	Lange and Schippmann 1999
Ja	san	FRLHT 2013
Jarana	san	FRLHT 2013
Jathikoshtam	tam	FRLHT 2013
Kadakhya	san	FRLHT 2013
Kakala	san	FRLHT 2013
Kankushta	kan	FRLHT 2013
Karwa koth	urd	FRLHT 2013
Kashmirja	san	FRLHT 2013
Kashtam	san	FRLHT 2013
Kasmira	san	FRLHT 2013
Katakuvayam	tam	FRLHT 2013
Kaubera	san	FRLHT 2013
Kinjalka	san	FRLHT 2013
Koot	hin	FRLHT 2013
Kootha	hin	FRLHT 2013
Koshta	kan	Lange and Schippmann 1999
Koshtae	kan	Lange and Schippmann 1999
Koshtam	tam	FRLHT 2013
Koshtha	kan	FRLHT 2013
Kosta	kan	FRLHT 2013
Kostam	tam	FRLHT 2013
Kostamu	tel	FRLHT 2013
Kostha	hin, kann, mar	FRLHT 2013
Kostu	tel	FRLHT 2013

Name	Language	Source
Kostum	tam	FRLHT 2013, Lange and Schippmann 1999
Kostuspflanze	ger	Lange and Schippmann 1999
Kosuta	kan	FRLHT 2013
Kot	hin, mar	FRLHT 2013
Kottam	mal, tam	FRLHT 2013
Kur	hin, ben, guj	FRLHT 2013, Lange and Schippmann 1999
Kura	tam	FRLHT 2013
Kushta	san, mar	FRLHT 2011, Lange and Schippmann 1999, WCCB 2011
Kushtam	san	FRLHT 2013
Kushtamu	tel	FRLHT 2013
Kushtha	san	FRLHT 2013, Lange and Schippmann 1999
Kushthh	mar	FRLHT 2013
Kust	hin, ara, per	FRLHT 2013, Lange and Schippmann 1999
Kustam	tel	FRLHT 2013, Lange and Schippmann 1999
Kusthah	san	FRLHT 2013, Lange and Schippmann 1999
Kut	hin, mal	Butola und Samant 2010, Lange and Schippmann 1999, Schmelzer 2001
Kutavapiritam	tam	FRLHT 2013
Kuth	eng, hin, ben, guj, kas, pun	Butola und Samant 2010, FRLHT 2011, Lange and Schippmann 1999, WCCB 2011
Kuthika	san	FRLHT 2013
Kutsita	san	FRLHT 2013
Lao mu xiang	chi	Lange and Schippmann 1999
Mokhyang	kor	Lange and Schippmann 1999
Mokko	jap	Lange and Schippmann 1999
Mook heong	mal	Lange and Schippmann 1999
Mu hsiang	mal	Lange and Schippmann 1999
Mu xiang	chi	Lange and Schippmann 1999, Stöger 2010
Niruja	san	FRLHT 2013
Oli	tam	FRLHT 2013
Ouplate	mum	Lange and Schippmann 1999
Ouplet	mar	FRLHT 2013
Pachak	ben, hin	FRLHT 2013, Lange and Schippmann 1999
Padmaka	san	FRLHT 2013
Pakala	san	FRLHT 2013
Pakalam	san	FRLHT 2013
Palaka	san	FRLHT 2013
Paribhadraka	san	FRLHT 2013
Paribhavya	san	FRLHT 2013
Pauskara	san	FRLHT 2013
Pavana	san	FRLHT 2013
Pokharmul	hin	FRLHT 2013
Post-khai	kas	Lange and Schippmann 1999
Puchok	mal	Schmelzer 2001
Puskara	san	FRLHT 2013
Puskaramula	san	FRLHT 2013
Putchuk	tam	FRLHT 2013, Lange and Schippmann 1999
Quest shirin	urd	FRLHT 2013
Qust	urd	FRLHT 2013
Qust shirin	urd	FRLHT 2013
Qust talkh	urd	FRLHT 2013
Qust-i-talkh	urd	FRLHT 2013

Radix Aucklandiae	pha	Chen et al. 2008
Radix Aucklandiae lappa	pha	Lange and Schippmann 1999
Radix Costus	pha	Lange and Schippmann 1999
Radix Saussureae	pha	Chen et al 2008, Lange and Schippmann 1999
Rama	san	FRLHT 2013
Roga	san	FRLHT 2013
Rogavhaya	san	FRLHT 2013
Ru-rta, Rur-ta	tib, bhu	FRLHT 2013, Jamphel et al. 2009, Lange and Schippmann 1999
Ruja	san	FRLHT 2013
Ruk	san	FRLHT 2013
Ruka	san	FRLHT 2013
Ruta	bhu	Jamphel et al. 2009
Saussurea costus Wurzel	pha	Lange and Schippmann 1999
Saussurea radix	pha	Lange and Schippmann 1999
Saussurea root	eng	Lange and Schippmann 1999
Seppudday	mal	FRLHT 2013
Sepuddy	mal	FRLHT 2013, Lange and Schippmann 1999
Sharshamay	urd	Adnan 2006
Simakkottam	mal	FRLHT 2013
Upaleta	guj	Lange and Schippmann 1999
Utpala	san	FRLHT 2013
Utpalam	san	FRLHT 2013
Name	**Language**	**Source**
Van hoc huong	vie	Nguyen Dao Ngoc Van and Nguyen Tap 2008
Vaniraja	san	FRLHT 2013
Vapya	san	FRLHT 2013
Vyadhi	san	FRLHT 2013
Vyapya	san	FRLHT 2013
Yun mu xiang	chi	Flora of China 2014, Lange and Schippmann 1999, Stöger 2010

ara = Arabic, bhu = Bhutanese, ben = Bengalese, chi = Chinese, eng = English, ger = German, guj = Gujarato, hin = Hindi, jap = Japanese, kan = Kanarese/Kannada, kas = Kashimiri, kor = Korean, mal = Malay, mar = Marathi, per = Persian, pha = Pharmaceutical nomenclature, pun = Punjabi, san = Sanskrit, tam = Tamil, tel = Telugu, tib = Tibetan, urd = Urdu, vie = Vietnamese

Annex 2: Trade and vernacular names of *Inula racemosa*

Name	Language	Source(s)
Elecampane	eng	Khare 2007, Mangathayaru 2009
Indian Elecampane	eng	Mangathayaru 2009
Kasmira	san	FRLHT ENVIS
Kusthabheda	san	FRLHT ENVIS
Ma bu	tib	FRLHT ENVIS
Ma nu	tib	FRLHT ENVIS
Ma nu ru rta	tib	FRLHT ENVIS
Mano	kas	Mangathayaru 2009
Manurucha	kas	Mangathayaru 2009
Mu-la	tib	FRLHT ENVIS
Padmapatra	san	FRLHT ENVIS
Pauskara	san	FRLHT ENVIS
Pauskaram	san	FRLHT ENVIS
Pauskaramula	san	FRLHT ENVIS
Pohakarmul	hin	FRLHT ENVIS
Poshkar	kas	Mangathayaru 2009
Pushakar	mar	FRLHT ENVIS
Pushkar mool	san, hin	Mangathayaru 2009
Pushkaramula	san	FRLHT ENVIS
Pushkaramulaka	san	FRLHT ENVIS
Puskara	san, tib	FRLHT ENVIS
Puskarahva	san	FRLHT ENVIS
Puskarajajata	san	FRLHT ENVIS
Puskarajata	san	FRLHT ENVIS
Puskarakhya	san	FRLHT ENVIS
Puskaram	san	FRLHT ENVIS
Puskaramu	tel	FRLHT ENVIS
Puskaramula	san, tib	FRLHT ENVIS
Puskaramulam	mal	FRLHT ENVIS
Puskarmul	eng, hin, nep, san	FRLHT ENVIS, IUCN Nepal 2000
Puskkaramulam	mal, tam	FRLHT ENVIS
Rasna	san	FRLHT ENVIS
Rasnabheda	kan	FRLHT ENVIS
Sunspear	eng	Mangathayaru 2009
Zong zhuang tu mu xiang	chi	Flora of China 2011

chi = Chinese, eng = English, hin = Hindi, kan = Kanarese/Kannada, kas = Kashmiri, nep = Nepali, mal = Malay, mar = Marathi, san = Sanskrit, tam = Tamil, tel = Telugu , tib = Tibetan

Annex 3: Abstract

Traditional medicines, often containing plants in their remedies, affect wild plant populations especially in South East Asia. If a sustainable use of these wild plant populations cannot be guaranteed, there is a need for action for CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora) in order to control their trade for sustainability.

Sixteen species have been listed in the CITES Appendices specifically because of their medicinal properties. Other plant species were included by listing whole families, e.g. orchids or tree ferns. The total number of listed medicinal plant species in CITES was quantified to more than 230, most of them being assigned to App. II (Schippmann 2001).

All species included in the present review are herbaceous, perennial plants growing in the Himalayan Region and facing some level of threat because their roots or rhizomes are overexploited and traded for medicinal purposes and incense.

Saussurea costus is the only plant listed in Appendix I. *Nardostachys grandiflora* is included in App. II and the international trade with *Inula racemosa* is currently not recorded or regulated.

Bhutan, China, India, Nepal and Pakistan are all part of the Himalayan Region and the five countries this review focused on.

Research objectives were to compare information availability between countries and species, and further to unveil taxonomic difficulties, the risk of confusion of species and adulteration. Additionally, history and areas of use were investigated, and available information on harvest, processing and cultivation was also summarized. Trade data from the UNEP WCMC trade database was analysed to point out important trends concerning the two listed species *S. costus* and *N. grandiflora*. Recommendations on how to improve international trade regulations for the three species in this review were developed and discussed.

Sources for this study included a great variety of different literature found through an extensive online search, at the University library in Vienna and in the personal stock of Dr. Uwe Schippmann at the German Federal Agency for Nature Conservation (BfN) in Bonn. Additionally, emails requesting further information were sent to the scientific authorities of Bhutan, China, India, Nepal and Pakistan and to two private

people involved in sustainable collection and cultivation of medicinal herbs, Ben Heron from Pukka Herbs and Prashanti De Jager from the Dunagiri Foundation.

A record mentioning potentially wild *S. costus* from Nepal was found (Gurung and Pyakurel 2006) and should be verified as soon as possible. Furthermore the eligibility of *S. costus'* listing in App.I is doubted.

Providing more information on cultivators and nurseries or even cultivating countries either in the CITES registered nurseries or CITES species+ could facilitate decision-making for Management Authorities.

Numerous adulterants for all three species were detected. Finding methods to distinguish these will be subject to further studies. A big difficulty is the identification of rhizome pieces on species level, which becomes impossible when dealing with processed products like powders or derivatives if correct documentation is not provided. This is also true for the differentiation if a product derives from the wild or was artificially propagated. Improvements to international trade regulations are recommended: The downlisting of *Saussurea costus* from App. I, the listing of *Nardostachys grandiflora* as complete genus *Nardostachys spp.* and the inclusion of *Inula racemosa* on Annex D of the Council Regulation (EC) No. 338/97.

Annex 4 : Zusammenfassung

Die steigende Nachfrage nach Heilmitteln aus traditionellen Medizinsystemen wirkt sich auch auf die Wildpopulationen der Pflanzen aus, die dort Anwendung finden, vor allem in Südostasien.

CITES (The Convention on International Trade in Endangered Species of Wild Fauna and Flora“) reguliert den Handel mit Pflanzen- und Tierarten, die in den Anhängen gelistet sind, um deren Fortbestand in freier Wildbahn nachhaltig zu gewährleisten.

16 Pflanzenarten wurden bisher dezidiert wegen ihrer medizinischen Eigenschaften in den Anhängen von CITES aufgenommen (Hamilton 2004). Weitere Pflanzenarten mit medizinischer Bedeutung finden sich ebenfalls in den Anhängen, wurden aber im Zuge von Listungen ganzer Familien inkludiert, z.B. Orchideen und Baumfarne (Schippmann 2001). Insgesamt wurden über 230 gelistete Medizinpflanzenarten von Schippmann (2001) identifiziert. Die meisten befinden sich in Anhang II (Schippmann 2001).

Forschungsziele waren u.a., die Informationsverfügbarkeit zu den einzelnen Arten und von den einzelnen Ländern zu vergleichen und dabei taxonomische Unklarheiten, sowie mögliche Adulteration mit anderen Pflanzenarten aufzudecken. Zusätzlich wurden dabei die Nutzungsgeschichte und Anwendungsgebiete untersucht, sowie Informationen zu Ernte, Verarbeitung und Kultivierung zusammengefasst. Die Gattung *Saussurea* wurde zusätzlich als Ganzes betrachtet, um zu untersuchen, ob weniger bekannte Arten ebenfalls medizinisch genutzt werden und es potentiell zu Verwechslungen mit *S. costus* kommen kann. Handelsdaten aus der UNEP WCMC Datenbank wurden analysiert, um wichtige Handelstrends der beiden CITES-gelisteten Arten *S. costus* and *N. grandiflora* aufzuzeigen.

Eine umfangreiche Literatursuche im Internet, an der Universitätsbibliothek Wien und im persönlichen Bestand von Dr. Uwe Schippmann (Bundesamt für Naturschutz Konstantinstr.110, 53179 Bonn) lieferte die Quellen für diese Studie. Zusätzlich wurden Emailanfragen an die wissenschaftlichen CITES-Behörden der Länder Bhutan, China, Indien, Nepal and Pakistan und an zwei Privatleute, Ben Heron von Pukka Herbs und Prashanti De Jager von der Dunagiri Foundation, die sich im Bereich der nachhaltigen Wildsammlung und Kultivierung von Heilkräutern engagieren, geschickt.

Ein potentielles Wildvorkommen von *S. costus* aus Nepal konnte nachgewiesen werden (Gurung and Pyakurel 2006). Dieser Fund sollte so schnell wie möglich bestätigt werden. Außerdem wäre eine bessere Informationsversorgung über Betriebe, die gelistete Arten kultivieren, oder zumindest eine Übersicht der Länder, in denen eine Art kultiviert wird, wünschenswert um die Entscheidungsfindung der jeweiligen Managementbehörden zu vereinfachen. Dies wäre entweder über die "CITES registered nurseries" oder über CITES species+ möglich. Für alle drei Pflanzenarten in dieser Studie konnten neue Arten, die in gewissem Maße zur Verfälschung von Produkten eingesetzt werden, aufgezeigt werden. Aufgabe weitere Studien wird es sein müssen, hier verlässliche Unterscheidungsmerkmale und -methoden zu finden. Eine große Schwierigkeit besteht auch in der Artidentifikation von Pflanzen aus im Handel befindlichen Produkten. Dies ist bereits bei Rhizomen, im Ganzen oder in Stücken schwierig, wird aber nahezu unmöglich bei Pulvern oder Derivaten, wenn keine korrekt ausgefüllten Dokumente beiliegen. Dies gilt auch für die Unterscheidung, ob Pflanzenmaterial aus der Wildnis oder aus Kultivierung stammt. Abschließend werden die Empfehlungen *Saussurea costus* vom App. I herunterzustufen, *Nardostachys grandiflora* als komplette Gattung im App. II zu listen und *Inula racemosa* im Annex D of the Council Regulation (EC) No. 338/97 ausgesprochen.

Annex 5 : Curriculum Vitae

ANGABEN ZUR PERSON

Name	**Kirsten Palme**
Geburtsdatum	31.05.1988
Geburtsort	Kaiserslautern, Deutschland
Staatsbürgerschaft	Deutsch

SCHUL – UND BERUFSBILDUNG

03/2011 – 05/2015	**Masterstudium Naturschutz und Biodiversitätsmanagement,** Universität Wien
10/2007 – 01/2011	**Bachelorstudium Biologie,** Universität Wien Schwerpunkt Ökologie
08/1998 – 03/2007	Burggymnasium Kaiserslautern (Deutschland) Allgemeine Hochschulreife: 16. März 2007

PRAKTIKA

05/2013 – 07/2013 06/2012 – 12/2012	**Nationalpark Donau-Auen GmbH,** Fachbereich Natur und Wisschenschaft, Orth a.d.Donau, Österreich
04/2007 – 06/2007	**Seehundstation Friedrichskoog,** Deutschland

BERUFSERFAHRUNG

10/2011 – heute	Geringfügige Beschäftigung bei **Tiergarten Schönbrunn** (Fütterungskommentierung), Wien
06/2014 – 07/2014 05/2013 – 07/2013	Mitarbeit beim **Artenschutzprojekt Europäische Sumpfschildkröte (*Emys orbicularis*)** im **Nationalpark Donau-Auen**