Teresa Mulliken and Petra Crofton

Review of the Status, Harvest, Trade and Management of Seven Asian CITES-listed Medicinal and Aromatic Plant Species

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Results of the R+D Project FKZ 804 86 003

Teresa Mulliken
Petra Crofton

Cover picture: Himalayan yew *(Taxus wallichiana),* Valley of Flowers National Park, Nanda Devi Biosphere Reserve. Photo: SAMIR SINHA (TRAFFIC India) 2006.

Authors' addresses:

Teresa Mulliken
TRAFFIC International
219a Huntingdon Road
Cambridge
CB3 0DL
UK
E-mail: Teresa.Mulliken@traffic.org

Petra Crofton
c/o IUCN/SSC Wildlife Trade Programme
219 a Huntingdon Road
Cambridge
CB3 0DL
UK

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INTRODUCTION

It is hoped that this information will be useful to national governments, non-governmental organizations working in the fields of conservation and development, and businesses concerned with the harvest, use and trade of medicinal plants. More importantly, it is hoped that it will support efforts to manage harvest and trade in a way that conserves wild species and ecosystems while meeting the current and future development needs of the people most dependent on them.

METHODS

This study was led by TRAFFIC, working with the Species Programme of IUCN – The World Conservation Union. Significant research support was provided by TRAFFIC offices in East Asia and Southeast Asia, offices of the World Conservation Union (IUCN) in Nepal and Pakistan, and independent consultants. Members of the IUCN/SSC Medicinal Plant Specialist Group and other experts also generously contributed information.

The species assessments build on the results of CITES significant trade reviews undertaken by SCHIPPMANN (2001) for Elephant's Foot *Dioscorea deltoidea*, Red Sanders *Pterocarpus santalinus*, Snakeroot *Rauvolfia serpentina* and Himalayan Yew *Taxus wallichiana*, and MULLIKEN (2000) for Jatamansi *Nardostachys grandiflora* and Kutki *Picrorhiza kurrooa*. The text of SCHIPPMANN (2001) and MULLIKEN (2000) was used as the starting point for the study, with researchers seeking to augment and update this information through a combination of literature reviews and web-based information searches, expert interviews and compilation and analysis of CITES annual report and Customs data. Such text was not available for Desert Cistanche *Cistanche deserticola*

The information provided herein reflects the hard work of Dr Uwe Schippmann and Asia-based IUCN and TRAFFIC colleagues and other experts who were willing to give so generously of their time and information. They deserve full credit for the breadth and depth of information in this report. Any errors of fact or interpretation remain the sole responsibility of the authors.

CITES MEDICINAL PLANT SPECIES IN ASIA – TREASURED PAST, THREATENED FUTURE?

Introduction

Wild plant species form the foundation of healthcare practices throughout much of Asia. This is particularly true in the case of traditional medicine practices, including codified systems such as traditional Chinese medicine, Ayurveda, Siddha, Unani and Tibetan medicines, and more localised healthcare traditions. Asia's wild plants also form a critical component of 'modern' healthcare practices. Compounds such as reserpine from Snakeroot *Rauvolfia serpentina* and paclitaxel from Himalayan Yew *Taxus wallichiana* have important pharmaceutical uses in Europe, North America and more widely. Some medicinal species are also in demand for their aromatic properties, the use of the oil of Jatamansi *Nardostachys grandiflora*, for example, appearing in written texts dating back over a thousand years. Still others, including Red Sanders *Pterocarpus santalinus*, are also valued for their timber.

Wild plant species also form an important component of livelihood strategies in Asia, with wild collection of medicinal and aromatic plants providing a critical source of income in many areas. This is particularly true in areas such as the high alpine regions of the Himalayas, where agricultural outputs are low and there are few other opportunities for income generation.

The combined and in many cases increasing demand for Asia's medicinal plants and the consequent increase in the rate of collection are having a negative impact on the wild populations of many species, to the point that some species are now considered to be threatened with extinction. National governments throughout the region have responded by establishing various systems of collection and trade controls to bring wild collection within sustainable levels. Governments, non-governmental organisations and in some cases the private sector have also begun investing in cultivation of certain species to meet demand. In order to help ensure that international trade was both sustainable and in accordance with national legislation, member countries of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) have also established international trade controls for some Asian medicinal species.

Earlier reviews of the status, wild collection and trade of a number of CITES-listed medicinal plant species, including those mentioned above, found that implementation of collection and trade controls was generally low, and in some cases nearly non-existent. Not surprisingly, there were also indications of continuing declines in wild populations despite these regulatory efforts. In order to support efforts to improve the management and conservation of medicinal plant species in trade, in 2004, the German Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN) contracted TRAFFIC to undertake a study of the status, use, trade and trade controls for seven Asian species (Table 1). Four of the seven, Elephant's Foot *Dioscorea deltoidea*, *Pterocarpus santalinus*, *Rauvolfia serpentina* and *Taxus wallichiana*, had already been reviewed by BfN as a contribution to the CITES Significant Trade Review process (SCHIPPMAN 2001). A further two, the Himalayan species *Nardostachys grandiflora* and Kutki *Picrorhiza kurrooa*, were previously reviewed by TRAFFIC under contract to the CITES Secretariat, also as part of the CITES Significant Trade Review Process (MULLIKEN 2000). That study also reviewed the trade in *Neopicrorhiza scrophulariiflora*, closely related and similar to *Picrorhiza kurrooa* and also referred to and traded as Kutki. The seventh, Desert Cistanche *Cistanche deserticola*, was listed in CITES Appendix II in 2000 and has not been the subject of a previous review.

The present study was led by TRAFFIC, working with the Species Programme of IUCN – The World Conservation Union. Research support was provided by TRAFFIC offices in East Asia and Southeast Asia, IUCN offices in Nepal and Pakistan, and independent consultants. Members of the IUCN/SSC Medicinal Plant Specialist Group and other experts generously contributed information. The text of MULLIKEN (2000) and SCHIPPMAN (2001) was used as the starting point for the study, with researchers seeking to augment and update this information through a combination of literature reviews and web-based information searches, expert interviews and compilation and analysis of CITES annual report and Customs data. The resulting r8ld

Table 1. CITES-listed medicinal plant species included in this review

Taxa/life form	Distribution/habitat	Main part(s) used medicinally	Entry into effect of CITES listing; annotation at time of writing*
Desert Cistanche *Cistanche deserticola* (perennial parasitic herb)	China, Mongolia	Stems	19 July 2000 Annotation #1
Elephant's Foot *Dioscorea deltoidea* (deciduous perennial with annual climbing stem)	Afghanistan, Bhutan, Cambodia, China, India, Lao PDR, Nepal, Pakistan, Thailand, Viet Nam	Rhizomes	01 July 1975 Annotation #1
Jatamansi *Nardostachys grandiflora* (perennial herb)	India, Nepal	Rhizomes	01 July 1975 Annotation #1

evidence of more widespread surveys to determine the status of the species at either the country or the global level. This situation can be explained in part by the vast size and remoteness of the species' habitats. For example, the appropriately named *Cistanche deserticola* is found in arid areas in China and Mongolia, while *Nardostachys grandiflora*, *Picrorhiza kurrooa* and *Neopicrorhiza scrophulariiflora* occur across large areas of the alpine Himalaya.

Based on the information that is available, it appears that all seven species have declined in the wild owing to over-collection to supply domestic and foreign medicinal markets. As a result, all are also considered to be threatened with extinction in at least parts of their range, although only one, the tree species *Pterocarpus santalinus*, has thus far been reviewed and classified as globally threatened (Endangered) in the IUbe6 ra

ple (OLSEN & LARSEN 2003). In India, according to one estimate, collection and processing of medicinal plants contribute at least 35 million workdays per year to the "poor and underemployed workforce" (ANON. 2001). Collection of medicinal plants also makes an important contribution to rural household incomes in parts of India, with *Picrorhiza kurrooa* collection considered particularly important in the tribal areas of Himachal Pradesh studied by NEGI & BHALLA (2002), who noted that most collectors were "small and marginal farmers". *Rauvolfia serpentina* collection from the wild in Thailand and Myanmar was said to be undertaken on an opportunistic basis by local people, often at the same time they are collecting other forest products. Information indicating a large-scale trade in *R. serpentina* from Myanmar to India, and an increase in processing within Myanmar in the mid-1990s, suggests that targeted collecting may also be taking place. In Pakistan, where *Dioscorea deltoidea* was said to be one of the main medicinal species collected in the mid-1990s, collection also involves the rural poor.

Although all of the species are collected for local use, in many areas the main reason to collect the species is to provide cash income and supply demand that may be hundreds to thousands of kilometres away from collection areas: in the case of *Taxus wallichiana* the distance is potentially 10 000 km or more. The path from wild collection to end market generally involves a complex trade chain, a typology of which has been proposed by OLSEN & BHATTARAI (2005) for trade from Nepal to India. The journey often begins with one or more days of walking from the site of collection to village, and then again from village to the nearest roadhead. Based on available information, with regard to Himalayan species, most though not all roads lead to India, which is both a major manufacturing centre and end consumer market. This is particularly true of trade from Nepal, which is fed by hundreds of thousands of medicinal plant collectors supplying raw materials through a multi-tiered system of middlemen leading to large-scale wholesalers in Nepal and India (OLSEN & BHATTARAI 2005). Raw materials are often transported on to large wholesale markets, e.g. in Delhi, Amritsar and Kolkata (Calcutta) for onward sale. Alternatively, traders may work directly with pharmaceutical companies, providing them samples for product testing in advance of sales, for example in the trade of *Dioscorea deltoidea* in India.

Those collecting for onward sale typically undertake little value added processing beyond cleaning and air drying. In the case of *Dioscorea deltoidea*, collectors in India may chop the tubers into smaller pieces to aid drying before onward sale. There has been investment in promoting essential oil extraction, including of *Nardostachys grandiflora*, for export from Nepal.

India at the centre. . .

As indicated above, available information indicates that India is a major destination for trade in the raw medicinal plant materials, and apparently the major destination for all but two of the seven species in this study; *Cistanche deserticola*, native to and primarily used in China, and possibly *Taxus wallichiana*, trade patterns for which have changed in recent years.

India's long and rich history of traditional medicine practices such as Ayurveda and highly developed

. . . but China increasing in market share?

China is a major and growing manufacturing centre fo

CITES controls have had little impact on the trade, both because the main products in trade for some species, e.g. extracts, are not currently covered by the Convention, and because implementation effort has been low more generally. Of particular concern is the apparent lack of CITES implementation for imports into India, a key consumer, with imports apparently not required to be accompanied by CITES export permits or recorded in India's CITES annual reports. The February 2006 decision by the Government of India to implement import controls for *Rauvolfia* spp. and several other species, including agarwood *Aquilaria* spp. and cacti, indicates a shift towards more comprehensive CITES implementation in that country. The only major evidence of successful CITES enforcement action relates to the trade in *Pterocarpus santalinus* timber, with numerous seizures reported within India and in destination countries.

The failure to implement either wild collection or trade controls seems likely to reflect the sheer enormity and complexity of the medicinal plant collection and trade throughout the region, and the lower importance given to addressing issues of illegal or unsustainable collection of plants relative to animal species, particularly charismatic species such as Tigers. This pattern is repeated in the case of international trade, which takes place across long and porous borders with few staff resourced to police them. The low level of

Discussion

Asia's wild medicinal plant populations continue to play a crucial role in human healthcare. This is
an settings, tanpoaditional as well as mod
healthcare practices. In some areas, Asia's medicinal plants also play a cncome generation.
It is thereTdipoe both surprising and worrying that the stat
ied, pt8ticulaply in light of concepons that wild popul

sources, particularly forest resources, should be considered in conjunction with regulatory approaches for managing wild collection.

Summary and recommendations

Throughout much of human history, Asia's medicinal plant species have simultaneously been treasured and taken for granted. They have been available and used to treat the ills of countless generations, originally within Asia, and more recently throughout much of the rest of the world. Changes in current collection and trade practices will be required if these plants are to survive in the wild and continue to be available for use by future generations. Numerous authors and organisations with direct experience concerning medicinal plant collection, use, trade and conservation in Asia have provided recommendations for promoting such changes (e.g. see BHATTARAI 1997, KARKI 2006, KINHAL *et al.* 2006, OLSEN 2005, OLSEN & LARSEN 2003, PEI SHENGJI 2001 and many others). Hopefully the suggestions below will serve to reinforce their recommendations and encourage support for their and others' efforts.

Given that many Asian species in trade both occur and are used in more than one country, a collaborative, multi-country approach is likely to be both more efficient and more effective at achieving increased knowledge, conservation and sustainable use of these and other species in the longer term. Equally, given the importance of medicinal plants in the context of conservation, development (including healthcare and in-

- ensuring that any bilateral trade agreements, such as the Indo-Nepal treaty, are consistent with other international obligations, e.g. CITES, with respect to international trade controls; and
- developing more detailed Customs codes for species tr

Overharvesting is considered the primary threat to the species (GOVERNMENT OF CHINA 2000). Livestock grazing, agro-industry farming, clear-cutting and collection of the host species *H. ammodendron* for wood are reported as additional threats (ZHANG 2005). PENG & XU (1995) suggested that the loss of *H. ammodendron* is the major threat. MENG ZHIBIN (2005) noted that this species is used as fuelwood. Its woody stem and branches burn well, being referred to as "coal of the desert" and are also used by local people for building materials. Further, the tender branches are used as camel feed in the winter and spring (FU & JIAN-MING 1992, PENG & XU 1995). Between the late 1950s and the early 1960s, *H. ammodendron* covered 1 127 000 ha, supporting an annual collection of about 800 t of *Cistanche deserticola,* but by the late 1960s this area had been reduced by approximately 50%, and further reductions have taken place subsequently (FAN 2001). *H. ammodendron* is listed as "vulnerable" in the *China Plant Red Data Book* (FU & JIAN-MING 1992).

Medicinal uses

Plant parts used for medicinal purposes: Dried stems.

The primary plant part used is the underground stem. In its dried form, it is referred to as 'Herba Cistanches'. Herba Cistanches was described in the oldest surviving Chinese herb classic, *Shennong*

Estimates of prior and current harvest quantities vary. ZHU (1990) considered that total harvests of Herba Cistanches might be as high as 7000 t in 1990; it is unclear whether this estimate includes other *Cistanche* species in addition to *C. deserticola*. TAN & al. (2004) provide much lower estimates, estimating annual production at 800 t in the 1950s, falling to 300 t by the end of 1980s (FAN 2001 gives a figure of 300 t in the early 1980s), and to around 120 t in 1994. Annual production in Inner Mongolia is believed to have decreased significantly during the past 20 to 30 years, and in 2002 was estimated at 70 t. In the 1980s, annual harvest in Xingjiang was estimated at 300 t (ANON. 1995b). Production in North Xingjiang was estimated at 50 t in 2002 (GOVERNMENT OF CHINA 2000).

Organized collection was estimated to involve “several thousand” people at the end of the twentieth century, and more recently, “more than ten thousand” (SUN & al. 2003). Collectors often target only this species. Harvesters are local to the harvest areas and include professional harvesters. They obtain a maximum of 20% of the value, whilst middlemen receive 30-40% and manufacturers and dealers at the other end of the trade chain some 40% (ZHANG 2005). The species is sold in wholesale medicine markets in each of the Chinese provinces (ZHANG 2005).

Cultivation. Cultivation of *Cistanche* in China began in 1985 and by 021volve “s[(F1000e5.6 8oaof)5%0h

T. arcenthoides, Kalidium foliatum, Reaumuria soongorica and *Nitraria sibirica* (IUCN/SSC & TRAFFIC 2004, LUO & al. 2002, MENG ZHIBIN in litt. 2005, TU & al. 1994, YIN & al. 2002, ZHANG & al. 2001). Species

Table 2. CITES-reported trade in (1995-2003)

Year	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S

Illegal harvest and trade. CITES annual report data record several seizures of *C. deserticola*, with 120 kg of derivatives seized by the USA in 2001, 59 000 derivatives (no unit provided) seized by the UK in 2002, and a further 198 kg of derivatives seized by the UK in 2003. There were numerous seizures of *Cistanche deserticola* products upon import into Canada in 2003 and 2004, appearing mainly to involve finished products (Table 3).

Legislation and regulations

Regulation of harvest, manufacture and domestic trade. *Cistanche deserticola* is protected under the Law on Wild Plant Protection (HE & SHI, 1995), which took effect 1 January 1997. Under this law, protected plant species are classified into those of "national key significance" and those of "local key significance". Protected plant species of national key significance are further divided into Category I and Category II-protected species. Trade in Category I-protected species is not allowed. Trade in plant species listed as Category II is subject to authorization by the relevant government agencies at the provincial/autonomous region level. The State Forestry Administration, the Ministry of Agriculture and other authorized governmental authorities at the provincial/autonomous region level are responsible for enforcing the Law of Wild Plant Protection. A list of 255 species is appended to this law.

The species is also listed in the Regulation on Wild Medicinal Resources Protection (RWMRP) as a Category III species, and therefore designated as a "major and commonly used wild medicinal species whose resources are reducing." The Government of China stated in 2002 that *C. deserticola* would be included as a Grade II species in the list of State Protected Species in China (ANON. 2002). However, it was not included in this list as of January 2005. Other *Cistanche* species are not listed as Grade II species, as the government does not consider them sufficiently threatened (TRAFFIC EAST ASIA in litt. 2006).

Harvest of *C. deserticola* was banned in 2000 via a Notification of the State Council (TRAFFIC EAST ASIA in litt. 2002, ZHAI BAOGUO in litt. 2005). However, *Cistanche* continues to be harvested in large quantities despite the ban on collection (CHEN & al. 2002). There are no restrictions on domestic use of the species, and management of the species in China is unclear, according to TRAFFIC EAST ASIA (in litt. 2006).

The use of wild Herba Cistanches to manufacture medicines is apparently prohibited through a formal Notification from the State Council by China's Ministry of Health (ZHAO & al. 2002). It is unclear whether this applies to all *Cistanche* species, or only *C. deserticola*. Incorporation of this notification into the legislation of individual provinces is not automatic, however, and the process may still be ongoing. The prohibition on manufacture does not apply more widely to all healthcare products such as medicated wines and tonics. Perhaps in response to this notification, medicated wine and tonics are increasingly purporting to contain *C. deserticola*.

Cistanche deserticola occurs in protected areas such as Linhe County, Inner Mongolia, where collection has not been observed (ZHAO RUN-HUAI in litt. 2005). Protected areas for *Haloxylon ammodendron* have been established (G

should be interpreted to refer to “undeveloped inflorescences.” China submitted a proposal to delete the annotation to CITES CoP12 (Santiago, November 2002), with the intention both of correcting the misuse of the term “root”, and bringing under CITES trade controls all parts and derivatives. The latter decision reflected recognition that a substantial component of international trade involved manufactured products. This proposal was also accepted, and became effective 13 February 2003. Confusion regarding the interpretation of the Convention for plant species listed without an annotation, and the decision that such listings referred only to whole plants, not parts or derivatives, prompted China to submit a proposal to CITES CoP 13 (Bangkok, October 2004) to annotate the proposal with Annotation #1, designating “all parts and derivatives, except: a) seeds, spores and pollen (including pollinia); b) seedling or tissue cultures obtained *in vitro*, in solid or liquid media, transported in sterile containers and c) cut flowers of artificially propagated plants.” This proposal was also accepted, effective 12 January 2005. The annotation was modified yet again at CITES CoP 14 (The Hague, June 2007), as part of a Plants Committee process to clarify and harmonise annotations for medicinal plants. The revised annotation, coming into effect on 13 September 2007, "Designates all parts and derivatives except: a) seeds and pollen; and b) finished products packaged and ready for retail trade.”

At present, there is no law formulated specifically to implement CITES within China, however, a series of regulations implementing CITES, the Import and Export Regulations of Endangered Wild Fauna and Flora, came into effect on 1 September 2006.

From 1 January 1998, China’s regulatory system for the export of wild animals and plants was strengthened by the Endangered Species Import and Export Management Office (under the State Forest Administration), the designated CITES Management Authority, and the Customs Authority. A wide range of animals and plants with their corresponding Harmonized System Customs codes are specified in an annex attached to a Joint Notification from the Management Authority and the Customs Authority. The list is said to be compiled on the basis of the CITES Appendices and the lists of key national protected animals and plants. The notification has been circulated among the officers of the Management Authority and Customs across the country and was copied to various other governmental agencies. Trade in live animals or plants, parts in their raw form, and products made from those animals and plants specified on the said list are controlled. According to the Joint Notification, where applicable, import/export permits or certificates are required.

Both *C. deserticola* imports into and exports from China require CITES permits. Exports of RWMRP Category III species are subject to a quota system as specified in Article 15 of the regulation. However, it is not clear how the quota system is implemented (GOVERNMENT OF CHINA 2000). Presumably any exports of *C. deserticola* would be subject to this quota requirement. Export permits for this species have not been issued by the Government of China since January 2004 owing to the scarcity of the species.

In Hong Kong, import and export of *C. deserticola* has required advance issuance of a licence since early 2002, with a maximum penalty for failure to obtain such a licence being a fine of HKD5 000 000 (about USD640 000) and two years imprisonment (LAI 2001). Registration of pre-Convention stock has also been required; a total of three tonnes has been registered. The Republic of Korea similarly requires presentation of export permits for the import of *C. deserticola* (L

Information regarding harvest and trade controls for *C. deserticola*

FU LI-KUO & J. JIAN-MING (Eds.) (1992): China Plant Red Data Book - Rare and Endangered Plants (Volume 1). Science Press, Beijing, China.

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XU HONGFA, TRAFFIC EAST ASIA (2005): in litt. to IUCN/SSC Wildlife Trade Programme, Cambridge, UK (05.05.2005).

YIN LIN-KE, ZHENG-MING CHEN & HUI-XIA PAN

Taxonomy *Dioscorea deltoidea* WALL. (family Dioscoreaceae)

Synonyms *Dioscorea nepalensis* SWEET ex BERNARDI, *Tamnus nepalensis* (SWEET) JACQUEMONT ex PRAIN & BURKILL

Trade names Bahrahkanda (san), Bhyakur (nep) Deltoid Yam (eng), Dioscorea (eng), Dioscoreae deltoideae radix (pha), Dioscoreae deltoideae rhizoma (pha), Discory (Uttaranchal), Elephant's foot (eng), Ghunar (nep), Kanis (Pakistan), Kildri (kas), Kins (kas), Kithi (kas), Kitra (pun), Kniss (pun), Kreench, (kas), Kriss (pun), Kukurtarul (nep), Medicinao()6J)m (eng), San-jiao-ye-shu-yu (chi), Singlimingli (hin), Tar (pun), Tarul (new), Tentur (Gurung), Vyakur (nep) (IUCN NEPAL 2004, KAUL In litt. 2005, HAN 2002, LANGE & SCHIPPMANN 1999, MANANDHAR 2002, OLSEN &

HAUHAN 1999, NAYAR & SASTRY 1988). Flowers April-May, fruits October-November according to HUSSAIN & al. (1979). According to KHAN (2002), in Pakistan, it sprouts after the snowmelt in April-May and flowers in June-July, with fruits ripening in August-September.

Distribution. Afghanistan, Bhutan, Cambodia, China, India, Lao PDR, Nepal, Pakistan, Thailand, Viet Nam.

List criteria rather than on comprehensive scientific evidence, and concluded that information was insufficient to determine the effects of current harvest levels. Declines in harvest rates from 1999 to 2004 are considered as a possible indication of overharvest in Nepal, though this could also reflect a decline in demand. Traders in Nepal believe that wild populations are sufficient to meet demand, should it increase in future (AMATYA in litt. 2005). Following consultation with representatives from the CITES Scientific Authority, Nepal's CITES Management Authority stated that they considered the species to be threatened in the wild in Nepal (SHARMA in litt. 2006).

Population declines have been observed in **Pakistan** due to overharvesting although regeneration from seeds is good. Habitat destruction due to agriculture, urbanization, population expansion, tourism and infrastructure is also considered to be a threat (IUCN Pakistan in litt. 2005). The species is considered

November-December (RAWAT in litt. 2005). According to CHAUHAN (1999) the optimum harvest season is from November-March. During this dormant stage, before new buds emerge, the diosgenin and yamogenin contents are highest (HUSSAIN & al. 1979, MORTON 1977). Regeneration of the rhizomes is often more successful than seed germination, but harvesting inhibits both (KAUL in litt. 2005, RAWAT in litt. 2005). Collection mainly takes place in cool, temperate regions, in particular among shrubs on rocky substrates (KAUL 1997) and secondary forest and forest edges. Rhizomes are collected from the wild especially in Jammu & Kashmir and Uttaranchal (ANON. 2000). In Jammu & Kashmir, hill communities collect the species as an opportunistic activity (KAUL in litt. 2005). Collection causes soil erosion. Other species are not collected simultaneously (RAWAT in litt. 2005). *D. deltoidea*

were harvested after growing for at least three years. He added that cultivation efforts had been made by various industries in India.

There is conflicting information regarding the levels of cultivation within **India**. Apparently considered to be

ico and China, which sold for INR1200-1300/kg (USD32-35/kg), compared to INR1700-2000/kg (USD45-53/kg) from the corporation (ANON. 2002c).

According to OLSEN & L

There does not appear to be a market for this species within **Europe** (LANGE 2005).

Illegal harvest and trade. In **India**, the species is found in wildlife sanctuaries and other protected areas

(see JAIN 2000 for a state-by-state analysis of legislation relevant to the harvest and trade of medicinal plants).

Wildlife harvest and domestic trade controls are implemented in **Nepal's** national parks, conservation areas and protected areas via the National Parks and Wildlife Conservation Act (1973); elsewhere in the country, implementation is via the Forest Act (1993) and the accompanying Forest Regulation (1995) (AMATYA in litt. 2005, OLSEN in litt. 2000, SHRESTA in litt. 2000). A summary of these and related controls for medicinal plants and other non-timber forest products has been compiled by the Asia Network for Sustainable Agriculture and Bioresources (ANSAB) and can be found on their website (BINAYEE undated).

The Forest Act and Regulation stipulate rules pertaining to the collection of forest products. Collection is authorized via licences issued by District Forest Officers (DFO). Licences are required to specify the collection area; the period in which harvest is to take place; the species and quantities to be collected; and method of harvest (AMATYA in litt. 2005, ARYAL 2000, OLSEN in litt. 2000). Licence applicants are required to provide this information and specify the purpose of collection. In accordance with the Regulation, District Forest Officers are required to verify the quantity of medicinal plants collected, collect any associated fees, and issue a "release order", which is required to transport harvested plants out of the district of origin. The release order should state: the species and quantity transported, the destination, and the period in which transportation must take place (ARYAL 2000, OLSEN in litt. 2000). There is also a provision to allow harvest and trade licences to be sold at auction (ARYAL 2000). No limits or quotas have been established for the harvest of *Dioscorea deltoidea (*AMATYA in litt. 2005).

In their 2001 study in the Dhading District, PANDIT & THAPA (2004) found that implementation of these licensing provisions was low in government forests, reflecting a combination of a lack of resource management rights among the local population and low government enforcement capacity. Inspection of harvested materials to ensure compliance with licence provisions was considered to be low. Adherence to licence provisions was similarly found to be low in community forests, where permitting provisions still applied, but harvest rights were restricted to members of forest user groups. Others have similarly noted low levels of implementation of national harvest and trade controls for medicinal plants and other NTFPs (e.g. see MULLIKEN 2000, OLSEN 2005).

The harvest of medicinal plants in **Pakistan** is controlled by the Forest Department. Three different types of harvest controls were reported as practiced (IQBAL 1991, RAPA 1987):

- Leasing the area for collection of medicinal herbs. This method was said to have been used in the Hazara forests in the North-West Frontier Province;
- Collection by the traders from local people who pay nominal royalties to the Forest Department. This method was said to be common in the Malakand forests in the North-West Frontier Province;
- Fixed quantities are auctioned off, e.g. by the Forest Department in Azad Kashmir.

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ervation of the Government of India, who is the CITES Management Authority and oversees CITES implementation in the country. The Director has four Regional Deputy Directors and four sub-regional offices of wildlife preservation, these serving as assistant CITES Management Authorities. The EXIM policy is put into effect via the provisions of the Foreign Trade (Development and Regulation) Act (1992) and enforced via the Customs Act (CITES MANAGEMENT

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Taxonomy **DC. (family Valerianaceae)**

Confusion regarding the taxonomy and trade names of *Nardostachys gr-gos*Jatal*a*si-4*i*(ep)*,(*J028Tc*a*s
nep and Pakistan), Ka
Ch'E (?), Mansi (Kur
Mushkbala (Pakistan),
(Tamang), Songban (ch
stan), Sumbulu (Pakis

MATYA in litt. 2005, ANON. undated, DHARMANANDA undated, JAIN in litt. 2005, RAWAT in litt. 2005, SUBEDI & SHRESTHA rm]TJ10.(Tama)5aers s ra f(ra)5.kpPra fora nne (fpra hwal), Tc(nnnaua)-0.6 nne (f(guj)Khari HATTARAI in litt. 2005).

Description. *Nardostachys grandiflora* is a long-lived, erect perennial herb, growing to a height of 10-60 cm. The plant stem, which is partly underground (i.e. a rhizome), has a long, thickened, woody root stock that is generally enclosed in fibers from the petioles of dead leaves. Rhizomes are short, thick, and dark-grey in colour, and crowned with the reddish-brown coloured, tufted, fibrous remains of petioles of rootstock leaves (AMATYA & STHAPIT 1994, ANON. undated). DUTTA & JAIN (2000) describe the rhizome as being 2.5-8 cm long, densely covered with silky reddish brown fibres matted together. A transverse cut of the rhizome reveals a reddish brown surface and a prominent ring surrounding porous wood, with short fractures exposing a reddish brown uneven surface. BHATTARAI (in litt. 2005) draws attention to the thick hairs covering the rhizome, which set it apart from *Valeriana jatamansi*, a species with which it has been said to be confused in trade. The upper portion of the stem is hairy (AMATYA & STHAPIT 1994).

Leaves develop from the rootstock and stem; those that develop from the rootstock are 15-18 cm long and 2.5 cm wide, longitudinally veined, and have a petiole, while those that arise from the stem are in one or two pairs, approximately 7.5 cm long and 2.5 cm wide, oblong or ovate in shape, and sessile (AMATYA & STHAPIT

& al. 2005). The species grows vegetatively with successive ramets (vegetative clones) produced very close together in a dense clump (GHIMIRE & al. 2005).

Distribution. Afghanistan (?), China, Bhutan, India, Myanmar (?), Nepal, Pakistan (?).

Nardostachys grandiflora has been confirmed to occur from Tehri Garhwal (Uttar Pradesh, now Uttaranchal, India) in the western Himalayas to Yunnan and southwest Sichuan in the east and Tibet, its range including China, Bhutan, India, and Nepal (ANON. 1970, KIHARA 1955, KITAMURA 1954, TIWARI & JOSHI 1974, WEBERLING 1975). Its occurrence in Afghanistan, Pakistan and Myanmar is questionable (see below). AMATYA & al. (1995) cite an altitudinal range of 2200-5000 m, OLSEN (2005a) of 3200-4500 m and GHIMIRE & al. (2005) of 3500 to over 5000 m. It typically grows on rocky outcrops, but can also be found in meadows, shrubland and forests (GHIMIRE & al. 2005).

In **China** *Nardostachys grandiflora* can be found in Gansu, Sichuan and Yunnan provinces and the Xijang (Tibet) Autonomous Region (USDA 2006). The species has a large range in **India**, being found from Himachal Pradesh to Arunachal Pradesh, and including the states of Uttaranchal, Sikkim and Assam (CHAUHAN 1999, VED & al. 2003a, 2003b) and Jammu & Kashmir (ANON. undated, DUTTA & JAIN 2000). The species is found on moist and dry rocky surfaces and in crevices in the alpine regions of the Garhwal Himalaya, the soil generally sandy or silty loam, acidic and with a high organic content (NAUTIYAL & al. 2003). Population densities of sample plots containing *N. grandiflora* were found to range from a low of 19 plants per m^2 to a high of 32 plants per m^2, with significant variation in morphological characteristics. In the Sikkim Himalaya, the species is found at an elevation of 3600-4800 m, RAI & al. (2000) providing a map of the species' distribution in that area.

Nardostachys grandiflora is found throughout the Himalayan region of **Nepal**. However, there is no detailed information on the species' distribution or status (OLSEN 2005a). According to AMATYA & al. (1995), it is found in greatest numbers in the Mid-Western Development Region (Dolpa, Humla, and Jumla etc.), its population gradually decreasing towards the east. Populations are concentrated in the districts of Jumla, Dolpa, Humla, and Kalikot, and to some extent the northern part of Gorkha, Rasuwa, and the southern part of Ganesh Himal (Nuwakot District) and Mustang (AMATYA & al. 1995). *N. grandiflora* is thinly distributed at elevations above 3300-3400 m. However, the population density in areas where it does occur is higher above 3400 m (THAPA & PRASAD 2000).

The species grows in dry, open pine forests, among dwarf rhododendron and juniper scrub, on open, stony and grassy slopes, in alpine meadows or small depressions, and on the turf of glacial flats (AMATYA & STHAPIT 1994). Soils in the species' natural habitat are moderately acidic, sandy loam, with high organic matter and low phosphate content. Based on its distribution, the species is not believed to favour extremely dry or wet areas (AMATYA & al. 1995).

Conflicting information is available on the distribution of the species. According to BHATTARAI (in litt. 2005), its occurrence in **Afghanistan** and **Myanmar,** as referenced in a draft data sheet for a 1997 Conservation and Management Plan (CAMP) workshop (ANON. 1997), is not confirmed. No other sources were identified referring to the species in Afghanistan, and it seems likely that earlier references to its occurrence there could reflect confusion between this species and *Valeriana jatamansi,* which does occur in Afghanistan according to a US Department of Agriculture database (USDA 2006). *Nardostachys grandiflora* is said to occur in the state of Shan according to the *Checklist of Plants of Myanmar* (ANON. 2003), however no further information on its occurrence there was identified.

There are also questions regarding the species' occurrence in **Pakistan**. AKHTER (in litt. 2005) contends that *N. grandiflora* does not occur in Pakistan, and notes that it is not listed in the *Flora of Pakistan* (NASIR 1976). IUCN PAKISTAN (in litt. 2005) agrees, suggesting that information indicating its distribution in that country could reflect confusion with *Valeriana jatamansi*. The species' reported occurrence in Punjab, India suggests that it might be likely to occur in neighbouring areas of Pakistan (ANON. 1996). According to KAHN (in litt. 2005), the species has been reported from Shogran in the Mansehra District, North West Frontier Province. However, a 1976 review of the medicinal plants of the Siran Valley in this district reported the occurrence of *Valeriana jatamansi*, but not *Nardostachys grandiflora* (SHAH & KHAN, undated).

Population status and threats. There are gaps in the information available concerning the population status of this species throughout much of its range. However, it is clear that populations have been declining in many areas, particularly in India and Nepal, owing to overharvest and habitat loss.

According to RAWAT (in litt. 2005), human-induced habitat loss and degradation continue to be the major threats to the species in **India**. In 1997, during a Conservation Assessment and Management Plan (CAMP) workshop, the species was assessed as "seriously threatened" there due to an observed population decline of 80% during the preceding 10 years. In Uttaranchal, India, the loss was estimated to be

around 75% (KALA in litt. 1997, RAO in litt. 1997). In 2003, *Nardostachys grandiflora* was assessed at a CAMP workshop as *Endangered*[2001] in Arunachal Pradesh, Sikkim and Himachal Pradesh and *Critically Endangered*[2001] in Uttaranchal, due to habitat degradation and loss and also harvest and trade (VED & al.

Medicinal uses

Plant parts used for medicinal purposes: Rhizomes and, to a lesser extent, roots.

According to JAIN (1994) and YANG (1996), both the roots and rhizomes of *Nardostachys grandiflora* are used. Texts referring to the medicinal properties of these species (e.g., ANON. 1993, JAIN 1994, KEYS 1976, YANG 1996) use both "root" and "rhizome" to refer to the plant parts in trade. The text that follows generally refers to the parts used and traded as "rhizomes", following LANGE & SCHIPPMANN (1999); however, it should be understood that this may refer to both roots and rhizomes. "Root" is used in cases where this is the specific term used by the source being cited.

Nardostachys grandiflora has been widely used as medicine for centuries within **India**. It is valued for its antispasmodic and stimulant properties and is therefore useful in the treatment of fits and heart palpitations, to treat constipation and regulate urination, menstruation and digestion (JAIN 1994). The species is used in both the Unani and Ayurvedic systems of medicine. It is reportedly also widely used in the modern medicine industry (CHAUHAN & NAUTIYAL 2005). An ethanolic extract of *Nardostachys grandiflora* rhizomes was found to protect against liver damage induced by thioacetamide in rats (ALI & al. 2000).

In **Nepal** the rhizomes of *N. grandiflora* are used in brain or uterine tonics, stimulants, external pain killers, as an antiseptic, for the treatment of epilepsy, hysteria, convulsions, heart palpitations, high blood pressure, fever, anxiety, insomnia, asthma and other bronchial problems and acidity (AMATYA in litt. 2005, ANON. 1993). They are used the formulation of traditional Ayurvedic medicines as well as modern herbal preparations (AMATYA in litt. 2005). In the Dolpa region, rhizomes are used by *amchi* (traditional medicine practitioners trained in Tibetan medicine) for treating complaints including epilepsy, wounds, coughs, colds and high blood pressure (GHIMIRE & al. 2005).

Nardostachys grandiflora is used to treat hysteria, epilepsy, neurosis, insomnia, constipation and scorpion stings in **Pakistan**. Under the name of *Asaroon*, the plant is used in nine herbal preparations, according to the *Hamdard Pharmacopoeia* (Qarabadain-e-Hamdard), for treatment of hemiplegia (paralysis of one side of the body, usually following brain injury), Bell's Palsy, Parkinson's disease, tremors, indigestion and deafness due to age (ANON. 1982, KAZMI & SIDDIQUI 1953, KHAN & ZAIDI 1989, ZAMAN & KHAN 1970). According to ARORA (1965), it is used as a single compound to treat hypertension. It is also an ingredient in *Khamira Abresham Hakim Arshadwala*, which is used extensively to treat hypertension, arrhythmia, palpitation and cardiac debility. It is also said to have been used as an aphrodisiac and to aid memory (MULLIKEN 2000).

In **China**, medicinal use of *t a t i o n*

death ceremonies (RAWAT in litt. 2005). In **Pakistan**, the essential oil is used as a flavouring agent, a hair tonic to stimulate hair growth and dye the hair black, an insect repellent, a basic ingredient in quality perfumes and in the cosmetic industry (MULLIKEN 2000). *N. grandiflora* is also said to be made into stick incense and sold in the Middle East (BURBAGE 1981).

Harvest and processing. There is a relatively large and growing body of work on the harvest and trade in medicinal plants in **Nepal** – over 100 studies according to O

District Forest Office (DFO) records of harvests for 1997/98 are much lower, approximately 96 t, reflecting the low level of adherence to, and enforcement of, harvest and domestic trade controls. DFO records for 1999/2000-2003/2004 are provided in Table 2, with figures for the latter year more closely approaching but still likely to significantly under-represent harvest and trade levels. Based on discussions with traders, AMATYA (in litt. 2005) estimates that the total quantity of *N. grandiflora* collected from the Karnali (Mid-Western Development Region) and Seti zones (Far Western Development Region) alone is around 200-250 t per annum.

During their 2001 survey of NTFP use in the Malekhukhola watershed, located in Dhading District of the Central Development Region, PANDIT & T

propagated plants. Cultivation was found to be commercially viable at the higher altitudes, but not at an altitude of 1800 m.

National market. *Nardostachys grandiflora* was one of the 162 species for which a demand and supply study was commissioned by the Department of Indian System of Medicine & Homeopathy, the Government of India and the World Health Organization (WHO), New Delhi. **India's** demand was estimated as 675 t during 2001-2002 and projected to be 867 t in 2004-2005, based on an annual projected growth of 8.7%. The price during 1999-2000 was reported to be INR150/kg (USD3.4/kg) (ANON. 2001-2002).

According to GUPTA (in litt. 2005) rhizomes are sold for INR115-125/kg (USD2.6-2.9/kg) in the main market for this species in Delhi, from which other markets are supplied. One well-known medium-size pharmacy in south India was said to have an annual demand of 2000 kg, which was purchased at the average price of INR170-175/kg (USD3.9-4.0/kg) from Uttaranchal (RAMACHANDRAN in litt. 2005).

Most of the information available for **Nepal** focuses on harvest for export rather than domestic demand for use in medicine and incense. Based on interviews with nine processors of *N. grandiflora* rhizomes for oil production, OLSEN (2005a) estimated annual industrial demand for rhizomes to range from 10-246 t, with an estimated 201 t purchased in 1997/1998.

OLSEN (2005a) estimated that Nepal supplies 82±5 per cent of the total global (domestic and international) trade in *N. grandiflora* rhizomes, followed by India (13±5%) and Bhutan (5±4%).

International trade. The main form of *N. grandiflora* in international trade is unprocessed rhizomes, OLSEN (2005a) estimated that this involves a minimum of 100 t and a maximum of 500 t per year, with approximately 300 t likely to have been traded in 1997/1998, and suggesting that semi-processed products such as oil and marc (the remains of the rhizomes after oil extraction) are traded in smaller amounts. There is also likely to be at least a limited trade in finished products, e.g. incense and Ayurvedic medicines. Information on the quantities of *N. grandiflora* in international trade is limited, as much of the trade is either unregulated or occurring outside of established trade controls, and therefore undocumented. Virtually no trade has been recorded in CITES annual reports, the one exception being China's report of the export of 12 500 kg of unprocessed rhyzomes to Nepal in 2001 (Table 4). No trade was reported during 2002 and 2003, with reported trade during 2004 limited to the trade in specimens used for training purposes.

Table 4. CITES-reported trade in (1995-2003)

Year	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S
1997	CL	DE	??						200	g	Derivatives	E	U
1997	CL	DE	??	200	g	Dried plants	E	U					
1997	DE	CL	??	200	g	Derivatives	E	U					
2000	DE	CH	NP						2		Specimens		W
2001	CN	NP		12 500	kg	Roots	T	W					

Source: CITES annual report data compiled by UNEP-WCMC.

Nepal is the main source of *N. grandiflora* in international trade, exporting significant quantities of rhizomes, oil and marc. Based on discussions with traders in Nepal and India (see below), it appears that China may be the second largest source of rhizomes (export from China to Nepal), followed by Bhutan (export from Bhutan to India).

OLSEN (1999) considered *N. grandiflora* to be one of the two most important medicinal plant species traded from **Nepal**. Based on interviews with traders, OLSEN (2005a) estimated that exports of unprocessed air-dried rhizomes from Nepal to India could range from 100-435 t, with an estimate of 289 t in 1997/98. However, this figure could involve some re-export of rhizomes imported into Nepal from China.

As export of unprocessed rhizomes is banned under national legislation, there are no official government export data for rhizome exports. Reported exports of "jatamansi marc" are recorded in Nepal's Customs export database. These totalled 148 t for 2000-2003 (Table 5). OLSEN (2005a) notes that marc is sold to India and abroad by central wholesalers. It is unclear whether the Customs data for Nepal presented in Table 5 include exports to India, or only to overseas buyers.

As noted above, there appears to be a growing trade from Nepal of *N. grandiflora* oil, the vast majority of which is

In the USA *N. grandiflora* is readily available for purchase via the internet where US-based companies market 'Spikenard essential oil'. The average price is approximately USD70/kg. The source of oil offered for sale is generally not identified, but Nepal has been given as the origin in some cases. There is no information to indicate quantities of oil traded to the USA (TRAFFIC NORTH AMERICA in litt. 2005). As noted above, there is a small but potentially growing trade in oil to countries in the European Union; there is also a small trade in rhizomes for medicinal use, with one company known to make a phytopharmaceutical based on this species (LANGE & VAN DEN BERG-STEIN in litt. 2005).

Illegal harvest and trade. Significant differences between harvest and trade volumes recorded in Nepal's District Forest Office records and the likely trade volumes based on interviews with harvesters and

a “release order”, which is required to transport harvested plants out of the district of origin. The release

shall be “free”, i.e. unrestricted, unless regulated under any legislation. Goods imported in accordance with this policy may be exported in the same form without a licence, provided that there is no import or export restriction for the items. Even goods restricted for import may be imported under Customs Bond for export without a licence provided that the items are freely exportable. Specific note is made in the policy that this does not preclude the application of other laws (DIRECTORATE GENERAL OF FOREIGN TRADE 2004).

Import and export restrictions for specific products are established via India’s ITC (HS) classifications in accordance with the broader policy. Several categories relevant to CITES-listed species have been identified as goods allowed to be imported without restriction (i.e. free of import duties or quotas), e.g. “medicinal plants, fresh or dried, whether or not cut, crushed or powdered” (Schedule 1 Chapter 12), lac, gums, resins and other vegetable extracts (Schedule 1, Chapter 13), pharmaceutical products (Schedule 1, Chapter 30) and essential oils (Schedule 1, Chapter 33). Although instructions under the EXIM policy for 1997-2002 stipulated that imports of plants, products and derivatives were subject to CITES provisions (TRAFFIC INDIA 1998), the low levels of trade data for imports of CITES-listed species into India indicate that these provisions were not implemented effectively.

It does not appear that any CITES-related import controls were established via the policy for 2004-2009 until early 2006, nor that these existed under other legislation (with the exception of *Saussurea lappa*), with the effect that imports of CITES-listed medicinal plant species was uncontrolled. However, on 6 February 2006 the ITC (HS) Classifications of Export and Import Items were amended such that imports of *Rauvolfia* spp. (all species) are to be subject to CITES provisions (Ministry of Commerce & Industry Department of Commerce Notification No. 42 RE-2005/2004-09). Similar amendments were made for

CITES implementation (AMATYA in litt. 2005). The treaty has been extended for a further five years, and will remain in effect until 5 March 2012.

At present, there is no law formulated specifically to implement CITES within **China**, however, a series of regulations implementing CITES, the Import and Export Regulations of Endangered Wild Fauna and Flora, came into effect on 1 September 2006. China's Law of Wild Plant Protection

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ZAMAN, M.B. & KHAN,

Taxonomy *Picrorhiza kurrooa* ROYLE ex BENTH (family Scrophulariaceae)

Synonyms *Picrorhiza scrophulariiflora* PENNELL

(1943) distinguished a second species, *Picrorhiza scrophulariiflora,* which was subsequently placed in a separate genus, *Neopicrorhiza*, by HONG (1984), although the original generic name is still widely used for the latter species. The two species are apparently largely or entirely allopatric, with *P. kurrooa* occurring in the Western Himalaya and *N. (P.) scrophulariiflora* found further east, although a sketch map in SMIT (2000) indicates a small area of apparent sympatry in north-east Uttar Pradesh (the Himalayan sections of which are now Uttaranchal), India. MILL (2000) has subsequently described a second species of *Neopicrorhiza* (*N. minima*) from northern Bhutan. For further details on the taxonomic history of *Picrorhiza* and *Neopicrorhiza scrophulariiflora* see SMIT (2000). The species *P. kurrooa* and *N. scrophulariiflora* are distinguished solely on floral characteristics and there is currently no way of separating those parts in trade (rhizomes and various derivatives thereof), other than by

The flowers of the two species can be distinguished as follows: in *Picrorhiza kurrooa* the corolla is 4-5 mm long, five-lobed and nearly actinomorphic (that is nearly radially symmetrical, an unusual feature in members of the Scrophulariaceae); the stamens are many times longer than the corolla; in *Neopicrorhiza scrophulariiflora* the corolla is 9-10 mm long, four-lobed and bilabiate with stamens equalling the corolla in length (SMIT 2000). The fruits of *N. scrophulariiflora* are found in many-seeded capsules, with about eight fruits per flowering ramet and some 6-18 seeds per fruit (GHIMIRE & al. 2005).

N. scrophulariiflora has been reported to flower in June-July and to fruit from August onwards in Nepal by GHIMIRE & al. (2005), who note that the timing of fruiting varies with altitude. Others report that flowering extends into August with fruiting taking place from October to November (AMATYA in litt. 2005). Seeds of *N. scrophulariiflora* are dispersed by wind, water and gravity, and germinate in May or June but germination rates are low and there is no persistent seed bank (GHIMIRE & al. 2005). According to RASTOGI & PANT (2004), flowering and seed production of *P. kurrooa* in Himachal Pradesh take place in the third year. Plants may root from stem nodes. In addition, underground rhizomes may sprout to form new rosettes some distance from the mother plant (AMATYA in litt. 2005, ANSAB 1999, GHIMIRE & al. 2005, IUCN-NEPAL 2004, LAMA & al. 2001, MANANDHAR 2002).

Distribution. See SMIT (2000) for a detailed list of localities in which *P. kurrooa* and *Neopicrorhiza scrophulariiflora*

source and on harvest levels across Nepal lacking, and evidence of overharvest inconclusive. AMATYA (in litt. 2005) notes that deforestation, forest fires, grazing and agriculture have contributed to habitat loss, but considers unregulated overharvesting to be the main threat. Uncontrolled burning of pasture and forest fires were considered the primary threats in Humla in the late 1990s, along with premature collection and unscientific harvest practice (ANSAB 1999).

GHIMIRE & al. (2005) found that *N. scrophulariiflora* appeared to be much less susceptible to the effects of indiscriminate harvest than *Nardostachys grandiflora*. This was because in harvesting *N. scrophulariiflora*, it was very likely that fragments of rhizomes extending laterally underground from the mother plant would be left behind and would be capable of regenerating the following season. They observed significant re-generation even in study plots where 100% of plants were harvested in a season. Such regeneration was thought much more likely to be from rhizome fragments than from seed – as noted above, seed germination rate appears to be very low.

In the *Red Data Book of Indian Plants* (NAYAR & SASTRY 1988), *P. kurrooa* (*sensu lato,* that is, including any Indian populations of *N. scrophulariiflora*) is classified as "vulnerable". According to the supporting statement provided with India's CITES listing proposal for the species, *Picrorhiza kurrooa* was thought to be common in **India** until the 1970s or 1980s, when perhaps over 60% of the population was destroyed because of collection prior to the fruiting season, which inhibited regeneration GOVERNMENT OF INDIA (1997). KALA (1997) considered that populations had declined by 75% in Uttar Pradesh, a Conservation Assessment and Management Plan (CAMP) workshop in the same year considering India's population as "threatened with extinction" and classifying it as "endangered" (TANDON 1997). In 2003, a second CAMP workshop assessed populations as: *Critically Endangered*[2001] in Uttaranchal (where the species concerned would be *P. kurrooa*); *Endangered*[2001] in Arunachal Pradesh (*P. kurrooa*), Jammu & Kashmir (*P. kurrooa*) and Himachal Pradesh (*P. kurrooa*); and *Vulnerable*[2001] in Sikkim (*N. scrophulariiflora*), on the basis of each population being affected by habitat degradation and loss, and harvest for medicine and trade (RAWAT in litt. 2005, VED & al. 2003a & 2003b). RAWAT (in litt. 2005) states that natural disasters (e.g. floods, land slides), human-induced habitat loss and degradation, and harvest for sale to domestic markets continue to be the major threats in India.

MUKHIA (2004) refered to the species as being "very rare" in **Bhutan**, noting that detailed surveys have not been done to confirm the availability

In **Nepal**, the roots have a wide range of uses, for example to treat coughs, skin disease, fever, indigestion, liver disease, jaundice, hepatitis and metabolic disorders. Formulators in Kathmandu reported that it is used as a purgative and laxative and to treat scorpion bites (AMATYA in litt. 2005), with uses also including treatment of high blood pressure, intestinal pain, eye disease, gastritis, bile disease, sore throats, blood, and lung fever (LAMA

there to be some 28 000 ha, with overall total stock (fresh weight) in the range 2300-3300 t, with a median estimate of 2800 t.

OLSEN & LARSEN (2003) found that commercial harvest of medicinal plants in general formed an integral part of the livelihood strategies of, conservatively, 7-10% of the population in areas classified as 'mountain regions' in Nepal (that is, some 25 000-35 000 people), providing from 3-44% of annual income (mean 12%). Using 1997/1998 data, they estimated the total annual harvester value of alpine and sub-alpine medicinal plants to be in the range of USD0.8-3.3 million. *N. scrophulariiflora* was the second-most important species involved, accounting for around

National market. The main commodities in national and international trade are unprocessed rhizomes, with smaller amounts of trade in processed products such as oil. Quantitative information on trade volumes is limited, as much of the trade is apparently unregulated and/or occurring outside established trade controls, and therefore undocumented.

In **Nepal**, where most harvesting of Kutki takes place, there is no industrial processing (OLSEN 2005a). The bulk of harvest is evidently destined for export, primarily to India but also to China. The remainder is used locally, apparently on a small scale. Ayurvedic formulators use Kutki as a basic ingredient, for instance in the treatment of liver diseases. A sample of eight formulators in Kathmandu reported using quantities ranging from 300-500 kg annually, with total use in the range of 700-1400 kg (AMATYA in litt. 2005).

Available data indicate that **India** is the major global consumer of Kutki, importing large amounts but also making use of local harvest. *Picrorhiza kurrooa* was one of the 162 species for which a demand and supply study was commissioned by the Department of Indian System of Medicine & Homeopathy, the Government of India and the World Health Organization (WHO), New Delhi. Demand for Kutki was estimated at 220 t during 2001/2002 and projected to reach 317 t in 2004/2005. The price during 1999-2000 was reported as INR150 000 (USD3435) per tonne (ANON. 2001-2002). In India, roots of Kutki were reported in 2004 as sold for INR180-190/kg (USD4.1-4.4/kg) at markets in Amritsar, Delhi and Kolkata (previously Calcutta) from where they are also distributed to smaller markets (GUPTA in litt. 2004). One typical Indian pharmacy reported annual demand of Kutki at 8000 kg, which was bought in Uttar Pradesh at an average price of INR250-260/kg (USD5.7-6.0/kg) (RAMACHANDRAN in litt. 2005).

No further information was identified on markets within Bhutan, China or Pakistan, however based on information on international trade, these may be significant.

which are not subject to CITES controls (MULLIKEN 2000). The great majority of international trade in un-

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(AMATYA in litt. 2005, ARYAL 2000, OLSEN in litt. 2000, SHRESTHA in litt. 2000). A summary of these and related controls for medicinal plants and other non-timber forest products has been compiled by the Asia Network for Sustainable Agriculture and Bioresources (ANSAB) and can be found on their website (BINAYEE undated).

The Forest Act and Regulation stipulate rules governing the collection of forest products. Collection is authorized via licences issued by District Forest Officers (DFO). Licences are required to specify the collection area; the period in which harvest is to take place; the species and quantities to be collected; and method of harvest (AMATYA in litt. 2005, OLSEN in litt. 2000). Licence applicants are required to provide this information and specify the purpose of collection. In accordance with the Regulation, District Forest Officers are required to verify the quantity of medicinal plants collected, collect any associated fees, and issue a “release order”, which is required to transport harvested plants out of the district of origin. The release order should state: the species and quantity transported; the destination; and the period in which transportation must take place (ARYAL 2000, OLSEN in litt. 2000). There is also a provision to allow harvest and trade licences to be sold at auction (ARYAL 2000). Conflicting information was received regarding whether export of *N. scrophulariiflora* was limited to processed or partially processed products, or whether export of unprocessed rhizomes was also allowed.

In their 2001 study in the Dhading District, PANDIT & THAPA (2004) found that implementation of these licensing provisions was low in government forests, reflecting a combination of a lack of resource management rights among the local population and low government enforcement capacity. Inspection of harvested materials to ensure compliance with licence provisions was considered to be low. Adherence to licence provisions was similarly found to be low in community forests, where permitting provisions stis

export shall be required”. As noted above, it appears

The treaty was extended for a further five years in 2002 and remained in effect until 5 March 2007 (ANON. 2002). Although some amendments were made, these did not reflect the concerns raised regarding CITES implementation (AMATYA in litt. 2005). The treaty has been ex

More than five years have passed since a CITES Secretariat funded study first drew attention to the prob-

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TRAFFIC INDIA ZQ 0 0 7 98.63 146.52 2.9403 Tm0.0021 Tc0AMAN

Taxonomy *Pterocarpus santalinus* L. f. (family Leguminosae)

Trade names Agaru (kan), Agarugandhamu (tel), Almug (eng), Atti (tam), Bois de Santal rouge (fre), Chandana (mar), Honne (kan), Kempugandha Chekke (kan), Lalchandan (hin), Lalchandan (ben), Leno de Sandalo rojo (spa), Lignum Santali rubrum (pha), Lignum Santalinum rubrum (pha), Patrangam (mal), Pterocarpi lignum (pha), Rakta Chandan (hin), Rakta

The Government of India considered both legal and illegal trade to threaten *P. santalinus* at the time they proposed it for inclusion in CITES Appendix II, with its restricted distribution and slow generation rate increasing the level of threat (ANON. 1994). The species was similarly considered "threatened" by GUAR (1994) and KHAN (1994), the latter also considering habitat destruction to be a threat. RAO & RAJU (2002) consider habitat alteration to be the primary threat. Habitat in the Central Deccan Plateau is considered under severe threat from conversion to cash crop plantations, fuel wood collection, and overgrazing by cattle (RAWAT & al. 2001).

HENRY (1994) considered the species unlikely to be threatened with extinction owing to its high seed production, and believed that adequate conservation methods have been taken by the Andhra Pradesh Forest Department to ensure that it was not threatened by habitat destruction or international trade. According to an Andhra Pradesh Forest Department staff member, there are very few specimens of harvestable size in the State Forests. Illegal harvest continues to be considered a key threat (ANON. 2004a).

Medicinal uses

Plant parts used for medicinal purposes:

Substitutes: RAO & RAJU (2002) state that three of the four *Pterocarpus* species occurring in India are valued and harvested for santalin: *P. santalinus*, *P. dalbergioides*, limited to the Andamans and *P. indicus*, introduced from Malaysia. A trader in Germany notes that there are many alternative products, that can be used as substitutes, for example cochineal and santalins from other species (LANGE 2005). Another species, *Andenathera pavonina,* also regularly referred to as 'red sandalwood', 'rubywood' and other common names used for *P. santalinus*is, is similarly used to produce santalin-based dyes. A US chemical supplier offering 'red sandalwood powder' appeared to treat the two species interchangeably (ANON. 2004b). Most of the "red sanders" currently available on the German market (e.g. in pharmacies) comes from other trees, mainly West African Red Sanders. The colour obtained from these trees is light red and not as dark as the true Red Sanders colour (LANGE 2005).

All four *Pterocarpus* species occurring in India are said to be valued for their wood, but only *P. santalinus* is highly valued for its heavy dark red heartwood, especially that possessing a wavy grain (RAU & RAJU 2002).

Harvest and processing. The colourant is only extracted from the heartwood, which is first reduced to chips or powder and the colourant then extracted with alcohol. The extract may be concentrated or stripped of solvent to give a solid product prior to sale. Specific formulations (as liquids, dispersed solids or water-soluble forms) are prepared prior to sale to particular users at strengths appropriate for the food product. No reliable published information was available on commercial extraction yields as of the mid-1990s (GREEN 1995).

Cultivation. The species can be artificially propagated via both seeds and cuttings (GREEN 1995). Plantations of *P. santalinus* were established as early as 1964 by the Andhra Pradesh Forest Department, with research into vegetative propagation reported in the 1990s with encouraging results (HENRY 1994). Plantations were also established in Kerala in 1983, with three different sites planted that were said to show promise. It was estimated that the trees would take 18-20 years to produce heartwood, but was not known if that heartwood would possess the high value wavy grain (BABU 1992). Cultivation trials were said to be aimed primarily at producing this higher value wood (REDDY & SRIVASUKI 1990, MOLUR & al. 1995).

SINGH (1997) gave precise instructions for commercial propagation but the extent of cultivation is not known. The Botanic Gardens at the University of Agricultural Sciences in Bangalore carried out germination and propagation studies between 1996 and 1997. The germination rate was found to be low, in part because many seedpods are empty, but germination could be improved by rubbing the pod or treating it with water or sulphuric acid. The rooting success of stem cuttings was found to depend on seasonal variations and the age of the mother tree (GEETHA 1996).

VEDAVATHY (2004) calculated that if, for commercial cultivation, 500 trees are planted on one hectare, a

kata (previously Calcutta), Mumbai and Haridwar. It was commonly used by India's herbal medicine industry and readily available. Estimates of domestic trade volumes varied widely – two traders estimated that sales in Delhi markets (presumably for all uses) were in the order of 100-400 t; the Dabur Research Foundation estimated the annual demand from the Ayurvedic industry to be 16 t. India's Ayurvedic Drug Manufacturer's Association 1999 estimate of annual production of crude herbal drugs in India considered that 3000 t of *P. santalinus* was produced per year, of which only 5% (i.e. 150 t) was used by Indian Ayurvedic pharmacies (KHADIWALE 1998, SCHIPPMANN 2001).

Pterocarpus santalinus was one of the 162 species for which a supply and demand study was commis-

Table 2. Reported exports of chips, extract and powder from India (tonnes) (1991/1992-2002/2003)*

Year	1992/ 1993	1993/ 1994	1994/ 1995	1995/ 1996	1996/ 1997	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003
Chips (1) (2) (3)	25.0	-	5.2+ 50.0	104.8							
Chips (4)					106.8	77.0	81.6	-	181.1	46.1	40.1

Table 5. Exports of "Red Sandal Wood" powder recorded in Indian Customs data per import destination (tonnes) (1996/19972003/2004)*

Importer	1997/ 1998	1998/ 1999	1999/ 2000	2000/ 2001	2001/ 2002	2002/ 2003	2003/ 2004
France	0.3			0.3			
Germany	0.5	0.9	0.8				
Hong Kong	2.6						
Malaysia	1.3				1.6	0.4	
United Arab Emirates		12.3		1.1	2.7	10.9	15.0
Taiwan			14.3	40.0	0.03	0.3	0.5
Japan**				0.6	0.02	1.1	0.3
Oman			2.7		0.03	0.1	0.03
Pakistan				5.0			

Table 6. CITES-reported trade in (1995-2003)

Year	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S
1995	IN	DK		2 700	kg	Extract	T	A					
	IN	FR		1 220	kg	Extract	T	A					
	IN	GB		100	kg	Extract	T	A					
	IN	IL		50	kg	Extract	T	A					
	IN	IT		1 650	kg	Extract	T	A					
	IN	NL		1 000	kg	Extract	T	A					
1996	IN	FR		1 500	kg	Extract	T	A					
	IN	GB		600	kg	Extract	T	A					
	IN	IT		2 000	kg	Extract	T	A					
1997	CL	DE	??										

ties in obtaining CITES permits in India. It appears that North America provides a relatively minor market, with reported trade limited to the seizure of five tonnes of timber in 1999, and the import of 4.4 t of powder in 2003/2004. *P. santalinus* powder is offered for sale via the web for use in incense, with prices quoted by US suppliers on the order of USD66-67/kg for bulk purchases.

Other than those products seized outright, it is unclear what proportion of the international trade in timber and possibly other products is illegal according to national export restrictions, which are unclear (see below).

Illegal harvest and trade. Illegal harvest and trade in *Pterocarpus santalinus* appears to be widespread, with numerous seizures reported both within India and in other countries (Tables 7 and 8).

Table 7. seizures of more than one tonne

Date	Location of seizure	Product	Quantity (tonnes)	Seizing authority	Source
1999	USA	Sawn wood	5	US Government	CITES trade statistics

Illegal harvest and trade is said to have increased in Andhra Pradesh following the ban on harvests in State Forests in 1982. In Andhra Pradesh, the Andhra Pradesh Forest Development Corporation (FDC) was appointed by the State Government as the main selling agent for seized timber (approximately 1800 t were seized by the Andhra Pradesh Government from 1992-2002). The FDC was said to sort the timber for sale onto the global (and presumably domestic) market (ANON. 2002a). In 2004 the Andhra Pradesh Forest Department was reported to have 2381 t of confiscated *P. santalinus* available for internal sale (ANON. 2004c).

There has been a rise in smuggling activity since approximately 2002 from Nellore, Chittoor and Kadapa districts, with demand for the wood in Japan and elsewhere in East Asia being cited as the main cause. Government forest department staff have been active in the busting of smuggling gangs (ANON. 2004d).

The Chennai unit of the Department of Revenue Intelligence seized over 73 t of *P. santalinus* worth INR1.5 crore (USD343 500) and arrested four persons from April 2003-March 2004. A further 175 t valued at over INR3.4 crore (USD778 600) was seized in six cases, with 11 people arrested, from April to December 2004. This included 20 t of logs seized in December 2004 destined for Malaysia (ANON. 2004e).

Twenty-eight tonnes of *P. santalinus* were seized in Mumbai en route to Singapore in February 2004, and a further 15 t seized in Pune approximately two weeks later (NIRAJ in litt. 2004). There were also three seizures of *P. santalinus* in Singapore in 2004. The shipments, totalling 56 t, were all intercepted by Customs officers after arriving from India. Two out of the three shipments were concealed with other commodities including cereals and coconut husks. The shipments were claimed to be “Poha” or Indian rice, “blended black tea” and “natural slate stone” (TRAFFIC SOUTHEAST ASIA 2004). In 2005, 20 t of wood were seized in a perfume factory in Madras (ANON. 2005b).

There were also numerous smaller seizures of *Ptercarpus santalinus* at various sea ports and airports, destined for the EU, the USA (mainly powder) and some other parts of the world. These items were seized as a result of violations of either India’s EXIM policy and/or CITES trade controls (Table 8).

Seized material may be sold by the Government (ANON. 2002a), however, under India’s Import and Export Policy, it would appear that this may only be exported as a value added product.

Table 8.

plants. Most have established lists of species banned from harvest from forests (“Negative lists”), which include threatened plants (Jain 2000).

The Indian Forest Act (1927) has been adopted by most of the States and is directly applicable to the Union Territories of India. The remaining States have enacted State Forest Acts of their own, which are largely based on the Indian Forest Act. The Forest Acts of the States have been amended from time to time as required. The States have framed Rules under the Acts to protect and preserve the forest wealth of their respective States (JAIN 2000). See JAIN (2000) for a state-by-state analysis of legislation relevant to the harvest and trade of medicinal plants.

P. santalinus is classified as a “reserved tree” under the Andhra Pradesh Preservation of Private Forest Rules, 1978. Cutting, transport and sale require permission from the Divisional Forest Officer in accordance with rules set by the State Government. According to a State Forest Officer, felling of this species in State Forests has been banned since 1982 (JAIN in litt. 2005). The Andhra Pradesh Sandal Wood and Red Sanders Wood Transit Rules (1969) also specify that any import, export or transport of *P. santalinus* wood, chips or powder must be accompanied by a permit detailing the items and quantities involved, their

CITES would not appear to be being implemented for *P. santalinus* exports from India or in countries of import. Over 500 t of wood chips have been exported from India since the CITES listing took effect according to India's Customs data. However, India's CITES annual reports do not show the export of any wood chips, with CITES-reported exports instead limited to extract and carvings, with these ceasing in 1999. Little trade has been reported by importing Parties with the exception of China, which reported significant imports from non-range States in 2002 and 2003.

It does not appear that export restrictions on wild specimens of CITES-listed species apply to re-exports of imported specimens, however this requires confirmation, nor does it appear that there are any specific provisions made for controlling re-exports of CITES-listed species, other than as may be required to prove that re-exports do not involve wild-collected stock from within India. No reference could be found to an earlier (2003) provision requiring exporters of value-added formulations made out of imported species from the list of "prohibited plants" to provide an affidavit to Customs authorities at the time of export that the specimens were legally imported (NTF NO. 03/2003 31/03/2003). However, CITES Management Authority staff state that proof of import is required prior to granting re-export permission, and that they take into account, for example, the amount of unprocessed product that would have been required on import to produce a given export quantity (JAIN in litt. 2005). CITES Re-export Certificates are issued for such shipments (AARTI 2005).

Exports are required to be limited to the following ports: Mumbai, Nhava Sheva, Kolkata, Cochin, Delhi, Chennai, Tuticorin, Amritsar, Calicut and Thiruvananthapuram (DIRECTORATE GENERAL OF FOREIGN TRADE

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RICHTER, H.G. & D

Taxonomy *Rauvolfia serpentina* (L.) BENTH. ex KURZ (family Apocynaceae)

Synonyms *Ophioxylon salutiferum* SALISB., *Ophioxylon obversum* MIQ., *Ophioxylon serpentinum* L., *Rauvolfia obversa* (MIQ.) BAILL., *Rauvolfia trifoliata* (GAERTN.) BAILL.

Trade names Araba (mun), Arachontita (ass), Arbre aux serpents (fre), Asrel (urd), Bomayaza (bur) Chandmaruwa (nep), Chandra (ben), Chandra (hin), Chandra (Mumbai), Chandrabhaga (hin), Chandrabhoya (hin), Chhota Chand (hin), Chandrika (India), Chivan Amelpodi (tam), Chivanamelpodi (tam), Chovannamilpori (tam), Chuvannavilpori (mal), Chuvannavilpuri (mal), Darujikipota (mun), Harkaya (mar), Harki (mar), Huring (mun), Indische Schlangenwurzel (ger), Jowansu (mik), Lotu-chand (hin), Makalmaran (Delhil), Paataala Garuda (tel), Paataalagani (tel), Patala-agandhi (tel), Patalagandhi (kan), Patalgarur (ori), Phulchiso (nep), Racine de serpentine (fre), Radix Rauwolfiae (pha), Rauwolfia (fre), Rauwolfia root (eng), Rauwolfiae radix (pha), Rauwolfiawurzel (ger), Ra-yom (tha), Sanochado (ori), Sarpaganda (fre), Sarpagandha (nep), Sarpagandha (san), Sarpagandhi (kan), Sarpaganthi (tam), Sarpaghanda (san), Schlangenholz (ger), Segno serpentino (ita), Serpentine root (eng), Serpentine wood (eng), Shegenmu (chi), Shivanabhiballi (kan), Simjenga (mun), Snakewood (eng), Supurolid (mun), Sutranavi (kan), Suvapavalporiyan (mal), Todong-pait-parao (kha) (FAO 2002, IUCN NEPAL 2004, JAICHAGUN in litt. 2006, LANGE & SCHIPPMANN 1999, MANANDHAR 2002).

Description

Population status and threats. The species is not included in the IUCN Red List (IUCN 2006).

In **India**, the species was considered to be 'endangered' in southern (Karnataka, Kerala, Tamil Nadu) and central India. Three Conservation Assessment and Management Plan (CAMP) workshops concluded that populations have declined more than 50% from 1985-1995 owing to loss of habitat and over-collection for the medicinal plant trade (MOLUR & al. 1995, MOLUR & WALKER 1998). ANSARI (1993) stated that genetic erosion has affected the species greatly and populations left in India have a very poor alkaloid content. Another CAMP workshop was held in Bhopal in 1998 when the species was assessed as *Critically Endangered*[1994] in Maharashtra owing to the same threats. The observed decline was, however, more than 80% from 1988-1998 (PATNAIK 1999). A CAMP workshop in July 2003 assessed the species *as Critically Endangered*[2001] in Chhattisgarh, Andhra Pradesh and Maharashtra and *Vulnerable*[2001] in Madhya Pradesh, Jammu & Kashmir, Uttaranchal, Assam and Meghalaya. Major threats were harvest for medicinal use and trade (VED & al. 2003). BALAKRISHNA (1993b) and JAIN & RAO (1983) reported the species to be 'vulnerable' in the Indian states of Kerala, Orissa and Tamil Nadu. Participants during a workshop on 'Endangered Medicinal Plant Species in Himachal Pradesh' described it as "endangered" (ANON. 2002a). AYENSU (1996) considers it to be threatened in India.

SIDDIQUE & al. (2004) consider the species to be "endangered" in the Barind Tract of **Bangladesh**. The species has been reported as being "vulnerable" in **Myanmar** in the UNEP-WCMC Threatened Plants Database, however, according to ZAW (in litt. 2005), populations are still abundant in the moist forest areas where it occurs, but could be declining in areas where habitat is degraded. AUNG DIN (2005) considered the major threat to be habitat degradation and change of land use. The species was assessed as *Critically Endangered* [in]

In western medicine, the alkaloid reserpine, first isolated from *Rauvolfia* roots in the early 1950s, quickly became important in the treatment of hypertension and

Cultivation. Efforts to domesticate the species were said in the 1990s to have only been partially successful, as seed germination is low and alkaloid content varies. Better results have been achieved when propagating via rootstock cuttings, but here the alkaloid content proved to be lower than in plants produced from seed (GOVERNMENT OF INDIA 1989, SAMANT & al. 1998, SHELDON & al. 1997). Efforts have also been made to propagate plants from tissue culture (CHANDEL & SHARMA 1996) and to produce the alkaloid in cell suspension cultures (HERMAN 1989). Cultivation methods have been steadily improving over the years (IUCN & TRAFFIC 1989, SINGH 1997).

In **India**, TRAFFIC INDIA (1998) noted that various forest departments had undertaken cultivation projects, but observed that cultivation had not been taken up commercially. This conflicts with AYENSU (1996), who stated that the species was commercially cultivated in India. Under irrigated conditions, optimum yield is achieved only after two to three years of cultivation from seed. *R. serpentina* has been selected for *in situ* and *ex situ* propagation in Chhattisgarh, and was considered a top priority species for development of *ex situ* cultivation in Himachal Pradesh (ANON. 2002a). The economic size for commercial cultivation of *R. serpentina* and other root yielding medicinal plants in India is said to be 25-30 ha (CHATTERJEE 2004).

According to RAJKARNIKAR & al. (2000), the species was not cultivated on a commercial scale in **Nepal**. However, germplasm has been conserved and propagated and experimental cultivation has been conducted in the past on two farms owned by the government, in Bara and Makwanpur. Seeds were planted in nurseries and after two months the seedlings were transplanted in the fields. Seeds directly sown in the fields did not succeed and here regeneration after collection only occured through remnants of roots left behind. More recently, in these and other Nepali regions, Kerkha (Jhapa), Dhakeri (Banke) and Shripur (Kailali), cultivation experiments were conducted on areas of three hectares or less with an average yield of 2000-2500 kg fresh root per hectare (AMATYA in litt. 2005). AYENSU (1996) has stated that *R. serpentina* is in commercial cultivation in Nepal.

During a TRAFFIC India market survey in 1997 the species was found to be commonly traded in the markets of Delhi, Kolkata, Mumbai, Haridwar and Amritsar. It was among the most significantly traded medicinal plants and was readily available. At the Delhi market, the species was said to come mainly from Uttaranchal, but with substantial quantities also imported from Bhutan, Nepal and Pakistan (TRAFFIC INDIA

roots and processed products are recorded in Customs data, which can therefore be compared with CITES annual report data.

Table 2. Indian Customs codes for trade in

India's Customs data also show the import into India of significant quantities of "Serpentina roots" from 1999/2000-2003/2004, with over 200 t of roots imported during this period (Table 5). Myanmar, a range State for *R. serpentina*, was the reported source of nearly three quarters of this trade (158 t). According to data provided by CHEMEXIL (1997/1998), 28 t of *Rauvolfia serpentina* was imported from Myanmar (GOVERNMENT OF INDIA PLANNING COMMISSION 2000).

Trade data for 1999-2000 correspond very roughly to CITES annual report data from Myanmar for 1999; none of the other imports are reflected in CITES data, however.

Two African countries were reported as the source of 47 t of roots, these are most likely another *Rauvolfia* species (e.g. *R. vomitoria*) rather than *R. serpentina*.

have been produced from imported *R. vomitoria*, and the exporter is provided with a No Objection Certificate. As the trade does not involve the CITES-listed *R. serpentina*, this trade is not recorded in CITES annual reports. *R. serpentina* is also exported in the form of formulations. As this product had been ex-

been received (ZAW in litt. 2005). Reports of large-scale imports from Myanmar documented in India's Customs data were received with surprise, and further enquiries were being made by the Forest Department as a result of receiving this information (AUNG DIN 2005).

Illegal trade from **Nepal** is suspected, potentially under the name "Chandmaruwa" (AMATYA in litt. 2005).

Legislation and regulations

Regulation of harvest, manufacturing and domestic trade. The main laws governing harvesting of medicinal plants in **India** are the Indian Forest Act (1927), and, to a lesser extent, the Wildlife (Protection) Act (1927/1991/2002). The Indian Forest Act (1927) consolidates the law relating to forest produce, the transit thereof and duty thereon, and empowers State Governments to regulate the transit of forest produce, e.g. medicinal plants. The Act deals specifically with reserved, protected, and village forests. Almost all the States and Union Territories in India have regulations regarding harvest, transit and trade in medicinal plants. Most have established lists of species banned from harvest from forests ("Negative lists"), which include threatened plants (JAIN 2000).

The Indian Forest Act (1927) has been adopted by most of the States and is directly applicable to the Union Territories of India. The remaining States have enacted State Forest Acts of their own, which are largely based on the Indian Forest Act. The Forest Acts of the States have been amended from time to time as required. The States have framed Rules under the Acts to protect and preserve the forest wealth of their respective States (JAIN 2000). Harvest and trade of *Rauvolfia serpentina* is banned in Chhattisgarh (ORaua7(3st23e)4.7(c.2(a)-0he States hav19[e)ef(cou0.)5n.5(a7(try, impl)5.ecement, transi3(i)5.ec1.14(0vre)st2395 , whi)6.ctIN

Regulation of international trade

CITES listing: *Rauvolfia serpentina* was listed in CITES Appendix II effective 18 January 1990 following acceptance of a proposal from India. The listing was annotated with Annotation #2, which designates “all parts and derivatives, except a) seeds and pollen; b) seedlings or tissue cultures obtained *in vitro*

prohibited. Further clarification is required to confirm whether this applies to wild specimens regardless of

Export of *Rauvolfia serpentina* from **Nepal** was banned in 1995 via publication of a notification in the Nepal Gazette (under rule 12 and 13 (2) of the Forest Regulation, 1995) on 3 April 1995. This was amended in 2001 to allow export in processed form, as long as processing takes place within Nepal and permission is obtained from the Department of Forests, advised by the Department of Plant Resources and Herb Production and Processing Co. Ltd. (per Clause 2 of Nepal Gazette vol. 3, Section 51 No. 36, dated 31 December 2001 issued by Ministry of Forests and Soil Conservation) (AMATYA in litt. 2005). According to PANDIT & THAPA (2004), the ban on export of raw materials of certain medicinal species has been misinterpreted by some District Forest Office staff as relating to trade from one District to another, rather than to export from Nepal, increasing the incentive for illegal trade by village collectors.

The Management Authority also maintains liaison with the Department of Customs, Intelligence, Police and other agencies. However, it was noted in 2000 that Customs officers had not been trained in the identification of medicinal plants (BISTA, *in litt.* 2000); it is unknown if training has been provided since that time. Personnel from the Department of Forests and District Forest Offices have been posted at the Customs points in the Terai to examine consignments containing wild flora (ARYAL 2000).

Treaty of Trade between Nepal and India

In an effort to expand trade between their two countries, the Governments of India and Nepal entered into a bilateral trade agreement in 1991. The treaty provides for preferential treatment (exemption from Customs duty and quantitative restrictions) of trade of certain “primary products”, which include forest produce that has not undergone processing, and Ayurvedic and herbal medicines (Article IV) (ANON. 2002c). Under this treaty, a certificate of origin issued by the Government of Nepal is the only document required for presentation to India’s Customs authorities at the time of import (MULLIKEN 2000). Trade in conjunction with the treaty is required to take place via one of the 22 border crossings designated in Annex A of the treaty. During the late 1990s, border officials were unaware that CITES documentation might also be required for export (as noted above, under India’s current CITES implementing legislation and the EXIM Policy, CITES export permits would not be required to accompany shipments into India in any event). The treaty contains provisions for stronger domestic measures on the part of national governments, and provides a list of articles not allowed preferential treatment (e.g. cigarettes and alcohol) as an annex. It appears that this annex could be amended to reflect CITES requirements (MULLIKEN 2000).

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trade from Nepal to India. The export of *Rauvolfia* spp. extracts and formulations from India is very large – over 260 t were exported from 1999/2000-2002/2003, however it is not known what proportion of this involves *R. serpentina*. India imports *Rauvolfia* roots from other countries, including from *R. serpentina* range States, to supply domestic production, including 70 t of roots from Myanmar between April 2003 and March 2004. This trade seems likely to have involved *R. serpentina*, as there is no information to suggest that *R. vomitoria* is cultivated in or exported from Myanmar, or of trade in other *Rauvolfia* species from that country. This and other trade to India therefore requires further examination, particularly in view of the fact that India only recently began applying CITES trade controls to imports of this species from other countries.

Exports (possibly re-exports) of roots and extract from India similarly require further examination.

Although it appears that efforts to cultivate *R. serpentina* on a commercial scale are underway in India and Nepal, and to a lesser extent in other range States, there is no evidence that cultivation is meeting a significant portion of demand in India or elsewhere. Given concerns regarding the status of the species, urgent action is required to document the source and quantity of specimens in trade, both domestically within India and internationally, and to develop mechanisms to ensure that wild harvests and trade are maintained within sustainable levels.

Possible next steps

Governments of *Rauvolfia serpentina* range States, particularly within India, Myanmar, Nepal and Thailand, might consider:

- Undertaking further work to document the population status and trends of this species, and identify factors contributing to population declines where these are found to occur;
- Examining harvest and exports in order to ensure that they are maintained within sustainable levels;
- Confirming domestic cultivation levels and the species and origin (wild, cultivated) of specimens exported and imported;
- Supporting local communities in the development of sustainable harvest practices and management plans for this species, taking into account the species' status, regeneration capacity and predicted future demand;
- Encouraging industries reliant on this species to support development of sustainable harvest regimes, and to ensure that all raw materials are sourced from sustainable and legal sources; and
- Working collaboratively to ensure that any international trade in this species is in accordance with national harvest and trade controls, as well as accompanied by appropriate CITES documents.

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U 1997), but were included in *T. wallichiana* by FARJON (1998). Clarification of the taxonomy of *T. wallichiana* and re-

PUROHIT & al. (2001) also draw attention to the negative effects of grazing by livestock, bark stripping by deer, exposure to direct sunlight and freezing temperatures and fire.

Distribution. Depending on the taxonomic treatment, *T. wallichiana* can be said to be wide-ranging in Asia, occurring from Afghanistan through the Himalayas to the Philippines (HARA & al. 1978-1982, RIEDL 1965). Its range comprises Afghanistan, Bhutan, China, India, Indonesia, Malaysia, Myanmar, Nepal, Pakistan, the Philippines and Viet Nam.

In **China** *Taxus* spp. are mainly distributed in the southwest, in Xizang (FU & JIN 1992) and Yunnan Provinces (XU 1997), but are also reported to occur in the

Other species similar to *T. wallichiana* occurring in China and listed in the CITES Appendices include *Taxus fuana* and *T. cuspidata. T. fuana* is considered to be *Vulnerable*[1994] globally by IUCN (IUCN 2004). However, revised evaluations provided by XIANG (in litt. 2004) for the Chinese populations only, consider *T. fuana* to be *Endangered*[2001] and *T. cuspidata* to be *Critically Endangered*[2001]

zone villages of Nanda Devi Biosphere Reserve in India collect *Taxus* bark and leaves mainly for traditional teas and for curing colds and coughs, a practice also common in other rural areas (MAIKHURI & al. 1998, MANANDHAR 2002). Two herbal formulations using *T. wallichiana* are manufactured in India (TRAFFIC INDIA 1998). Extracts are also used in medicinal hair oils. In Pakistan, decoction of the stem is used against tuberculosis (AHMED & al. 2004). Only a small fraction (*ca*. 1000 kg) of the total amounts harvested are used in traditional medicine in that country (AHMAD in litt. 2005).

Taxus wallichiana is, along with other *Taxus* species, the source of taxanes, a group of compounds of which one, paclitaxel, has proved effective in the treatment of certain cancers, particularly ovarian and breast cancers, and AIDS-related Karposi's sarcoma. Paclitaxel was discovered by the US National Cancer Institute (NCI) in the bark of the North American species Pacific Yew *Taxus brevifolia* and demonstrated to have cancer-fighting properties. Further research was conducted by the US National Institutes of Health, and a private-sector partner sought to further develop and market paclitaxel. The pharmaceutical company Bristol Meyers Squibb (BMS) was selected in this regard, and subsequently brought paclitaxel to the market under the trade name Taxol® (MCCOY 2004, US GOVERNMENT ACCOUNTING OFFICE 2003). Concern regarding the sustainability of *T. brevifolia* harvests and the availability of supplies needed to produce paclitaxel spurred development of methods to synthesize paclitaxel from another taxane (10-Deactylbaccatin III or 10-DAB), found in other *Taxus* species, including *T. wallichiana*. This new development not only increased the number of species from which to derive paclitaxel, but also expanded the extraction of taxanes to leaves, a more sustainable source of taxanes than bark. Although leaves are needed in large quantities, methods of extraction have become increasingly efficient (SCHIPPMAN 2001).

By 1993, the amount of *Taxus* bark required to yield one kilogramme of paclitaxel was said to have been reduced from approximately 13 500 kg to 6800 kg, the equivalent of the bark of some 1000 trees (SHELDON & al. 1997). According to BEDI & al. (1996), 7272 kg of bark were required to produce one kilogramme of paclitaxel. PHILLIPS & DWYER (1999) calculated production of one kilogramme of paclitaxel to require 10 000 kg of bark or approximately 3000 trees. According to a more recent estimate, three tons of leaves are required to make one kilogramme of paclitaxel (MCCOY 2004).

The number of paclitaxel manufacturers and of paclitaxel and other taxane-based drugs has expanded in recent years. This is in part owing to the entry into the market of generic paclitaxel drugs, and in part to the development of new treatments. For example, the anti-cancer treatment Taxotere® is based on docetaxel, derived from 10-DAB, and in 2004 was considered a faster-growing drug than paclitaxel in US markets (MCCOY 2004). In January 2005, the US Food and Drug Administration approved Abraxane®, made by attaching paclitaxel molecules to albumin protein, for the treatment of breast cancer (POLLACK 2005). Paclitaxel has also been used as a coating in coronary stents (FOREMAN 2002).

BEDI & al. (1996) projected world demand for paclitaxel to be 700 kg per year. This appears to have been an overestimate; global demand for paclitaxel in 2004 was estimated at 400 kg per year (MCCOY 2004). However, while the US market was described as “stagnant”, the European market was expected to expand with the entry into the market of generic products (MCCOY 2004). Further growth in the global market for paclitaxel is expected, with a prediction that it will climb to over 1000 kg per year by 2008, according to one Canadian paclitaxel producer (MCCOY 2004).

Similar species**.** Besides the North American *Taxus brevifolia* and the European *T. baccata*, a number of Asian species other than *T. wallichiana,* such as *T. chinensis* and *T. cuspidate*, are the source of taxanes from which paclitaxel can be derived chemically. *T. wallichiana* was said by BASYAL

TRAFFIC 1994, OLDFIELD & al. 1998). In Pakistan *T. wallichiana* is the species most preferred as a source of timber for roofing traditional hous

The main harvesting areas in **India** are the cool temperate zones between 2200-3000 m, mainly in Uttaranchal and Himachal Pradesh (where the species was assessed in 2003 as *Endangered*[2001]) Harvesting takes place all year around, preferably when the tree is tall and mature, 15-20 years old (RAWAT in litt. 2005). Trade figures compiled by the Arunachal Pradesh State Forest Department based on royalty fee payments give an indication of the scale of earlier harvests in that state (Table 1).

result of enforcement of harvest bans (AHMAD in litt. 2005). Harvesters sort the leaf-bearing shoots from the branches before onward sale to middlemen, who separate the leaves from the shoots, dry and pack them. Regional traders sort the leaves according to quality for onward sale to wholesalers and exporters. There is no pharmaceutical extraction of taxanes within Pakistan (AHMAD in litt. 2005).

There are no extraction facilities for *Taxus* in **Viet Nam** (THOMAS & LUU NGUYEN DUC 2004).

Cultivation. Much of the information regarding cultivation of *Taxus* for production of taxanes is not specific with regard to the species involved. In countries where more than one species occurs, e.g. China, it seems likely that cultivation efforts are not focused entirely or perhaps even predominantly on *T. wallichiana*. Even in countries where *T. wallichiana* is the dominant native species, it could be that non-native species or cultivars are being cultivated. The following text should therefore not be considered as referring specifically to *T. wallichiana,* except where specified.

Cultivation efforts during the 1990s were focused on breeding for higher yields of paclitaxel and improved propagation techniques (IUCN & TRAFFIC 1994, SHELDON & al. 1997), and it seems likely that this remains the case today. Propagation can be via stem cuttings or through seed; the latter is considered time consuming, owing to the long dormancy of the seeds (one year) and the slow growth of plants. The aim of experiments with mass macro-propagation of elite plants is to obtain optimal harvest of clippings from cloned trees closely planted together. Cultivation trials also include other species like *T. baccata, T. cuspidata* and *T. chinensis* (BEDI & al. 1996, RIKHARI & al. 1998, SHELDON & al. 1997).

In recent yeara

Some research into propagation methods has been carried out by the Forest Science Institute in southern **Viet Nam**, and there is a strong interest in the establishment of plantations. Field gene banks derived from locally sourced material have been set up as part of a conservation and utilization programme (NGHIA 2000).

National market. Information provided by ZHANG & al. (2004) indicated that as well as producing *Taxus* extracts for export, there is a domestic market for paclitaxel within China, with exports being lower than domestic production. Imports of finished paclitaxel

According to the Director of the Shanghai branch of China's CITES Management Authority, most of the *Taxus* materials imported for the production of paclitaxel come from the USA and Canada, with importing companies saying that the specimens come from plantations (TRAFFIC NORTH AMERICA 2004.). More recently, Management Authority staff advised that almost all material used to extract paclitaxel in China has increasingly been imported from other countries, primarily Canada, with small quantities imported from Germany, and no materials imported from India or Nepal (ZHAI 2005).

Table 3. CITES-reported trade in (1997-2003)

Year	Country of Export	Country of Import	Origin	Export					Import				
				Quantity	Unit	Term	P	S	Quantity	Unit	Term	P	S
1997	CL	DE	??						200	g	Derivatives	E	U
1997	DE	CL	??	200	g	Derivatives	E	U					
1999	CN	ID		2000	kg	Derivatives	T	W					
1999	CN	IN		2000	kg	Derivatives	T	W					
1999	IT	MT							1		Live	T	I
2000	CN	KR		200	g	Extract	T	W					
2000	CN	US		55	kg	Extract	T	W					
2000	CN	US		615	g	Extract	T	W					
2000	DE	CH	BT						1		Specimens		A
2001	CN	US		38	kg	Extract	T	W					
2001	IN	IT		100	kg	Leaves	T	A	100	kg	Leaves	T	W
2002	CN	US		1	g	Extract	T	W					
2002	CN	US		3	kg	Extract	T	W					
2003	MM	CN							500 000	kg	Bark	T	A
2003	MM	CN							50 000	kg	Extract	T	W

Source: CITES annual report data compiled by UNEP-WCMC.

In line with the above, many Chinese manufacturers of paclitaxel claim to source their raw materials from North American *Taxus* species and plantations, but it is not clear to what extent this is the case (TRAFFIC NORTH AMERICAp[(Ta)6.8(22

Table 4. Exports of paclitaxel and docetaxel recorded in India's Customs data (t)* (1999/2000-2004/2005)

Importer	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005
Argentina					0.15	
Bahrain		0.10				
Barbados					0.30	
Brazil					8.68	
Belarus					0.20	2.48
Colombia						0.43
Cuba					0.60	

switched to using cultivated *T. baccata*. In 2001, 100 kg of leaves from cultivated sources were reported as exported by India, Italy reporting the import as wild sourced. No other exports are reported in India's CITES annual reports.

Paclitaxel extraction was reported as taking place wi

but does not establish requirements with regard to the size of specimens allowed to be harvested (MACIVOR & PETERS 2000).

The main laws governing harvesting of medicinal plants in **India**

Three different types of harvest controls were reported as practised (IQBAL 1991, RAPA 1987):

- Leasing the area for collection of medicinal herbs. This method was said to have been used in the Hazara forests in the North-West Frontier Province;
- Collection by the traders from local people who pay nominal royalties to the Forest Department. This method was said to have been common in the Malakand forests in the North-West Frontier Province; and
- Auctioning off fixed quantities, e.g. by the Forest Department in Azad Kashmir.

As stipulated in Chapter 12 of the ITC (HS) classifications, the export of plants, plant portions, their derivatives and extracts of species included in CITES Appendix I and II and obtained from the wild is generally prohibited. Further clarification is required to confirm whether this applies to wild specimens regardless ofies9(n5599mi)

Conclusions

Taxus wallichiana is a multipurpose tree species valued through much of its range as a source of timber, fuelwood, fodder, tea, traditional medicine and, since the early 1990s, paclitaxel and other taxanes used in anti-cancer medications. Slow growing, slow to regenerate and sensitive to canopy disturbance and fire, it appears that this species was declining in some parts of its range even before harvest for production of taxanes began. However, high demand for bark and leaves for paclitaxel production resulted in a significant increase in the rate of harvest leading to population declines in China, India and Nepal, and potentially elsewhere in the species' range. Cultivation has been promoted in each of these countries, but as yet does not appear to be making a major contribution to *T. wallichiana* supplies. International trade in *T. wallichiana* and other Asian *Taxus* species involves a combination of leaves, bark and extracts in various stages of processing. Much of the preliminary processing appears to take place within the three range States named above, while the final pharmaceutical products are more likely to be produced and con-

Further information is required to determine how CITES authorities within those countries that allow export of raw materials or extracts maintain chain of custody controls in order to discriminate between CITES and non-CITES species. Further information is also required with regard to the making of non-detriment findings when trade involves wild-harvested specimens. Unlike cultivation, it seems that relatively little emphasis has been placed thus far on making such findings, or on developing sustainable harvest rotations for bark and leaves of *T. wallichiana* or other Asian *Taxus* species. Increased emphasis on sustainable harvest methods in Asian range States could serve multiple purposes, including securing income for rural (and potentially landless) producers and increasing the sustainability of *Taxus* harvests for other purposes, e.g. fodder and local production of traditional medicines and teas. Given the slow growth of the species, it seems unlikely that a similar approach would be successful with regard to timber harvests. However it might be that the promise of long-term cash income from needles and bark could outweigh the short-term benefits to be gained from use and sales of timber.

Possible next steps

Range States for Asian *Taxus* species might consider

- increasing domestic chain of custody controls for *Taxus* parts, derivatives and products; and
- investing in sustainable forest management and associated forest tenure approaches for *Taxus* species, and cross-sharing of lessons learned at the local, national and regional levels.

Range, consumer and intermediary processing States for Asian *Taxus* species might consider

- Developing and distributing improved identification materials for Asian *Taxus* parts and derivatives likely to be in trade;
- Developing a standardized CITES labelling system for chemical derivatives and extracts;
- Developing of a notification system to report the issuance and/or acceptance of CITES export permits for raw as well as processed materials; and
- Greater sharing of information regarding national harvest and trade controls, including the making of CITES non-detriment findings.

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ANNEX 1. LIST OF ISO COUNTRY CODES AND COUNTRY NAMES

GY
HT
HM
VA
HN
HK
HU
IS
IN
ID
IR
IQ
IE
IM
IL
IT
JM
JP
JE
JO
KZ
KE
KI
KP
KR
KW
KG
LA
LV
LB

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ANNEX 3. GUIDE TO INFORMATION WITHIN TABLES ON CITES-REPORTED TRADE

Data on international trade reported by CITES Parties (CITES annual report data) were obtained from the UNEP-World Conservation Monitoring Centre, which maintains this information on behalf of the CITES Secretariat. These are presented in the form of “comparative tabulations”, which allow comparison of trade reported by exporting/re-exporting Parties with that reported by importing Parties. When considering these data it is important to bear in mi

P Personal
Q Circuses and travelling exhibitions
S Scientific
T Commercial Trade
Z Zoos

The reported **source** of the transaction relates to the original source of the species being traded and again is shown by a one-letter code:

A Plants that are artificially propagated in accordance