

***Swertia* L. (Gentianaceae) in Nepal Himalaya: Checklist, Phylogeography, Ethnobotany and Conservation Status**

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Abstract

Swertia L., a morphologically diverse but taxonomically distinct genus's circumscription has often been debated. Four problems still need to be solved: species delimitation, section delimitation, and relation with allied genera and domestication of the species for economic benefits. In the present paper an attempt has been made to prepare a checklist of *Swertia* species, and documentation of distribution patterns, existing ethnobotanical uses and conservation practices in Nepal. Some integrated measures, which might help to fill up the gaps in our knowledge, are also recommended.

Key words: *Swertia*, taxonomy, phylogeography, conservation, ethnobotany, Nepal Himalaya.

Introduction

Swertia L (Gentianaceae – Gentianeae – Swertiinae) is a morphologically diverse but taxonomically distinct genus. The taxa in its present circumscription comprises ca 150 species and is annual, biennial or perennial herb ranging from 2-4 cm. to over 1.5 m in height with 4-5 merous flowers, 1 or 2 nectaries at the base of characteristically rotate corolla lobes. The genus mostly occurs in alpine or temperate habitats in Asia, Africa and N. America. The circumscription of the genus has often been debated, resulting disagreement amongst taxonomists due to the morphological similarities (nectariferous and rotate corolla lobes) among the species of *Swertia* and the related genera.

Nepal, a central segment of Himalayan mountain systems, is rich in species diversity due to its transitional location between the Paleoartic and Indo-Malayan realms, and a great variety of physiographical characteristics and abundant diverse ecosystems within a short span of space. The meadow, open forest and scrub ecosystems of the mountainous regions of Eastern, Central and Western regions of the country are the suitable habitats of *Swertia* species (Joshi, 2007). Information on taxonomy, distribution, ethnobotany and conservation of the *Swertia* species are very limited (Bhattarai, 1992; Joshi, 1988, Joshi, 2000, 2004; Joshi and Joshi, 2005; Manandhar, 2002; Sacherer, 1979; Shrestha *et al.*, 1998). Although several authors have tried to enumerate the species and varieties, systematic classification of *Swertia* has still been a problematic. Four problems still need to be solved: species delimitation, section delimitation, and relation with allied genera and domestication of the species for economic benefits. In the present paper an attempt has been made to prepare a checklist of *Swertia*

species, documentation of distribution patterns, ethnobotanical uses and conservation practices and to recommend some measures which might help to fill up the gaps in our knowledge.

Materials and Methods

The plant materials were collected from the diverse habitats of various villages and adjoining areas of Rasuwa, Sindhupalchok, Dolakha, Makwanpur, Kathmandu, and Lalitpur Districts and identified with the help of local floras. Information relating to the distribution, ethnobotany and trade and conservation practices including people perception were gathered using various techniques such as interviews, discussion with local people, traders and direct observation on the way the useful plants and their parts were being collected and used (Joshi and Edington, 1990). For preparation of checklist, specimens have been checked with the herbarium specimens of the National Herbarium, and Plant Laboratories, Godavari (KATH), and Central Department of Botany, Tribhuvan University (TUCH), Nepal and Harvard University Herbaria, USA. Voucher specimens are housed in the Biodiversity Research Center, EMA Group, Nepal and in Harvard University Herbaria, Cambridge, MA, USA.

Taxonomy: Checklist of *Swertia* species

Although Nepal remained almost completely closed to foreigners until 1949, the flora of the country was no means entirely unknown. Many earlier workers have collected and described the plants from the different parts of the country. After 1960, major botanical expeditions, particularly from British Museum, England and Kyoto and Tokyo Universities of Japan have explored the country. The major contributions relating to the species of *Swertia* found in Nepal was made by national, regional and international botanists and institutions. Among the contributions on documentation of the taxa, the significant collections and studies of the species of *Swertia* date back to Smith (1970), who had described three new species : *Swertia acaulis*, collected on open slopes, foot of Wabak khola, east of Num, Arun valley, 4600m; *S. gracilescens*, collected on grass slopes, Kali gandaki valley, Taglung, south of Tukucha, 3700m; and *S. staintonii*, collected on open slopes, Arun valley, Chhoyang Khola, west of Num, 3800m. In 1976, 21 species of *Swertia* found in Nepal: *S. acaulis*, *S. alata*, *S. angustifolia*, *S. bimaculata*, *S. chirayita*, *S. cordata*, *S. cuneata*, *S. dilatata*, *S. gracilescens*, *S. hispidicalyx*, *S. hookeri*, *S. kingii*, *S. multicaulis*, *S. nervosa*, *S. paniculata*, *S. pedicellata*, *S. petiolata*, *S. purpurascens*, *S. racemosa*, *S. speciosa*, and *S. tetragona* have documented in *Catalogue of Nepalese Vascular Plants* (Malla *et al*, 1976a). Similarly, Hara *et al.* (1982) in *Enumeration of Flowering Plants of Nepal Vol. III* enumerated 27 species of *Swertia* along with bibliographic citation and synonyms. In 1984, Polunin and Stainton described 8 species of *Swertia* occurring in Nepal: *S. angustifolia*, *S. alternifolia*, *S. cuneata*, *S. hookeri*, *S. multicaulis*, *S. petiolata*, *S. racemosa*, *S. speciosa* in their book *Flowers of the Himalaya*. Ohba and Akiyama (1992) have reported 7 species of *Swertia*: *S. acaulis*, *S. cuneata*, *S. dilatata*, *S. hookeri*, *S. macrosperma*, *S. multicaulis*, and *S. pseudo-hookeri*. from the alpine areas of the Jaljale Himal, Eastern Nepal. In 2000, *Annotated Checklist of the Flowering Plants of Nepal* was published that includes 28 species and 4 varieties of *Swertia* (Press *et al*, 2000). *Swertia gracilescens* which was earlier reported as new species by Smith 1970, is removed and has been assigned as the synonymes of *Swertia paniculata*. The *Flowering Plants of Nepal* (Phanerogams), (edited by Bista, Adhikari and Rajbhandari, 2001) enumerated 29 species with 3 varieties of *Swertia*. In this categorization, both *S. gracilescens* and *S. paniculata* have kept as distinct species and *S. dilatate* without varieties. Shah (1990, 1992) and Chassot (2003) has reported new species: *Swertia nepalensis* and *S. barunensis* from Nepal respectively. Recently, *S. wardii* has documented from the foothills of the Kangchenjunga mountain, eastern Nepal (WWF, 2008).

The circumscription of *Swertia* has been subject to major change ever since its establishment. The identification and systematic arrangement of species have carried out based on only morphological characteristics. These

works show controversy in species and varieties boundaries. Some species are excluded in the respective groups and some are placed as synonymes and some new species added to the family.

During the present study, a checklist was prepared studying our own collected specimens and checking and reviewing the herbarium specimens stored in universities and research institutions and consulting various relevant documents and papers. Table 1 presents the 31 species of *Swertia* with varieties and their distribution in Nepal.

Table 1. Species of *Swertia* and their Distribution in Nepal.

| Botanical names (* Endemic species) | Nepali Name | Distribution (Altitude & Region) C= Central Region W=Western Region E = Eastern Region |
|--|--|---|
| * <i>Swertia acaulis</i> H. Sm. | | 3700-5500m., C & E |
| <i>Swertia alata</i> (Royle ex D. Don) C.B. Clarke | Chiraito | 2000-3600m., W & C |
| <i>Swertia alternifolia</i> Royle | | 3000-4000m., C |
| <i>Swertia Swertia angustifolia</i> Buch.-Ham ex D. Don D. don D. Don <i>S. angustifolia</i> var <i>angustifolia</i> <i>S. angustifolia</i> var <i>pulchella</i> (D. Don.) Burkill <i>S. angustifolia</i> var <i>wallichiana</i> Burkill. | Chiraito, Bhale chiraito, Gotha Tite. | 600-2600m., W,C.&E. 2000m, W,C &E. 600m, C & E |
| <i>Swertia barunensis</i> P. Chassot | | 4200m, E. |
| <i>Swertia bimaculata</i> (Sieb. & Zucc) C. B. Clarke | Chiraito, Tite | 900-2700m., E. |
| <i>Swertia candelabrum</i> H. Sm. | | 4800m.,C. |
| <i>Swertia chirayita</i> (Roxb. ex Fleming) H. Karstrn | Chiraito, Tite, Pothi chiraito. | 1500-2500m., C & E. |
| <i>Swertia ciliate</i> (D. Don ex G. Don) B. L. Burtt = <i>S. purpurascens</i> Clarke | Chiraito, Kalo Chiraito | 2800-4000m., W, C, & E |
| <i>Swertia cordata</i> (G. Don) C.B. Clarke | | 2000-3000m., W,C & E. |
| <i>Swertia cuneata</i> D. Don | Pyajji Chiraito | 3900-5000m., W,C, &E. |
| <i>Swertia dilatata</i> C. B. Clarke <i>S. dilatata</i> var <i>dilatata</i> <i>S. dilatata</i> var <i>pilosa</i> C.B. Clarke | Chiraito, Sirlinge | 1800-4000m, E. 2000-3000m, C. |
| <i>Swertia hispidicalyx</i> Burkill | | 4000-4200m, C. |
| <i>Swertia hookeri</i> C.B. Clarke | | 3800-4300m., E. |
| <i>Swertia kingii</i> Hook. f. | Chiraito | 3100-4500m., C & E. |
| <i>Swertia lurida</i> (D. Don. ex G. Don) C.B. Clarke | | 2500m., W & C. |
| <i>Swertia macrosperma</i> (C.B. Clarke) C.B. Clarke | | 2000-3200m., C & E. |
| <i>Swertia multicaulis</i> D. Don | Chiraito, Sermaguru | 4000-4900m, C & E. |
| <i>Swertia nepalensis</i> J. Shah | | 3850 m, C. |
| <i>Swertia nervosa</i> (G. Don) C. B. Clarke | Chiraito, Tite, Kalo Choraito, Aullo ghans | 700-3000m., W,C, & E . |

| | | |
|---|----------------|------------------------|
| <i>Swertia paniculata</i> Wall. = <i>Swertia gracilescens</i> H. Sm = <i>S. griffithii</i> Clarke | Chiraito, Tite | 1500-4000m., W, C & E. |
| <i>Swertia pedicellata</i> Banerji | Chiraito | E. |
| <i>Swertia petiolata</i> D. Don | | 5600m., W. |
| <i>Swertia pseudo-hookeri</i> H. Smith | | 3420-4030m., E. |
| <i>Swertia racemosa</i> (Griseb.) C.B. Clarke | Chiraito | 3000-5000m., W,C, & E. |
| <i>Swertia ramosa</i> W.W. Sm. | | 4100m., E. |
| <i>Swertia speciosa</i> D. Don = <i>S. perfoliata</i> G. Don. | Chiraito | 1400-3000m., W,C, & E. |
| <i>Swertia staintonii</i> H. Sm. | | 3800-4400m., E. |
| <i>Swertia teres</i> (G. Don) J. Shah | | 3000-5000m., W,C, & E. |
| <i>Swertia tetragona</i> Edgew. | | 2400-3300m., W. |
| <i>Swertia wardii</i> C. Marquand | | E. |

Swertia shows wide range of morphological variation within and among the population resulting a considerable uncertainty about the delimitation of species. Among the collected plant specimens from different areas., *S. racemosa* shows a pronounced variation in the presence of cilia on margin of leaf, sepals, and bracts as well as on veins. Similarly wide ranges of variation in morphological traits among the population of *S. chirayita* and *S. nervosa* were also reported by Raskoti and Sakya (2004) and Pant and Bimb (2005) respectively.

Biogeography of *Swertia* species

Nepal's diverse geomorphology over a wide range of latitude, longitude, and elevation has provided an abundance of habitats and ecological niches, which help to explain spectacular diversity of plant species growing in the region (Bajracharya, 1996). Among the phytogeographical features, the Himalaya and adjacent ranges are not only regarded as a 'meeting places' of different floristic elements entering from different directions (Banerji, 1963), but also gave rise to many new and endemic species, especially in the alpine zone, i.e. *Androsace nortonii*, *Primula wollastonii*, *Swertia acaulis*. Thus Nepalese flora is not only represented by a mix of the southern slopes of Himalayas, but also a mix of high and dry plateau flora of Tibet (China) with that of the humid monsoon region of Indian sub-continental plains floras (Kanai, 1966; Yoshida, 2006a & b).

Swertia species are widely distributed in tropical to alpine habitats of the Eastern, Central and Western regions. Out of 75 districts of the country, *Swertia* species have documented from 54 districts so far (Fig.1). Such wide distribution of the species of *Swertia* and other plant communities could also be highlighted with the help of recent evidence of the geological past of the Asian region and migration of species from the neighboring continents. However, as there are no fossil records relating to the *Swertia* and other species of Gentiniaceae in Nepal, it is not possible to discuss the phylogeny and biogeographical distribution from the palenological point of view. But formation of Tibetan Plateau and upliftment of Himalyas and other mountain ranges (Karakoram, Kunlun Shan, Tian Shan, Hengduan mountains) due to collide of Deccan plate with the southern Laurasia coastline at about 45 million years BP in Eocene times and geobotanical development of the Himalaya might have changed climatic patterns and encounter some important changes with the dispersal and distribution of plants. At present, it is difficult to interpreate these issues due to lack of data as well as generic relation of inter and intraspecies relationships are not yet well enough resolved. Priority should be given to integrated study of the taxa and its eco-distribution for a conclusive biogeographic interpretation.

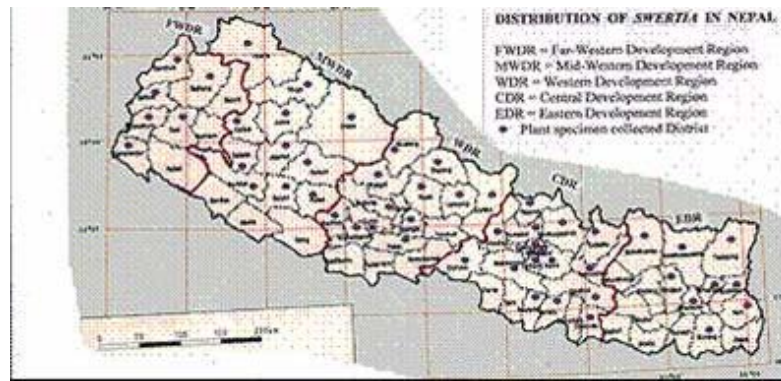


Fig. 1 Horizontal distribution of *Swertia*.

Ethnobotanical value of *Swertia*

The rural people of Nepal rely heavily on plant resources for their primary healthcare and treatment of diseases. The people have developed unique indigenous knowledge related to the uses of plant resources due to constant association with the forests. The traditional knowledge related to the therapeutic uses of plants may be utilized for the improvement of the economic status of the local communities. However, less priority has given to document these valuable practices and plant resources. The works relating to the ethnobotanical investigation and sustainable management of the resources including *Swertia* species are very sporadic (Baral and Kurmi 2005; Bhattarai, 1992, Bhattarai *et al*, 2007; Jha *et al*, 2001; Joshi, 1988; Joshi and Edington, 1990, Lama *et al*, 2001; Manandhar, 2002; Siwakoti and Siwakoti, 2003, Shrestha, 1991). Recently, Joshi (2008) has documented the medicinal uses of some species of *Swertia* (Table 2). Besides this, some works on the ethnomedicinal uses of *S. alata*, *S. bimaculata*; *S. cuneata*; *S. kingii*, *S. tetragona* have also carried out (Ghimire, 2001; Manandhar, 2002; Sacherer, 1979; Subedi, 2006). Among the species, *S. chirayita* is the important for its medicinal properties. Herbal medicines such as Diabecon, Melicon V-ointment, Ayush-64 and Mensturyl syrup contain chirata (*Swertia*) extract in different amount for its antipyretic, hypoglycemic, antifungal and antibacterial properties (Joshi and Dhawan, 2005).

Table 2. Ethnomedicinal uses of some species of *Swertia*

| Botanical name | Nepali name | Uses |
|---|--|--|
| <i>Swertia angustifolia</i> Buch.-Ham ex D. Don | Chiraito, Bhale chiraito, Gotha Tite. | Plant is crushed and boiled in water and two teaspoonful decoction is given to treat malaria fever 2-3 times a day; root juice is taken to give relief from cold and cough |
| <i>Swertia chirayita</i> (Roxb. ex Fleming) H. Karstrn | Chiraito, Tite, Pothi chiraito. | The plants are dipped in water overnight and the bitter juice is taken the next morning to cure malarial fever; decoction of the plant is used as tonic that influence on the digestive organs and also used as anathelmatic, especially for children; Juice of the root is taken to cure liver diseases; paste of the plant is also used in common ailments like cough, cold, asthma, headache and fever; roots crushed and paste rubbed over joints for quick relief; leaves warmed and paste prepared with mustard oil applied over boils and |

| | | |
|--|--|--|
| | | scabies. |
| <i>Swertia ciliata</i> (D. Don ex G. Don) B.L. Burt | Chiraito, Kalo Chiraito | Decoction of plant is given three times a day for 5-7 days to control cough, cold and fever. Plant is also used as a substitute for <i>S. chirayita</i> . |
| <i>Swertia delatata</i> C.B. Clarke | Chiraito, Sirlinge | Paste is applied locally to get relief from joint pains; extract is used to treat scabies; juice of plant is taken orally twice a day before meal to treat fever and headache |
| <i>Swertia multicaulis</i> D. Don | Chiraito, Sarma guru (Sarmagu) | Plant ground and paste applied over wounds for healing; two to three teaspoonful of decoction of plant is given twice a day to cure fever, cough and cold; decoction of plant is also given for 2-3 days as anthelmintic. |
| <i>Swertia nervosa</i> (Will. Ex G. Don) C.B. Clarke | Chiraito, Tite, Kalo Choraito, Aullo ghans | Decoction of root is applied in skin diseases; plant is crushed and boiled in water and two teaspoonful decoction is given twice a day in empty stomach to treat malaria fever; extract of the plant is also given in the morning to cure 'Gano' (Gasball) and stomach problem |
| <i>Swertia paniculata</i> Wall. | Chiraito, Tite | Decoction of the plant is used as tonic; plant is also used as substitute for <i>S. chirayita</i> in the treatment of malarial and other fever. |
| <i>Swertia pedicellata</i> Banerji | Chiraito | Plant paste is applied externally on forehead to get relief from headache. |
| <i>Swertia racemosa</i> (Wall. ex Griseb.) C.B. Clarke | Chiraito | Plant is tonic; two teaspoonful of decoction of plant is given twice a day to treat fever and cough; paste of the plant is applied locally to treat eczema and pimples; juice of aerial part is taken orally twice a day before meals to treat jaundice. |

Source: Joshi (2008)

Conservation Status

The rural people collect the 'Chiraito' (*Swertia*) or their products directly from the wild populations of the forest, meadow, scrub or shady habitats which are already dwindling due to over-exploitation and unsustainable land-use, thus accelerating their genetic erosion. Unsustainable collection of the species has been done due to their usefulness to cure various ailments, their increasing price, and increasing demand as raw materials for preparation of Ayurvedic and Allopathic medicines. Every year a huge amount of medicinal plants are collected for export. The income from the chiraito was used by collectors for foodstuffs, including salt, clothes, to pay off loans and to buy cattle (Daniggelis, 1999).

The plants are collected before the maturation of seeds. The whole plant is pulled out, sun-dried for a few days, wrapped by bamboo slip and sold to the local traders as dried brownish stems with root and

leaves intact. Unsustainable harvesting without considering the age of the plant and seed maturity reduces regeneration significantly. Extensive collection and unscientific harvesting practices of these plants from the natural habitat leads to an increasing danger of extinction (Bhattarai and Shrestha, 1996; Edwards, 1993; Joshi, 2008). The present rate of exploitation has rendered some species to the status of threatened and endangered species (Joshi and Joshi, 2005; Joshi, Joshi and Joshi, 2000; Joshi, Shrestha and Joshi, 2003; Joshi and Joshi 1991).

Swertia species occupies one of the major portions in the trade of medicinal and aromatic plants from Nepal. About Nine species (*S. chirayita*, *S. angustifolia*, *S. ciliata*, *S. dilatata*, *S. multicaulis*, *S. racemosa*, *S. tetragona*, *S. alata*, *S. nervosa*) have been reported under trade in different trading centers of Nepal (Barakoti, 2002) with common name “chiraito” except for *Swertia multicaulis* (sarmaguru). Among these species, *Swertia chirayita* plays dominant role in trade and is considered superior in quality. Adulteration of chiraito with other low quality species of *Swertia* and other related species are very common in the trade of chiraito.

During the field survey, serious threats to the population of *Swertia* were noticed due to habitat destruction and land use change. Even without tree-removal, extensive grazing of domestic animals in the forests can be damaging to the species. When questioned about the changing status of *Swertia*, our respondents (villagers and traders) informed that the abundance and production of *Swertia* is decreasing every year in the central and eastern parts of the country. Therefore, appropriate conservation measures for these species are urgently needed.

Conservation Efforts and Achievements

During the last few years, some initiatives have been taken for the conservation of plant resources in Nepal. The National Periodic Plans, National Conservation Strategy for Nepal, Master Plan for the Forestry Sector, Nepal Environment Policy and Action Plan (NEPAP), and Agricultural Perspective Plan have given top priority for ecological balance, conservation of habitats and sustainable use of biological resources. Sustainable Development Agenda and Nepal Biodiversity Strategy have also clearly identified the need for conservation, important areas for actions and strategies for conservation of bioresources.

Government of Nepal has introduced a legal basis for conservation of biodiversity and habitats i.e. Wildlife Protection Act 1958, Forest Act 1961, the Forest Protection (Special Arrangement) Act 1967, Plant Protection Act, 1972, National Parks and Wildlife Conservation Act, 1973 and Environment Protection Act 1997. Some species have also been proposed for legal status under the Forest Regulation 1995 (amended in 2001). A clear shift in legislative provisions was initiated in the protected areas and community forests for species conservation and made special provisions to facilitate public participation in the conservation and sustainable utilization of bioresources. However, the issues of property right, fair and equitable sharing of benefit has yet to materialize by defining these terminologies.

Nepal has also ratified the International Conventions and agreements relevant to species conservation and habitat management i.e. Plant protection Agreement for the South East Asia and Pacific Region, 1956; Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention) 1971; Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973; Convention on Biological Diversity (CBD) 1992. As an obligation of contracting party of Biodiversity Convention, Nepal has formulated a Nepal Biodiversity Strategy and Non-wood Forest Products Policy. Within the constraints of resources and technical know-how, Nepal has been involved in various projects such as survey and documentation of species, ethenobotany and indigenous knowledge, cultivation and conservation of useful species, and researches on

molecular structure and make-up and chemical components (Barakoti, 2002; Bimb and Pant, 2006; Chassot *et al.* 2001; NAST, 2007; Joshi, 2007, 2008; Joshi and Li, 2008; Shrestha, 1991, Shrestha *et al.*, 1998). Molecular studies of some species of *Swertia* are also under investigation (Joshi, 2007).

Strategy for Sustainable Management

Despite the implementation of various activities for the conservation of the species and their habitats, there is a growing consensus among the conservationists that the conservation of bio-resources is entering into a stage of crisis, since there has been hardly any attempt to conserve these resources in an integrated manner (Joshi and Joshi, 2005). Therefore, the following strategies have been recommended for sustainable management of plant resources in an environmentally sound way.

1. *Formulation of Policy, Action Plan and Programmes:* Though some initiatives have already taken for conservation and sustainable utilization of the useful species, less priority is given to conserve these resources in an integrated manner. The existing policy related to conservation and sustainable management of useful plants is also fragmented in different sectoral policies. Therefore, priority should be given to formulate integrated national, regional and local policy, action plan and program related to the conservation and sustainable uses of the economic and useful plants, especially *Swertia* species, taking into consideration of the characteristics of ecosystems, productivity of the species, needs of the people and sustainable management of species.

2. *Inventory and Documentation of the Species with Indigenous Uses, knowledge and Practices:* Although investigation on species has been conducted in different parts of the country, there is a paucity of quantitative and systematic data on species diversity, phylogeny and biogeographical distribution, chemical constituents of the species and characteristics of habitats. Many biogeographical areas of the country have still remained unexplored. Therefore, it is strongly recommended that major thrust should be given to an intensive inventory and documentation of useful species with their potentiality for utilization and existing indigenous knowledge and practices relating to the uses of the species.

3. *Domestication, Income generation and Conservation of useful species:* Despite the increasing demand for herbal industry, the plant is still collected from the wild, it is sparsely cultivated and negligible efforts have done for development of proper agro-techniques of the domestication. The people of the studied villages have comprehensive knowledge about plants and their potential uses. Therefore, emphasis should be given to implement some pilot programmes for domestication and cultivation of *Swertia* species. This will help in providing additional income and benefits to local people contributing to poverty alleviation and sustainable development of the country

For conservation of the species, top priority should be given to *in-situ* conservation. Such steps will not only contribute to protect the habitats but also help to maintain the ecological processes. Emphasis should also be given to conserve species in *ex-situ* conservation. The novel technique of in-vitro conservation and micropropagation can help in conservation and production of a large number of disease-free, true-to-type plants (Wawrosch *et al.* 1999). However, there exists a need to translate these in-vitro studies to the field for practical applications.

4. *Involvement of People in integrated management of species and habitats:* It is also obvious that the success and sustainability of the conservation activities depend upon the involvement of the local people. Emphasis should be given to initiate a special program for raising people's awareness about domestication, conservation and sustainable management of species. In this program people should also be involved from the planning

phases of the activities.

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