

# ORCHID DIVERSITY OF NORTHEAST INDIA – TRADITIONAL KNOWLEDGE AND STRATEGIC PLAN FOR CONSERVATION

A S Ninawe and T S Swapna<sup>1</sup>

Department of Biotechnology, Block-2, CGO Complex, Lodhi Road, New Delhi- 110 003, India

<sup>1</sup>Department of Botany, University of Kerala, Thiruvananthapuram- 695 581, Kerala, India

## Abstract

Orchids, belonging to the family Orchidaceae exhibit an incredible range of diversity in size, shape and colour of their flowers. They occupy top position amongst all the flowering plants and are valued for cut flower production and as potted plants. They are known for their long lasting and bewitchingly beautiful flowers, which fetch a high price in the international market. Taxonomically, they represent the most highly evolved family amongst monocotyledons with more than 800 genera and 25,000-35,000 species in the world and the present figure of the hybrids among these touches around 100,000. Since the early 1970's, different groups in various Universities and Research Institutions have been working on ethnobotany and traditional knowledge in orchids and published many reports. Most of the literature pertains to ethnobotany or agricultural operations including shifting of cultivation and festivals of NorthEastern region of India where orchids flower throughout the year. The present paper reports the detailed information on ethnobotanical and traditional knowledge system undertaken by various workers from the NorthEastern region with rich plant resources and the vast wealth available with the various tribes in the region. Status of important orchids and their economic value are also mentioned here along with suggestions required for harnessing the rich bio-resources and translating the same into economic products.

## Introduction

ORCHIDS ARE known to the mankind since Vedic period. In the Rig-Veda and the Atharva-Veda, ancient knowledge texts originated in ancient Indian subcontinent (1500 - 800 B.C.), two orchids (*Rasna-Vanda tessellata*; Sanjeevani- *Flickingeria macraei*) were mentioned as medicinally important. Subsequently, *Sushruta Samhita* and *Charaka Samhita* listed about a dozen orchid plants used in Ayurveda medicine. The word *Orchis* was used for the first time by Theophrastus, pupil of Plato and Aristotle in the Greek manuscript *An Enquiry into Plants* between 370-285 BC. Subsequently, Dioscorides, pupil of Theophrastus, during 1<sup>st</sup> Century, in *Herbals of Middle Ages*, highlighted the sexual powers of the bulbs of orchid plant in accordance with the doctrine of signatures (Rao, 2003). The name orchid is derived from the word *Orchis*- the first discovered orchid plant. The Greek word *Orchis* literally means *testicles* simulating the morphology of underground tubers of the orchid plant. Besides medicinal value, orchids have cultural and religious importance in various parts of the world (Rao, 2003). In India, the fox-tail orchid *Rhynchostylis retusa* which is popularly known as *Kopohphool* in Assam has a great cultural significance. The sweet fragrant and beautiful rose-purple colored inflorescence of this orchid is adorned by the lady dancers during Bihu festival as a tradition. Similarly, the bright golden flowered inflorescence of *Dendrobium hookerianum*

is regarded as pious and used by Bhuddists in decoration of Gompas (Pagodas) to worship Lord Buddha.

Orchids form 9% of our flora and Orchidaceae is one of the largest families amongst higher plants in India. There are about 25,000 species of orchids estimated to occur in the world. In India, about 1,350 species are found; out of about 900 species (nearly 69 %) are reported from North East India (NE). About 150 species are endemic to North East India (De and Singh, 2015). As far as species distribution is concerned in North East India state-wise, Arunachal Pradesh has the maximum number of orchids *i.e.* 577 species of 147 genera followed by Sikkim with 561 species in 144 genera, Meghalaya with 380 species in 113 genera, Nagaland with 387 species in 107 genera, Manipur with 314 species in 93 genera, Mizoram with 253 species in 86 genera, Assam with 231 species in 82 genera and Tripura has least number of orchids *i.e.* 39 species of 29 genera. The distribution of orchid species in different regions of India particularly in NorthWestern Himalayas is approximately 800 species, in NorthEastern, India 900 species and in Western Ghats, 300 species (Kataki *et al.*, 1984).

NorthEastern India due to its peculiar gradient and varied climatic conditions contains largest group of temperate and sub-tropical orchids. The diversity is so large that there are terrestrial, epiphytic and also saprophytic orchids. In general, terrestrial orchids are more common in NorthWestern India, epiphytic orchids

in NorthEastern India and small flowered orchids in Western Ghats. The largest terrestrial genus is *Habenaria* (nearly 100 spp.) and the largest epiphytic genus is *Dendrobium* (nearly 70 spp.). Most of the *Paphiopedilum* (lady's slipper) species are restricted to NorthEastern Himalayas except for *P. druryi*. *P. druryi* in Kerala was thought to be extinct in its natural habitat but, rediscovered, multiplied and now reallocated in Western Ghats. Mao *et al.* (2009) reviewed the plant wealth of North-East India mentioning diverse physiography with mountains, plateaus and plains as well as ethnobotanical characterization of the region. Both Himalaya as well as Indo-Burma biodiversity hotspots has unique bio-geographic regions comprising of major recognized biomes in the world. It holds about 50% of Indian biodiversity and is the richest reservoir of plant diversity. In about 132 wild genera, nearly 287 species are endemic distributed over 71 genera (Hegde, 1997). Earlier an attempt was also made on the assessment of orchid diversity in orchids of Himachal Pradesh (Barman *et al.*, 2016; Kumar *et al.*, 2016). Hegde *et al.* (2016) also highlighted the commercial potential of Indian orchids. The physiological adaptive condition of the family constrains their existence and spreading giving thereby an evidence for high endemism in orchids.

### Documentation and Sustainable Utilization of Orchids in NorthEastern Region

Though studies on rich orchid bio-resources of NorthEastern region have been made by various workers but economic benefit for the people in terms of income generation and medicinal value has not so far been adequately recorded. Systematic investigation to authenticate and develop novel drugs from the rich orchid bio-resources is required as the environmental and ecological scenario of the region is changing rapidly (Mao *et al.*, 2009). A survey was carried out for orchid diversity in NorthEastern states of India with special reference to its medicinal and ornamental value in the forests of Manipur, and 26 new species of orchids were recorded. *In situ* and *ex situ* conservation for sustainable use of indigenous species without exploiting the plants from natural conditions was suggested for developing orchid industry. There is a need for development of orchid based cottage industry by transfer of technology in nurseries and post-harvest handling of commercial orchids to the local farmers/entrepreneurs. Though research work on establishing *ex situ* and *in situ* conservation areas of RET species of orchids and standardizing hybridization protocols, tissue culture protocols for few species and DNA bar-coding is in

progress, orchid species are rapidly depleting due to various anthropogenic activities and rapid urbanization. Also, due to lack of knowledge on sustainable harvesting practices, plant collectors over exploited many important medicinal plants without knowing the future consequences. The region also has a unique problem of enforcing conservation law. The distinct tribes in the region have rich indigenous traditional knowledge system on the uses of biodiversity components for their daily sustenance like food, fodder, shelter and also for healthcare. The type and quantity of utilization of local plants depends on the ethnic group they belong to and also their remoteness from the modern world. The valuable ethno-botanical information along with the rich bio-resources of the region needs to be conserved and taken up for sustainable utilisation involving the active participation of various ethnic tribes. They should be trained in good harvest practices and post harvest technology as well as its translation into useful products. The concerned authorities and parties need to build local people's confidence coupled with sensitizing the people about the virtues of conservation and invite them to involve in the preparation of Biodiversity Registers as a joint venture (Mao *et al.*, 2009). People should be encouraged to take up entrepreneurships or business ventures sustainably utilizing the rich bio-resources and indigenous system of knowledge with value addition to it through scientific and technological inputs from the various neighbouring research institutions in the country. Therefore, the need of the hour for the region is to utilize the rich bio-resources along with the rich indigenous wealth for the benefit of the people in the region and our country in a sustainable way.

### Traditional Knowledge

Orchids were known for their medicinal value in older days, but in recent years they are in great demand in national and international market due to their ornamental value. The long lasting quality of cut-flowers together with multi colors and curious shapes prompt the orchids to occupy one the top 5 places in the international cut-flower trade market. Demand is raising orchids in the market especially for hybrid orchids which are developed by cross breeding among the natural species. Small countries like Thailand and Singapore are earning multi million dollars of income every year by exporting tropical orchid cut-flowers and plants.

Along with wild edible vegetables and fruits, nutritional values of these plants are needed to be investigated. Ethno-botanical reports were mainly on ethno-medicinal plants with a very few publications on food and beverages. Many of the known medicinal uses of plants

have not been studied empirically in detail for the active chemical compounds. Among the orchid species of NorthEastern India, four orchids *i.e.* Jeevak (*Malaxis muscifera*), Rishabhak (*Malaxis acuminata*), Riddhi (*Habenaria intermedia* and *Eulophia nuda*) and Vriddhi (*Habenaria edgeworthii*) are used in 'Astavarga' group of drugs in Ayurvedic system of medicine. Some of other orchid species being used in various Ayurveda medicines are Jeevanti (*Flickingeria macraei*), Rasna (*Vanda tessellata*), Munjatak (*Orchis latifolia*), Amarkand (*Eulophia nuda*) etc. *Dendrobium* species *i.e.*, *D. aduncum*, *D. densiflorum*, *D. jenkinsii*, *D. nobile*,

used in preparation of Chinese tonic 'Shi Hu' which has aphrodisiac properties (Yi *et al.*, 2005). It is reported that the local traditional medicinal practitioners of different tribes in NorthEastern Indian states use wild orchid species to treat various diseases. However, the traditional knowledge of orchids for medicinal use has not been well documented for the benefit of researchers. Various plant parts like leaves, roots, stem, bulbs are used for curing ailments in traditional medicine. Some of the plant parts and orchids commonly used for treatment of various ailments are listed in Tables 1-5.

Table 1. Medicinal uses of orchid roots in NorthEastern India.

Species	Habit	Medicinal uses
<i>Acampe praemorsa</i> (Roxb.) Blatt. & McCann	Epiphytic shrub	Roots are used for treating rheumatism, sciatica and neuralgias well as for controlling asthma, bronchitis and eye diseases. Also used as tonic, curing syphilis and uterine diseases. Root paste is used to treat scorpion and snake bites by external application (Chowdhery, 1998; Nongdam, 2014; Yonzon <i>et al.</i> , 2012b)
<i>Aerides odorata</i> Lour.	Epiphyte	Root paste is used for curing joint pain and swelling (Hossain, 2011)
<i>Arundina graminifolia</i> (D.Don) Hochr.	Terrestrial	The root decoction is used for controlling diabetes, tumor, hyperliposis and hepatitis (Kumar, 2002)
<i>Brachycorythis obcordata</i> (Buch.-Ham. ex D.Don) Summerh.	Terrestrial herb	Dried and powdered root can be consumed as tonic after mixing with milk (Balami, 2004)
<i>Calanthe plantaginea</i> Lindl.	Terrestrial	Powdered root with milk is consumed as tonic and aphrodisiac (Subedi, 2011)
<i>C. triplicata</i> (Willem.) Ames	Terrestrial	Roots are chewed for diarrhea and tooth cavities with other ingredients. Roots are also used to treat swollen hands, with other ingredients (Jalal <i>et al.</i> , 2010)
<i>Cephalanthera longifolia</i> (L.) Fritsch.	Terrestrial herb	Roots and rhizome are used as a tonic to promote lactation in cattle (Haq, 2012)
<i>Cremastra appendiculata</i> (D.Don) Makino	Terrestrial herb	Roots used for toothache as paste and as emollient. Tuber used for abscesses, scrofula, freckles and as an antidote to snake bite. Tuber is also useful for treatment of cancer (Xue <i>et al.</i> , 2006)
<i>Crepidium acuminatum</i> (D. Don) Szlach	Epiphyte	Root powder is used for burns (Subedi, 2011)
<i>Cymbidium aloifolium</i> (L.) Sw.	Epiphyte	Root paste is used to cure tumors and nervous disorders. Powdered root with ginger is used to cure vomiting and diarrhea, vertigo, weakness of eyes and paralysis. (Subedi, 2011; Jalal <i>et al.</i> , 2010)
<i>C. elegans</i> Lindl.	Epiphyte	Fresh juice is coagulating, applied on the deep wound to stop bleeding (Baral and Khurmi, 2006)
<i>C. iridoides</i> D. Don	Epiphyte	Fresh juice is used to stop bleeding. Powder is used as tonic (Vaidya <i>et al.</i> , 2000)
<i>Cypripedium cordigerum</i> D. Don	Terrestrial	Tonic, edible as a vegetable (Baral and Khurmi, 2006)
<i>C. elegans</i> Reichb .f.	Terrestrial	Nervine tonic in hysteria, spasm, madness, epilepsy and rheumatism (Baral and Khurmi, 2006)
<i>Denia cylindrostycha</i> Lindl.	Terrestrial	Decoction of tuber used to strengthen kidneys (Subedi <i>et al.</i> , 2013)

Table 1. Medicinal uses of orchid roots in NorthEastern India (contd.).

Species	Habit	Medicinal uses
<i>Eria pannea</i> Lindl.	Epiphyte	Used for bone ache (Nongdam, 2014)
<i>Eulophia nuda</i> Lindl.	Terrestrial	Used for treating bronchitis, tumour and blood related diseases (Kumar, 2002)
<i>Geodorum densiflorum</i> (Lam.) Schltr.	Terrestrial	For wounds and insect bites (Hossain, 2011)
<i>Goodyera repens</i> (L.) R.Br.	Terrestrial	Tubers are used as blood purifier (Pant and Raskoti, 2013)
<i>Gymnadenia orchidis</i> Lindl.	Terrestrial	Salep made from tubers is used as aphrodisiac, tonic <i>etc.</i> and for treating urinary disorders (Baral and Khurmi, 2006)
<i>Herminium monorchis</i> (L.) R.Br.	Epiphyte	Used as tonic (Pant and Raskoti, 2013)
<i>Pholidota articulata</i> Lindl.	Epiphyte	For treatment of cancer, skin ulcers and eruptions (Subedi, 2011)
<i>P. pallida</i> Lindl.	Epiphyte	Used to treat abdominal pain and rheumatic pain (Vaidya <i>et al.</i> , 2002)
<i>Platanthera edgeworthii</i> (Hook. f. ex Collett) R. K. Gupta	Terrestrial	Used as blood purifier (Subedi, 2011)
<i>Ponerorchis chusua</i> (D.Don) Soo	Terrestrial	Tubers used for treating diarrhoea, dysentery and chronic fever (Subedi, 2011)
<i>Rhynchostylis retusa</i> (L.) Bl.	Epiphyte	Roots are used for treating asthma, tuberculosis, nervous twitchings, cramps and rheumatism. Also used for treating kidney stone, menstrual disorders, also as an emollient (Manandhar, 2002; Baral and Khurmi, 2006)
<i>Satyrium nepalense</i> D.Don	Terrestrial	Tubers are used as aphrodisiac (Jalal <i>et al.</i> , 2010) and for curing malaria and dysentery
<i>Spiranthes sinensis</i> (Pers.) Ames	Terrestrial	Tuber is powdered and used to prepare energy tonic (Subedi, 2011) and sores (Jalal <i>et al.</i> , 2010)
<i>Trudelia cristata</i> (Lindl.) Senghas	Epiphyte	For wounds, cuts and dislocation of bones (Joshi and Joshi, 2000; Baral and Khurmi, 2006)
<i>Vanda roxburghii</i> R.Br.	Epiphyte	The roots are used in controlling rheumatism, nervous problems, bronchitis and fever (Chawla <i>et al.</i> , 1992)
<i>Zeuxine strateumatica</i> (L.) Schltr.	Terrestrial	Dried powder used for tonic (Subedi, 2011)

## Pharmacological Significance of Orchids

Several important drugs used in modern medicine came from medicinal plants but studies on orchids for the pharmacological potential and identification of bioactive molecules are still meagre. Phytochemical and pharmacological properties of orchids were started to get reported recently implying the need for basic scientific investigations on medicinal orchids using indigenous medical systems. The use of orchids in herbal medicine has a very long history (cf. Pathak *et al.*, 2010). A total of 365 plants, including several orchids are listed in the earliest known Chinese *Materia Medica*. As early as 1892, E de Wildeman had already begun investigation of orchid alkaloids in domesticated European orchid species as well as *Dendrobium nobile* and *Phalaenopsis lueddemanniana*. Until 1896, E de

Dröog analyzed 104 species in 78 genera. W Boorsma detected alkaloids in species like *Liparis parviflora* and *Paphiopedilum javanicum* in late 1890s (cf. Mazumder *et al.*, 2010). Orchid phytochemicals are generally categorized as alkaloids, flavonoids, carotenoids, anthocyanins and sterols. Among orchids, *Dendrobium* is the leading genus for phytochemical content and Zhang *et al.* (2003) reviewed 100 compounds from 42 *Dendrobium* species, including 32 alkaloids, 6 coumarins, 15 bibenzyls, 4 fluorenones, 22 phenanthrenes and 7 sesquiterpenoids. Presence of these phytochemicals might provide antimicrobial, antitumor, anti-inflammatory, antiviral activities of the orchids (Singh *et al.*, 2012).

Tuber of *Cremastra appendiculata* yields cirrohopetalanthrin with moderate action against colon

Table 2. Medicinal uses of orchid leaves in NorthEastern India.

Species	Habit	Medicinal uses
<i>Acampe praemorsa</i> (Roxb.) Blatt. & McCann	Epiphytic shrub	Leaf paste mixed with garlic is taken for stomach disorder caused by hyper acidity (Yonzone <i>et al.</i> , 2012b)
<i>Aerides multiflora</i> Roxb.	Epiphyte	Power used as tonic (Subedi, 2011)
<i>A. odorata</i> Lour.	Epiphyte	Leaf juice is used to control tuberculosis (Das <i>et al.</i> , 2008) powder used to treat wounds and cuts. Also used for ear ache (Jalal <i>et al.</i> , 2010)
<i>A. rosea</i> Lodd. ex Lindl. & Paxt	Epiphyte	Treating wounds (Vaidya <i>et al.</i> , 2000)
<i>Anoectochilus setaceus</i> Blume.	Terrestrial	Leaves are used for snake bite and ingredient in certain medicinal oils (Rao, 2003)
<i>Bulbophyllum careyanum</i> (W.J.Hook) Spreng.	Epiphyte	Leaf powder mixed with honey is used for abortion in early months and for recovery after child birth (Joshi <i>et al.</i> , 2009)
<i>Coelogyne fimbriata</i> Lindl.	Epiphyte	Leaf powder was used in tonic preparation and aphrodisiac (Pant and Raskoti, 2013)
<i>Corymborkis veratrifolia</i> (Reinw.) Bl.	Terrestrial	Fresh leaf juice is used as an emetic to reduce fever in children. (Yonzone, 2012a)
<i>Cymbidium elegans</i> Lindl.	Epiphyte	Stops bleeding (Vaidya <i>et al.</i> , 2000; Subedi 2011)
<i>C. iridoides</i> D. Don	Epiphyte	Fresh juice enhances coagulation and stop bleeding (Vaidya <i>et al.</i> , 2000; Subedi 2011) Used as tonic too
<i>Echioglossum williamsoni</i> (Rchb.f.) Szlach.	Terrestrial	Leaf juice applied to cure swellings of hands, legs and for bone fractures (Rao, 2003)
<i>Goodyera repens</i> (L.) R.Br.	Terrestrial	Leaves for female disorders, stomach and bladder diseases. Chewed leaves applied to reptile bite together with drinking of leaf juice. Used as blood purifier (Pant and Rascoti, 2013)
<i>G. schlechtendaliana</i> Rchb.f.	Terrestrial	Tincture of the plant in rice wine is used for internal injuries and to improve circulation. (Du <i>et al.</i> , 2002)
<i>Luisa trichorrhiza</i> (W.J. Hook.) Bl.	Epiphyte	Paste of cylindrical leaves is applied to relieve muscular pain (Vaidya <i>et al.</i> , 2000)
<i>Luisia zeylanica</i> Lindl.	Epiphyte	Used to treat chronic wounds, boils and burns (Manandhar, 2002; Baral and Khurmi, 2006)
<i>Mycaranthes pannea</i> (Lindl.) S.C.Chen & J.J.Wood	Epiphyte	Leaves used decoction used in bathing in cases of ague (Rao, 2003)
<i>Nervilia aragoana</i> Gaud.	Terrestrial	The decoction of leaves is used as protective medicine after childbirth (Yoganarasimhan, 1996)
<i>Papilionanthe teres</i> (Roxb.) Schltr.	Epiphyte	Used for pus formation in ear, nose bleeding etc. and high fever (Medhi and Chakrabarti, 2009)
<i>Platanthera edgeworthii</i> (Hook. f. ex Collett) R. K. Gupta	Terrestrial	Power is used as blood purifier (Subedi, 2011)
<i>Renanthera imschootiana</i> Rolfe	Epiphyte	Paste can be applied to treat skin diseases (Deorani and Sharma, 2007)
<i>Rhynchostylis retusa</i> (L.) Bl.	Epiphyte	Leaf powder used to cure rheumatic diseases (Lawler, 1982)
<i>Spathoglottis plicata</i> Bl.	Terrestrial	Decoction of the boiled plant used for rheumatism and used in hot as a foment (Mollik <i>et al.</i> , 2009)
<i>Vanda coerulea</i> Griff. ex Lindl.	Epiphyte	Leaf juice is used for diarrhea, dysentery, external application for skin diseases and as expectorant (Deorani and Sharma, 2007)
<i>V. roxburghii</i> R.Br.	Epiphyte	Used for treatment of certain inflammatory conditions (Chawla <i>et al.</i> , 1992) Also used as remedy for otitis
<i>V. tessellata</i> (Roxb.) W.J.Hook. ex Don	Epiphyte	Used in rheumatism and allied disorders, paste of leaves is used for fever (Suresh <i>et al.</i> , 2000)
<i>V. testacea</i> (Lindl.) Reichb.f.	Epiphyte	Juice has antiviral and anticancer property. Used for ear ache also (Vaidya <i>et al.</i> , 2000; Baral and Khurmi, 2006)

# Colored

J. ORCHID SOC. INDIA

(DECEMBER 30,



*Paphiopedilum venustum*



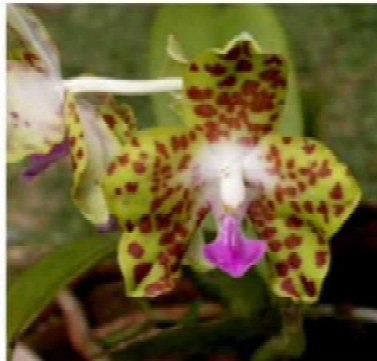
*Vanda bicolor*



*Vanda coerulea*



*Esmeralda cathcartii*



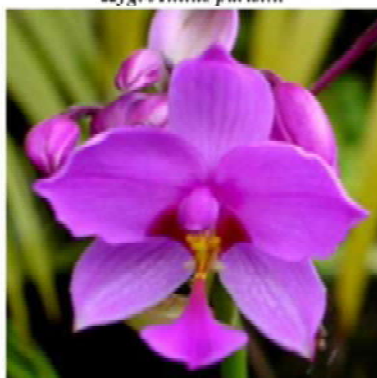
*Hygrochilus parishii*



*Phalaenopsis mannii*



*Calanthe tricarinata*



*Spathoglottis plicata*



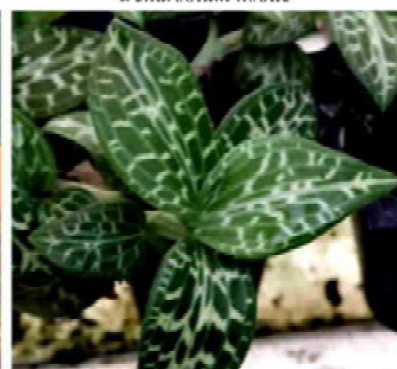
*Dendrobium nobile*



*Dendrobium sulcatum*



*Anoectochilus roxburghii*



*Goodyera schlechtendaliana*

Figs. 1-12. Some ornamental orchids of NorthEastern India.

cancer and breast cancer. The plant also yields isoflavanoids which are potent inhibitors of angiogenesis (Xue *et al.*, 2006). *Arundina graminifolia* has good medicinal properties due to its rich content of stilbenoid,

flavanoid and phenanthrene (Hossain, 2011). Interest in the orchids for exploring the rich phytochemicals made them vulnerable to intense exploitation which threatens their existence.



# Colored

2017)

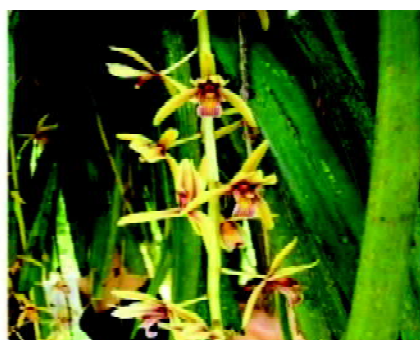
NINAWE AND SWAPNA - ORCHID DIVERSITY OF NORTHEAST INDIA



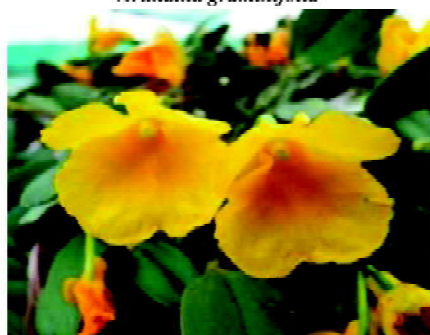
*Arundina graminifolia*



*Bulbophyllum careyanum*



*Cymbidium aloifolium*



*Dendrobium jenkinsii*



*Dendrobium nobile*



*Dendrobium transparens*



*Papilionanthe uniflora*



*Phaius tankervilleae*



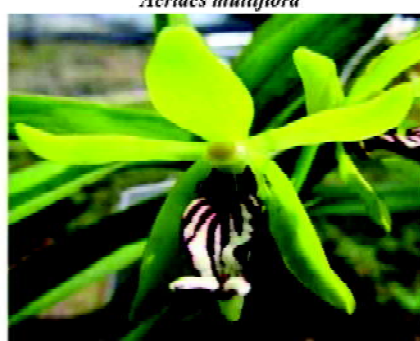
*Aerides multiflora*



*Thunia alba*



*Vanda coerulea*



*Vanda cristata*

Figs. 13-24. Some medicinal orchids from NorthEastern India.

## Diversity and Economic Potential of Orchids

Out of about 960 species of orchids found in NorthEastern India, 400 species are ornamental and

have a commercial importance. Amongst the epiphytic orchids, species of *Aerides*, *Arachnis*, *Coelogyne*, *Cymbidium*, *Dendrobium*, *Esmeralda*, *Phalaenopsis*, *Vanda* etc. have commercial importance. They are extensively used as parents in the breeding programmes to develop commercially potential hybrids. Among the

terrestrial species of NorthEastern India, the species of *Calanthe*, *Eulophia*, *Paphiopedilum*, *Pecteilis*, *Phaius*, and *Spathoglottis* etc. are of great ornamental value (Singh, 1986). The species of *Anoectochilus*, *Goodyera*, and *Zeuxine* etc. are popularly known as 'Jewel Orchids' indicating beautiful ornamentation on their leaves, and have great demand in the market as foliage ornamentals. Some small species of *Ascocentrum*, *Bulbophyllum*, *Gastrochilus*, *Oberonia*, *Porpax*, *Robiquetia*, *Schoenorchis* etc. are very cute and have a great demand as miniatures. (Figs. 1-24 have been reproduced with permission from Dr. Rao).

Medhi *et al.* (2012) reported orchid hybrids of *Aranda*, *Cattleya*, *Cymbidium*, *Dendrobium*, *Mokara*, *Oncidium*, *Paphiopedilum*, *Phalaenopsis*, *Renantanda*, *Vanda* etc. with different colour and forms used for cut flowers, floral display and as exhibits. Tribes of NorthEastern hill region use wild orchids for a variety of folk medicine as orchids are rich in phytochemicals like alkaloids, flavonoids, glycosides, carbohydrates etc. (De, 2011). Fragrant orchids like *Aerides multiflorum*, *Aerides odoratum*, *Cattleya maxima*, *Coelogyne cristata*, *Coelogyne ochracea*, *Dendrobium chrysotoxum*, *Lycaste*, *Oncidium spaceolatum*, *Rhynchostylis retusa* and *Zygopetalum intermedium* are delightful in outdoor settings. Parts of the orchid plants like leaves, tubers and pseudobulbs of different species are used for edible purposes. *Anoectochilus* leaves are used as vegetables in Indonesia and Malaysia. Edible tubers include *Caladenia carnea* and *Microtis uniflora*, while edible pseudobulbs include *Cymbidium maladimum* and *Dendrobium speciosum*. *Vanilla*- a major spice crop and source of vanillin comes from *Vanilla planifolia*. Miniature cymbidiums can be used as value added packed items. Bright flowers of orchid genera like *Cattleya*, *Cymbidium*, *Dendrobium*, *Paphiopedilum*, *Pholidota* etc. can be used for dry flower arrangements. Among orchids, *Cymbidium*, *Dendrobium* and *Phalaenopsis* are excellent for wedding decoration (De and Medhi, 2014).

Studies on orchid genetic materials for breeding and species trade carried out under the breeding programme emphasizes selection of healthy plants and flowers by visual observation. Extensive breeding programmes succeeded in developing 35 new hybrids at various institutions. Protoplast fusion, isozyme electrophoresis and DNA bar coding were used to assist in varietal and species identification. Inter-group hybridization between *Phalaenopsis* type dendrobiums extend flowering season, expands the range of flower colors, shapes and increases the flowering rate (Chen *et al.*, 1995; Davidson, 1994). Majority of commercially grown orchids today are hybrids derived from *Arachnis*,

*Ascocentrum*, *Cattleya*, *Cymbidium*, *Dendrobium*, *Oncidium*, *Paphiopedilum*, *Phalaenopsis*, *Renanthera* and *Vanda* (Mercy and Dale, 1997). *Vanda coerulea* and *V. sanderiana* are the two important *Vanda* species connected at base level to most of the vandaceous hybrids (Fuchs, 1997). Polyploidy and introgressive hybridization have played an important role in the development of orchid hybrids.

Many Indian species have earned worldwide recognition in breeding programs due to their innate attractiveness along with their ability to transmit these characters to hybrids. Some of the prominent species are *Aerides multiflora*, *Cymbidium devonianum*, *C. elegans*, *C. lowianum*, *C. tracyanum*, *Dendrobium aggregatum*, *D. chrysotoxum*, *D. fomosum*, *D. nobile*, *Paphiopedilum venustum*, *Vanda coerulea*, etc. (Bose and Bhattacharjee, 1980).

### Endemic Orchids

Chowdhery (1998, 2001) reported distribution of orchids from tropical to alpine zones in forest trees, river banks, bamboo and palm thickets, forest floor, grassy slopes and rocky areas and are considered as an element in Farming System Research. Orchids, believed to have evolved in this region form a very noticeable feature of the vegetation. Of about 1331 species of orchids belonging to 186 genera reported from India, North East India supports the highest number of about 900 species (Kumaria and Tandon, 2007). The major orchids are reported from the NorthEastern States of India (Chowdhery 2009; De and Medhi, 2014; Tripathi and Barik, 2003) (Table 6). Amongst the large number of reported species, many valuable orchids comes from the NorthEastern states are threatened species (Table 7). Some of the orchid species which are endemic not only to this region, but also to the home states like in Sikkim and Arunachal Pradesh Himalayas in which they are distributed, the Naga and Manipur hills, the Lusai - Mizo hills and Khasi -Jaintia hills. These species are *Dendrobium parviflorum*, *Dendrobium spatella* and *Luisia macrotis* from Assam; *Dendrobium palpebrae* and *Vanda coerulea* from Arunachal Pradesh; *Cymbidium tigrinum* and *Renanthera imschootiana* from Nagaland; *Anoectochilus crispus*, *Cymbidium eburneum*, *Habenaria khasiana*, *Liparis deliculata*; *Paphiopedilum venustum*, *Taeniophyllum khasianum* and *Tainia khasiana* from Meghalaya; *Renanthera imschootiana* from Tripura; *Dendrobium palpebrae* from Mizoram; *Ascocentrum ampullaceum* var. *auranticum*, *Epidendrum radicans* and *Vanda stangeana* from Manipur; *Calanthe whiteana*, *Cymbidium whiteae* and *Vanda pumila* from Sikkim (Nayar, 1996).



Status of orchid diversity in Eastern Himalayas and North Eastern India was reviewed by Hajra and De (2010). About 207 species of orchids belonging to 67 genera have been reported from Manipur. Due to over-exploitation, most of the orchids have already been depleted considerably and several are seen only in orchidaria. Some of the taxa facing threat of survival are *Anoectochilus tetraplerus*, *Ascocentrum ampullaceum*, *A. miniatum*, *Dendrobium bensonae*, *D. draconis*, *D. heterocarpum* and *D. wardianum* (Hegde, 2012). Amongst the species reported, the Khasi, Jaintia and Garo hills around Shillong in the state of Meghalaya boast of more than 300 species of orchids (Haridasan and Rao, 1985; Nayar and Sastry, 1987, 1988, 1990). Mizoram being the home land of *Vanda coerulea* (Blue Vanda) and *Renanthera imschootiana* (Red Vanda), has many orchid species which are having ethnobotanical values including *Arundina graminifolia*, *Eria spicata*, *Eulophia nuda*, *Geodorum densiflorum*, *Malaxis acuminata*, *Phaius tankervilleae*, *Pholidota imbricata*, *Rhynchostylis retusa* and *Vanda testacea* (Nayar and Sastry 1987, 1988, 1990). Nagaland has about 241 species. Most of the orchids here are epiphytes or lithophytes. A few terrestrial orchids are also found in the state (Nayar and Sastry, 1987, 1988, 1990).

### Threats and Conservation Measures

Many orchid species in North Eastern India are endangered due to their natural habitat destruction by man like forest clearance for agricultural practices, timber operation, road construction, hydropower dam construction *etc.* Epiphytes are decreasing in population generally due to indiscriminate cutting of large and very old trees which hosts a large number of orchids on their trunks and branches. Cutting of plants leads to reduction of shade in forest floor. Terrestrial orchids including mycotrophs are disappearing day by day due to reduction in shady forest floors and moist stream banks. Orchids are getting rare in nature due to their poor rate of regeneration capacity. Orchids in the wild need specific fungus for seed germination and specific pollinator for fruit setting. Many orchids are epiphytic and need tree cover for their existence. Diversity and conservation of rare and endemic orchids of North Eastern India has been studied in all the eight states, *i.e.* Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura by Gogoi *et al.* (2012). North East India sustains has highest number of orchids with about 856 species, amongst them, 34 species of orchids are identified among the threatened plants of India (Ahmedullah and Nayar, 1999; Gogoi *et al.*, 2012; Nayar and Sastry 1987, 1988, 1990) and 85 species are endemic to this region (Das and Deori, 1983). Out of the eight orchid habitat

regions in India, the two most important areas namely; the Eastern Himalayas and the North Eastern Region fall within the political boundaries of North Eastern Region (De and Medhi, 2014).

The studies undertaken on species diversity of plants and animals in the North Eastern region exhibited wide diversity of species in each ecosystem which are necessary to preserve the ecological pyramid that sustains all living things. This is essential for preserving ecological processes, such as fixing and recycling of nutrients, soil formation, circulation and cleansing of air and water, water balance maintenance and protection of watershed, maintaining stream and river flows throughout the year, erosion control and local flood reduction (Chatterjee *et al.* 2006). According to Hegde (2005), North East India is a hotspot of biodiversity occupying 7.7% of India's total geographical area supporting 50% of the flora (nearly 8000 species), of which 31.58% (*ca.* 2526 species) is endemic and is rich in orchids, ferns, oaks (*Quercus* spp.), bamboos, rhododendrons (*Rhododendron* spp.), magnolias (*Magnolia* spp.) *etc.* Orchids exhibited behavioral changes as they modify their physiological characters to adapt to their new environment. Failure in this adaptation leads to shifting of these plants to favourable environments. They can remain dormant for a long period, which may lead to extinction in case of severe environmental changes. Several biotic and abiotic factors adversely affect orchid diversity (Barman and Devadas, 2013).

India has strengthened its activities on biodiversity conservation by implementing the Indian Forest Act, 1927; the Forest (Conservation) Act, 1980; the Wildlife (Protection) Act, 1972; the Environment (Protection) Act, 1986; the Biodiversity Act, 2002; the Biodiversity Rule, 2004, *etc.* India became a party to Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) since 1976 and is also a signatory of the Convention on Biological Diversity (CBD) since 1992. A network of protected areas like national parks, sanctuaries, biosphere reserves, arboreta, botanical gardens, *etc.* have been established throughout the country and North East region has great importance with 4 biosphere reserves, 48 sanctuaries, 14 national parks, and two world heritage sites (Yumnam, 2008). There is urgent need to conserve the valuable biological resources in natural habitats supplemented with preservation using modern methods of conservation like *in vitro* conservation, seed storage and cryo-preservation. A networking of institutions engaged in conservation of orchids including *in situ* conservation, coupled with strong orchid breeding

Table 3. Medicinal uses of orchid stem/pseudobulb in NorthEastern India.

Species	Habit	Medicinal uses
<i>Aerides multiflora</i> Roxb.	Epiphyte	For treating cuts and wounds (Subedi, 2011; Vaidya <i>et al.</i> , 2000)
<i>Anoectochilus setaceus</i> Blume	Epiphyte	Used as one of the ingredient in certain medicinal oils and for treatment of snake bite poisoning (Jayaweera, 1982)
<i>Arundina graminifolia</i> (D. Don) Hochr	Terrestrial	Shows antibacterial activity (Singh and Duggal 2009)
<i>Bulbophyllum careyanum</i> (Hoo.) Spreng	Epiphyte	Paste of pseudobulb applied for burns, wounds and recovery from child birth (Joshi <i>et al.</i> , 2009)
<i>B. leopardinum</i> (Wall.) Lindl	Epiphyte	Pseudobulb and leaf juice applied to cure burns (Pant <i>et al.</i> , 2016)
<i>B. odoratissimum</i> (J.E. Sm.) Lindl.	Epiphyte	Paste of pseudobulb applied on fractured area to straighten bones and treat tuberculosis (Joshi <i>et al.</i> , 2009)
<i>Calanthe tricarinata</i> Lindl.	Terrestrial	Pseudobulbs are used as aphrodisiac (Vaidya <i>et al.</i> , 2000)
<i>C. triplicata</i> (Willem.) Ames	Terrestrial	Pseudobulbs used as a masticatory for gastrointestinal disorders (Rao, 2004), for diarrhoea and tooth ache (Jalal <i>et al.</i> , 2010)
<i>Coelogyne corymbosa</i> Lindl.	Epiphyte	Paste of pseudobulbs is used for relief from headache by application on forehead and juice used for burns (Vaidya <i>et al.</i> , 2000)
<i>C. cristata</i> Lindl.	Epiphyte	Used for headache, fever and indigestion. Also used for wounds, sores and cuts (Joshi and Joshi, 2000)
<i>C. fimbriata</i> Lindl.	Epiphyte	Used for tonic preparation (Subedi, 2011)
<i>C. flaccida</i> Lindl.	Epiphyte	Used to cure headache and fever. Juice is taken for indigestion (Baral and Khurmi, 2006; Subedi 2011)
<i>Coelogyne nitida</i> (Wall. ex D. Don. Lindl.)	Epiphyte	Paste and juice are applied for headache, fever and in burns (Subedi, 2011)
<i>C. ovalis</i> Lindl.	Epiphyte	Used as aphrodisiac (Baral and Khurmi, 2006)
<i>C. prolifera</i> Lindl.	Epiphyte	Used for cuts, boils, backache (Baral and Khurmi, 2006) as well as relief from fever and headache (Subedi 2011)
<i>C. stricta</i> (D. Don) Schltr.	Epiphyte	For head ache and fever (Subedi 2011)
<i>Crepidium acuminatum</i> (D. Don) Szlach.	Terrestrial herb	Bulbous stem is used for strength, enhanced sperm formation. Used against cancers of the liver, breast, cervix <i>etc.</i> (Joong <i>et al.</i> , 2004)
<i>Cymbidium elegans</i> Lindl.	Epiphyte	Enhances coagulation and stops bleeding (Vaidya <i>et al.</i> 2000)
<i>C. iridoides</i> D. Don	Epiphyte	Stops bleeding, used as tonic (Vaidya <i>et al.</i> , 2000)
<i>Dendrobium amoenum</i> Wall. ex Lindl.	Epiphyte	To cure skin burn and cuts (Subedi, 2011)
<i>D. chrysanthum</i> Lindl.	Epiphytic	Stem is used as a tonic for the stomach, promote the production of body fluid, and reduce fever (Jiangsu, 1986)
<i>D. crepidatum</i> Lindl.	Epiphyte	Used for treating fracture and dislocated bone (Pant and Raskoti, 2013)
<i>D. densiflorum</i> Lindl.	Epiphyte	Used to treat boils, pimples and other skin eruption (Subedi, 2011)
<i>D. eriiflorum</i> Griff.	Epiphyte	For treating fractured and dislocated bones (Subedi 2011)
<i>D. heterocarpum</i> Lindl.	Epiphyte	Canes as paste used to set dislocated bones (Subedi, 2011)

Table 3. Medicinal uses of orchid stem/pseudobulb in NorthEastern India (contd.).

Species	Habit	Medicinal uses
<i>D. jenkinsii</i> Wall. ex Lindl.	Epiphytic	Fresh and dried stems used in preparation of Chinese drug <i>Shih-hu</i> , Used for dehydration in fever and eyes (Panda and Mandal, 2013)
<i>D. moschatum</i> (Buch.-Ham.) Sw.	Epiphytic	Used to treat fractured and dislocated bone (Pant and Raskoti, 2013)
<i>D. nobile</i> Lindl.	Epiphyte	Fresh and dried bulbs are used for longevity and aphrodisiac, stomachic, pectoral, antiphlogistic, expectorant, analgesic, antipyretic, antiepileptic. It is also used to increase appetite, to cure rheumatism, excessive perspiration, impotence, entropion, leucorrhoea, menstrual pain etc. (Baral and Khurmi, 2006)
<i>D. transparens</i> Lindl.	Epiphyte	Paste of stem used for bone setting (Subedi, 2011)
<i>Dienia cylindrostycha</i> Lindl.	Terrestrial	Used as tonic (Subedi, 2011)
<i>Eria spicata</i> (D.Don) Hand. Maza	Epiphyte	To relieve from head ache and stomach ailments (Kumar, 2002)
<i>Gymnadenia orchidis</i> Lindl.	Terrestrial	Powered pseudobulbs are used to treat cuts and wounds. Also used for liver and urinary disorders and gastric problems (Vaidya et al., 2000; Manandhar, 2002)
<i>Liparis odorata</i> (Willd.) Lindl.	Terrestrial	Treatment of cancerous ulcers and gangrene (Singh and Dey, 2005)
<i>Malaxis acuminata</i> D. Don	Terrestrial	Decoction of pseudobulb can be used to control bleeding diathesis, burning sensation in stomach, fever, arthritis and blood vomiting (Nongdam, 2014)
<i>Otochilus albus</i> Lindl.	Epiphyte	Dried and powdered pseudobulbs are used for improving general strength as tonic (Subedi, 2013)
<i>Papilionanthe teres</i> (Roxb.) Schltr.	Epiphyte	Juice is used to treat pus formation and pain in ear, nose bleeding etc. Used for treatment of dislocated bones (Manandhar, 2002)
<i>Phaius tankervilleae</i> (L. Herit.) Bl.	Epiphyte	Pseudobulb paste used to heal swellings and to soothe pain of abscess (Panda and Mandal, 2013)
<i>Pholidota articulata</i> Lindl.	Epiphyte	Treatment for dislocation of bones (Manandhar, 2002)
<i>Pholidota chinensis</i> Lindl.	Epiphyte	Aqueous extract of pseudobulbs is helpful for soothing feverish stomach, and toothache. Tincture is used for internal bleeding, asthma, tuberculosis, rheumatism and dysentery (Vaidya et al., 2000)
<i>Pholidota imbricata</i> W.J. Hook.	Epiphyte	Paste mixed with mustard oil is applied on joints for rheumatic pains. Water extract of crushed pseudobulbs reduce abdominal pain (Subedi, 2011)
<i>Pholidota pallida</i> Lindl.	Epiphyte	Paste and juice of pseudobulbs used to cure navel and abdominal pain, reduce fever and sleep (Subedi et al., 2013)
<i>Platanthera sikkimensis</i> (J.D. Hook.) U.C.Pradhan	Terrestrial	For naval abdominal and rheumatic pain (Vaidya et al., 2000; Basal and Kurmi, 2006)
<i>Pleione maculata</i> (Lindl.) Lindl	Epiphyte	Pseudobulbs used to treat liver complaints and stomach diseases (Vaidya et al., 2000)
<i>P. praecox</i> (Sm.) D. Don	Epiphyte	Dried powder is used as tonic and paste for cut and wound (Manandhar, 2002; Basal and Kurmi, 2006)
<i>Thunia alba</i> (Lindl.) Reichb.f	Epiphyte	Paste of stem is used to treat bone fractures and dislocations (Basal and Kurmi, 2006)
<i>Tropidia curculigoides</i> Lindl.	Epiphyte	Decoction is used for treating malaria and diarrhea (Panda and Mandal, 2013)

Table 4. Medicinal uses of orchid flowers/fruits/ seeds in NorthEastern India.

Species	Habit	Medicinal uses
<i>Aerides multiflora</i> Roxb.	Epiphyte	Ground fruit is used for healing wounds (De and Medhi, 2015)
<i>Calanthe sylvatica</i> (Thouars) Lindl.	Epiphyte	Flowers used to stop nasal bleeding (Vaidya <i>et al.</i> , 2000)
<i>C. triplicata</i> (Willem.) Ames	Terrestrial	Flowers used as a pain killer in caries (Mythili <i>et al.</i> , 2014)
<i>Cymbidium hookerianum</i> Reichb.f.	Epiphyte	Seeds applied on cuts and injuries as hemostatic (Yonzone <i>et al.</i> , 2012a)
<i>Rhynchosyilis retusa</i> (L.) Bl.	Epiphyte	Dried flowers used as insect repellent and to induce vomiting (Thakur <i>et al.</i> , 2010)
<i>Vanda coerulea</i> Griff. exLindl.	Epiphytic	Juice from the flower parts used as eye drops for controlling glaucoma, cataract and blindness (Deorani and Sharma, 2007)

Table 5. Medicinal uses of orchids (Whole plants) in NorthEastern India.

Species	Habit	Medicinal uses
<i>Anoectochilus roxburghii</i> (Wall.) Lindl.	Terrestrial	Used to treat tuberculosis (Baral and Khurmi, 2006)
<i>Bulbophyllum leopardinum</i> (Wall.) Lindl.	Epiphyte	Fresh pulp or juice is used in burns (Subedi, 2011)
<i>B. odoratissimum</i> (J.E.Sm.) Lindl.	Epiphyte	Used to treat tuberculosis and fracture (Joshi <i>et al.</i> , 2009)
<i>B. umbellatum</i> Lindl.	Epiphyte	Used to enhance congenity (Baral and Khurmi, 2006)
<i>Conchidium muscicola</i> (Lindl.) Rauschert.	Epiphyte	Used in cardiac, respiratory and nervous disorder (Shrestha, 2000)
<i>Cymbidium devonianum</i> Lindl. Paxt.	Epiphyte	Concentrated decoction of plant is taken in cough and cold (Baral and Khurmi, 2006)
<i>Cypripedium himalaicum</i> Rolfe ex Hemsl.	Terrestrial	Used for urine blocks treatment, heart disease, cough and chest problems (Subedi, 2011)
<i>Dendrobium fimbriatum</i> W.J. Hook.	Epiphyte	Used for treating upset liver and nervous debility (Vaidya <i>et al.</i> , 2000)
<i>D. longicornu</i> Lindl.	Epiphyte	Plant juice is used to relieve fever and cough (Manandhar 2002; Subedi, 2011)
<i>D. macraei</i> (Lindl.) Seidenf.	Epiphyte	Paste is used for snake bite, general stimulant, asthma, bronchitis, throat trouble, and fever. Also used as an aphrodisiac (Baral and Khurmi, 2006)
<i>D. monticola</i> P.F. Hunt & Summerh.	Epiphyte	Used in boils and pimples and other skin eruptions (Shrestha, 2000; Vaidya <i>et al.</i> , 2000)
<i>Eria bamboosifolia</i> Lindl.	Epiphyte	Used to treat stomach disorder in combination with <i>Aegle marmelos</i> (Das <i>et al.</i> , 2008)
<i>Flickingeria fugax</i> (Reichb. f.) Hawkes	Terrestrial	Tonic and general stimulant (Subedi, 2011)
<i>Goodyera schlechtendaliana</i> Reichb.f.	Terrestrial	To cure internal injuries and improve blood circulation (Du <i>et al.</i> , 2002)
<i>Habenaria commelinifolia</i> (Roxb.) Wall. ex Lindl.	Epiphyte	Used as Salep in combination with other orchids (Baral and Khurmi, 2006)
<i>Herminium lanceum</i> (Thunb. ex Sw.) Vujik	Terrestrial	Extract of plant given in suppressed urination (Pant and Raskoti, 2013).
<i>Luisa trichorrhiza</i> (W.J.Hook.) Bl.	Epiphyte	Paste of whole plants in empty stomach is used for controlling Jaundice (Das <i>et al.</i> , 2008)
<i>Nervilia aragoana</i> Gaudich.	Terrestrial	Used in uropathy, haemoptysis cough asthma, vomiting, diarrhoea & mental instability (Vaidya <i>et al.</i> , 2000)
<i>Otochilus albus</i> Lindl.	Epiphyte	Used as a tonic (Subedi, 2011)
<i>O. porrectus</i> Lindl.	Epiphyte	Used as tonic and for treatment of sinusitis and rheumatism (Joshi and Joshi, 2000; Baral and Khurmi, 2006)
<i>Papilionanthe teres</i> (Roxb.) Schltr.	Epiphyte	For treating dislocated bones (Manandhar, 2002)
<i>Rhynchosyilis retusa</i> (L.) Bl.	Epiphyte	Rheumatism, cuts and wounds (Shrestha, 2000)
<i>Smitinandia micrantha</i> (Lindl.) Holtt.	Epiphyte	Root powder as a tonic and stem has antibacterial property (Vaidya <i>et al.</i> , 2000)
<i>Thunia alba</i> (Lindl.) Reichb. f.	Epiphyte	Plant paste is applied to treat dislocated bones (Manandhar, 2002)

Table 6. Major orchids in NorthEastern States of India.

State	Species
Arunachal Pradesh	<i>Arundina graminifolia</i> , <i>Aerides odorata</i> , <i>A. williamsii</i> , <i>A. rosea</i> , <i>Cymbidium pendulum</i> , <i>C. aloifolium</i> , <i>Dendrobium aphyllum</i> , <i>D. nobile</i> , <i>D. moschatum</i> , <i>D. fimbriatum</i> , <i>D. densiflorum</i> , <i>D. giganteum</i> , <i>D. grandiflorum</i> , <i>D. eburneum</i> , <i>D. mastersii</i> , <i>Paphiopedilum fairrieianum</i> , <i>P. venustum</i> , <i>P. spicerianum</i> , <i>Rhynchostylis retusa</i> , <i>Renanthera imschootiana</i> , <i>Vanda coerulea</i>
Assam	<i>Bulbophyllum obrienianum</i> , <i>Calanthe odora</i> , <i>Dendrobium parviflorum</i> , <i>D. spatella</i> , <i>Eria pumila</i> , <i>Eulophia candida</i> , <i>Galeola altissima</i> , <i>Goodyera procera</i> , <i>Liparis plantaginea</i> , <i>Luisia macrotis</i> , <i>Phalaenopsis mastersii</i> , <i>Spiranthis sinensis</i> , <i>Tainia barbata</i> , <i>Vanilla pilifera</i>
Manipur	<i>Anoectochilus tetraplerus</i> , <i>Ascocentrum ampullaceum</i> , <i>A. miniatum</i> , <i>Dendrobium bensonae</i> , <i>D. draconis</i> , <i>D. heterocarpum</i> , <i>D. wardianum</i> , <i>Renanthera imschootiana</i> , <i>Vanda coerulea</i>
Meghalaya	<i>Anoectochilus brevibrabris</i> , <i>Coelogyne corymbosa</i> , <i>Cymbidium elegans</i> , <i>Dendrobium devonianum</i> , <i>Paphiopedilum insigne</i> , <i>P. venustum</i> , <i>Rhynchostylis retusa</i> , and <i>Vanda coerulea</i>
Mizoram	<i>Arundina graminifolia</i> , <i>Eria spicata</i> , <i>Eulophia nuda</i> , <i>Geodorum densiflorum</i> , <i>Malaxis acuminata</i> , <i>Paphiopedilum hirsutissimum</i> and <i>P. villosum</i> , <i>Phaius tankervilleae</i> , <i>Pholidota imbricata</i> , <i>Renanthera imschootiana</i> , <i>Rhynchostylis retusa</i> , <i>Vanda coerulea</i> and <i>Vanda testacea</i>
Nagaland	<i>Arundina graminifolia</i> , <i>Ascocentrum ampullaceum</i> , <i>Bulbophyllum rothschildianum</i> , <i>Cymbidium tigrinum</i> , <i>Dendrobium wardianum</i> , <i>D. thyrsoiflorum</i> , <i>Paphiopedilum insigne</i> , <i>Renanthera imschootiana</i> , <i>Rhynchostylis retusa</i> , <i>Vanda</i> spp.
Sikkim	<i>Anoectochilus sikkimensis</i> , <i>Biermannia bimaculata</i> , <i>Calanthe trulliformis</i> , <i>C. alpina</i> , <i>C. whiteana</i> , <i>C. chloroleuca</i> , <i>C. anganii</i> , <i>C. keshabii</i> , <i>C. yuksomensis</i> , <i>Coelogyne cristata</i> , <i>Cymbidium eburneum</i> , <i>C. devonianum</i> , <i>Cypripedium tibeticum</i> , <i>C. himalicum</i> , <i>C. elegance</i> , <i>C. whiteae</i> , <i>Dendrobium chrysotoxum</i> , <i>D. densiflorum</i> , <i>D. falconeri</i> , <i>D. wardianum</i> , <i>Dedicia cunninghamii</i> , <i>Gastrochillus affinis</i> , <i>Liparis dongchenii</i> , <i>Malaxis saprophyllum</i> , <i>Oberonia micranthus</i> , <i>Risleya atropurpurea</i> , <i>Satyrium nepalense</i> , <i>Taeniophyllum retro-apiculatum</i> , <i>T. crepidiforme</i> , <i>Thrixpernum pygmaeum</i> , <i>Uncifera lancifolia</i> , <i>Vanda pumila</i>
Tripura	<i>Dendrobium</i> spp., <i>Renanthera imschootiana</i> , <i>Vanda coerulea</i> .

(cf. Chowdhery 2009; De and Medhi (2014); Tripathi and Barik, 2003)

Table 7. Threatened orchids of NorthEast India.

Threatened Orchid Species	
<i>Acanthephippium sylhetense</i>	<i>Anoectochilus tetraplerus</i>
<i>Bulleya yunnanensis</i>	<i>Cymbidium eburneum</i>
<i>C. devonianum</i>	<i>C. tigrinum</i>
<i>Dendrobium chrysotoxum</i>	<i>D. bensoniae</i>
<i>D. densiflorum</i>	<i>D. draconis</i>
<i>D. falconeri</i>	<i>Epigeneium rotundatum</i>
<i>Eria fragrans</i>	<i>P. fairrieianum</i>
<i>P. venustum</i>	<i>Paphiopedilum insigne</i>
<i>P. villosum</i>	<i>Renanthera imschootiana</i>
<i>V. coerulea</i>	<i>Vanda pumila</i>
<i>Vanilla pilifera</i>	

(cf. Tandon et al., 2007; Hegde, 2012)

programme would enhance judicious utilization of orchids (Medhi et al., 2012).

### Future Strategic Action Plan for Effective Conservation of Orchids

Many futuristic and strategic action plans were suggested by many experts for the conservation of Orchids in NorthEastern India. Most important step should be the inclusion of medicinally and ornamentally important wild orchids under the protection of Indian Wildlife Protection Act to restrict their collection from the wild (Rao, 2003). Areas where wild orchids are abundant should be declared as sanctuaries for their conservation *in situ*. Most of the orchids are elevation specific and for conservation of orchids, elevation and richness of diversity should be taken into account. Gene banks at various altitudinal zones and orchidaria should be enriched with species of ethnobotanical importance. Rescued orchid seedlings from degraded forest can be rehabilitated in such centers. Preparation and maintenance of herbaria will be helpful for proper identification. DNA barcoding of orchid species especially of rare medicinal orchids is essential which



will be helpful for preventing illegal transportation through the international borders and inland check gates. Traditional knowledge and medicinal properties of the wild orchids should be gathered by explorations in tribal settlement areas by research institutions and organizations like Botanical Survey of India. Along with preparation of such inventory list of traditional knowledge, pharmacological evaluation of orchids should be encouraged for validation of such gathered information (Acharya and Rokaya, 2010).

Advanced technologies and *in vitro* propagation should be adopted and standardized for mass production and rehabilitation of Rare, Endangered and Threatened (RET) listed plants and also to meet industrial needs. Awareness among the tribal people is crucial for *in situ* conservation of wild orchids. Awareness campaign and educational nature camps may be organized in selected areas with rich orchid diversity to invite attention and motivate local people for conservation of wild species around them. They can be encouraged to introduce appropriate farming systems and commercially propagate wild and ornamental orchids as an alternative livelihood option.

## Conclusion

Orchids can grow in wide range of substrates. They are both economically and medicinally important which could have great impact on our country's economy. North Eastern region of India is rich in orchid diversity, but orchid family is now facing serious threat due to various environmental factors and climate change. Many of them are now included in RET list of IUCN and will face extinction unless there is urgent and necessary actions including awareness programmes against indiscriminate collection are taken. Department of Forest and Wildlife, together with NGOs and local people should hold hand in hand to protect the unique and vast genetic diversity of orchids in North East India.

## References

- Acharya, K. P. and M. B. Rokaya. 2010. Medicinal orchids of Nepal: Are they well protected? *Our Nature*, **8**: 82-91.
- Ahmedullah, M. and M. P. Nayar. 1999. *Red Data Book of Indian Plants*. Vol. 4 (Peninsular India), Botanical Survey of India, Calcutta, India.
- Balami, N. P. 2004. Ethnomedicinal uses of plants among the Newar community of Pharping village of Kathmandu district. *Nepal Tribhuvan Univ. J.*, **24**: 13-19.
- Baral, S. R. and P. P. Khurmi. 2006. *A Compendium of Medicinal Plants of Nepal*. Mass Printing Press, Kathmandu, Nepal.
- Barman, D. and R. Devadas. 2013. Climate change on orchid population and conservation strategies: A review. *J. Crop Weed*, **9**(2): 1-1.
- Barman, T., Jyoti, Anjana, S. Marpa, M. Lal, A. Singh, P. Sharma, and S. S. Samant. 2016. Diversity, distribution, and status of orchids in Upper Beas Catchment and Parbati Valley of Kullu district, Himachal Pradesh. *J. Orchid Soc. India*, **30**: 57-64.
- Bose, T. K. and S. K. Bhattacharjee. 1980. *Orchids in India*. Naya Prakash Publishers, Calcutta, West Bengal, India.
- Chatterjee, S., A. Saikia, P. Dutta, D. Ghosh, G. Pangging, and A. K. Goswami. 2006. *Biodiversity Significance of North-East India*. WWF-India, New Delhi.
- Chawla, A. S., A. K. Sharma, S. S. Handa, and K. L. Dhar. 1992. Chemical studies and antiinflammatory activity of *Vanda roxburghii* roots. *Indian J. Pharm. Sci.*, **54**: 159-61.
- Chen, W. H., Y. M. Fu, R. M., Hsieh, C. C. Wu, M. S. Chyou, and W. T. Tsai. 1995. Modern breeding in *Phalaenopsis* orchid. *Taiwan Sugar*, **42** (3): 17-22.
- Chowdhery, H. J. 1998. *Orchid Flora of Arunachal Pradesh*, Bishen Singh. Mahendra Pal Singh, Dehra Dun, India.
- Chowdhery, H. J. 2001. Orchid diversity in North-East India. *J. Orchid Soc. India*, **15**: 1-17.
- Chowdhery, H. J. 2009. Orchid diversity in northeastern states of India. *J. Orchid Soc. India*, **23**(1-2): 19-42.
- Das, S. and N. C. Deori, 1983. A Cens Endemic Orchids of North-Eastern India. In: *An Assessment of Threatened Plants of India*, (eds. S. K. Jain and R. R. Rao) pp. 104-09. Howrah, Botanical Survey of India, India.
- Das, P. K., S. Sahoo, and S. Bal. 2008. Ethnobotanical studies on orchids of Niyamgiri Hill Ranges, Orissa, India. *Ethnobot. Leaflets*, **12**: 70-78.
- Davidson, B. 1994. *Dendrobium* breeding trend. *Amer. Orchid Soc. Bull.*, **63**: 638-45.
- De, L. C. 2011. *Value Addition in Flowers and Orchids*. New India Publishing Agency, Pitam Pura, New Delhi, India.
- De, L. C., and R. P. Medhi. 2014. Diversity and conservation of rare and endemic orchids of North East India - A review. *Indian J. Hill Farming*, **27**(1): 138-53.
- De, L. C., and R. P. Medhi. 2015. Orchid- A diversified component of farming systems for profitability and livelihood security for small and marginal farmers. *J. Glob. Biosci.*, **4**(2): 1393-1406.
- De, L. C. and D. R. Singh. 2015. Biodiversity, conservation and bio-piracy in orchids- An overview. *J. Glob. Biosci.*, **4**(4): 2030-43.
- De, L. C., Promila Pathak, A. N. Rao, and P. K. Rajeevan. 2014. Value Addition in Orchids. In: *Commercial Orchids*, (eds. M. Golachowska and E. Monu), De Gruyter Open Ltd., Warsaw/Berlin.
- Deorani, S. C. and G. D. Sharma. 2007. *Medicinal Plants of Nagaland*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
- Droog, É. de. 1896. *Contribution à l'étude de la localisation microchimique des alcaloïdes dans la famille des Orchidacées, par Émile de Droog...* F. Hayez.

- Du, X. M., N. Y. Sun, N. Takizawa, Y. T. Guo, and Y. Shoyama. 2002. Sedative and anticonvulsant activities of goodyerin, flavonol glycoside from *Goodyera schlechtendaliana*. *Phytother. Res.*, **16**: 261-63.
- Fuchs, R. F. 1997. Fabulous vandaceous intergenerics. *Orchids*, **66**: 350-57.
- Gogoi, K, R. L. Borah, G. C. Sharma, and R. Yonzon. 2012. Present status of orchid species diversity resources and distribution in Dibrugarh District of Assam of North East India. *Inter. J. Modern Bot.*, **2**(2): 19-33.
- Hajra, P. K. and A. De. 2010. Phyto-geographic analysis of orchid flora in India, *J. Orchid Soc. India*, **24** (1-2): 43-46.
- Haq, F. 2012. The ethno botanical uses of medicinal plants of Allai Valley, Western Himalaya Pakistan. *Inter. J. Plant Res.*, **2**(1): 21-34.
- Haridasan, K. and R. R. Rao. 1985. Forest Flora of Meghalaya— 2 Volume, Bishen Singh Mahendrapal Singh, Dehradun, India.
- Hegde, S. N. 1997. Orchid wealth of India, *Proc. Ind. Nat. Acad. Sci.* **63**(3): 229-44.
- Hegde, S. N. 2012. *Ex situ* and *in situ* conservation of orchids in India. *J. Orchid Soc. India*, **26**(1-2): 1-4.
- Hegde, S. N. 2016. Commercial potential of orchids in India and societal benefits. *J. Orchid Soc. India*, **30**(1-2): 43-49.
- Hossain, M. M. 2011. Therapeutic orchids: Traditional uses and recent advances-An overview. *Fitoterapia*, **82**: 102-40.
- Jalal, J. S., S. P. Kumar, L. Tewari, and Y. P. S. Pangtey. 2010. Orchids Uses in Traditional Medicine in India. In: *National Seminar in Medicinal Plants of Himalayas*, Regional Research Institute, Himalaya, India.
- Jayaweera, D. M. A. 1982. Medicinal plants (indigenous and exotic) used in Ceylon, Part 4. Colombo: The National Science Council of Sri Lanka, 159.
- Jiangsu. 1986. *New Medical College Dictionary of Chinese Herb Medicines*. pp. 586-90. Shanghai Scientific and Technologic Press, Shanghai.
- Joong, S. S., H. K. Jin, L. Jiyong, N. K. Si, and J. K. Ho. 2004. Anti-angiogenic activity of a homoisoflavanone from *Cremastra appendiculata*. *Planta. Med.*, **70**: 171-73.
- Joshi, K. K., and S. D. Joshi. 2000. *Genetic Heritage of Medicinal and Aromatic Plants of Nepal Himalayas*. Buddha Academy Publisher and Distributors, Pvt. Kathmandu, Nepal.
- Joshi, G., L. M. Tewari, N. Lohani, K. Upreti, J. S. Jalal, and G. Tewari. 2009. Diversity of orchids in Uttarakhand and their conservation strategy with special reference to their medicinal importance. *Rep. Opin.*, **1**: 47-52.
- Kataki, S. K., S. K. Jain, and A. R. K. Sastry. 1984. *Distribution of Orchids of Sikkim and North East India*. *Plant Conservation Bull* 5, Botanical Survey of India, Howrah, India.
- Kumar, S. 2002. *The Medicinal Plants of North-East India*. Scientific Publishers, Jodhpur, India.
- Kumar, Deepak, Pooja Kumari, S. S. Samant, and Shiv Paul. 2016. Assessment of orchid diversity in selected sacred groves of Kullu district, Himachal Pradesh, India. *J. Orchid Soc. India*, **30**: 89-95.
- Kumaria, S., and P. Tandon. 2007. Biotechnological approaches to conservation of orchids, the wondrous and mystic plants of North-East India. *Man Soc., J. North East Stud.*, Spring IV, 57-71.
- Lawler, L. J. 1982. Ethnobotany of Orchidaceae. In: *Orchid Biology- Reviews and Perspectives* (ed. J. Arditti) pp. 27-149. John Wiley and Sons Inc., New York U.S.A.
- Maheswari, P. and U. Singh. 1965. *Dictionary of Economic Plants in India*, ICAR, New Delhi.
- Manandhar, N. P. 2002. *Plants and People of Nepal*. Timber Press, Portland, Oregon, U.S.A.
- Mao, A. A., T. M. Hynniewta, and M. Sanjappa. 2009. Plant wealth of Northeast India with reference to ethno botany. *Indian J. Tradit. Knowl.*, **8**(1): 96-103.
- Mazumder, P. B., G. D. Sharma, C. M. Dutta, D. N. Choudhury, T. Das, and B. Mazumder. 2010. *In vitro* propagation and phytochemical screening of *Papilionanthe teres* (Roxb.) Schltr. Assam University Journal of Science & Technology. *Biol. Environ. Sci.*, **5**(1): 37-42.
- Medhi, R. P. and S. Chakrabarti. 2009. Traditional Knowledge of NE people on conservation of wild orchids. *Indian J. Tradit. Knowl.*, **8**(1): 11-16.
- Medhi, R. P., S. Chakraborti, and M. Rampal. 2012. Orchid biodiversity in India: Conservation and utilization. *Ind. J. Genet.*, **72**(2): 148-56.
- Mercy, S. T., and B. Dale. 1997. *Orchids*. St. Josephs Press, Thiruvananthapuram, Kerala, India.
- Mollik, A. H, S. Hossain, T. Islam, R. Jahan, and M. Rahmatullah. 2009. Medicinal plants used against rheumatoid arthritis by traditional medicinal practitioners of Bangladesh. *Planta Med.*, **75**: 959. 10.1055/s-0029-1234537.
- Mythili, K., C. U. Reddy, D. Chamundeeswari, and P. K. Manna. 2014. Determination of total phenol, alkaloid, flavonoid and tannin in different extracts of *Calanthe triplicata*: Research and reviews. *J. Pharma. Phytochem.*, **2**(2): 40-44.
- Nayar, M. P. 1996. *Hotspots of Endemic Plants of India, Nepal and Bhutan*. Tropical Botanic Garden and Research Institute, Trivandrum, India.
- Nayar, M. P. and A. R. K. Sastry. 1987. *Red Data Book of Indian Plants*. Volume I. Botanical Survey of India, India.
- Nayar, M. P. and A. R. K. Sastry. 1988. *Red Data Book of Indian Plants*. Volume II. Botanical Survey of India, India.
- Nayar, M. P. and A. R. K. Sastry. 1990. *Red Data Book of Indian Plants*. Volume III. Botanical Survey of India, India.
- Nongdam, P. 2014. Ethno-medicinal uses of some orchids of Nagaland- North-east India. *Res. J. Med. Plants*, **8**(3): 126-39
- Panda, A. K. and D. Mandal. 2013. The folklore medicines of Sikkim. *Anc. Sci. Life*, **33**(2): 92-96.

- Pant, B. and B. B. Raskoti. 2013. *Medicinal Orchids of Nepal*. Himalayan Map House Pvt. Ltd., Kathmandu, Nepal.
- Pant, P., M. R. Paudel, M. B. Chand, and S. H. Wagner. 2016. *A Treasure Trove of Orchids in Central Nepal*, Central Department of Botany, Tribhuvan University Kirtipur, Kathmandu, Nepal.
- Pathak, Promila, A. Bhattacharya, S.P. Vij, K.C. Mahant, Mandeep K. Dhillon, and H. Piri. 2010. An update on the medicinal orchids of Himachal Pradesh with brief notes on their habit, distribution, and flowering period. *J. Non Timber Forest Products*, **17**(13): 365-72.
- Rao, A. N. 2003. Medicinal marvels from the mountains of Arunachal Pradesh, *Amruth*, sep-oct: 3.
- Rao, A. N. 2004. *Medicinal Orchid wealth of Arunachal Pradesh*. *Newsletter Envis Node Indian Med. Plants*, **1**(2): 1-5.
- Shrestha, R. 2000. Some medicinal orchids of Nepal. In: *The Himalayan Plants, can they Save Us?* Proc. Nepal-Japan joint symposium on conservation and utilization of Himalayan medicinal resources (Eds. T. Watanabe, A. Takano, M.S. Bista and H.K. Saiju) pp. 153-56. Society for the Conservation and Development of Himalayan Medicinal Resources (SCDHMR), Nepal.
- Singh, F. 1986. Orchids. In: *Ornamental Horticulture in India*, (ed. K. L. Chadha and B. Choudhary) pp. 127. Publications and Information Division, ICAR, New Delhi, India.
- Singh, M. P., and S. Dey. 2005. *Indian Medicinal Plants*. Satish Serial Pub. House, Azadpur, New Delhi, India.
- Singh, A. and S. Duggal. 2009. Medicinal Orchids: An Overview. *Ethnobot. Leaflets*, **13**: 351-63.
- Singh, S., A. K. Singh, S. Kumar, M. Kumar, P. K. Pandey, and M. C. K. Singh. 2012. Medicinal properties and uses of orchids: A concise review, *Elixir Appl. Bot.*, **52**: 11627-34.
- Subedi, A. 2011. New species, pollinator interactions and pharmaceutical potential of Himalayan orchids. Ph.D. Thesis, Leiden University, The Netherlands.
- Subedi, A., K. Bimal, C. Young, D. Yuntao, T. Andel, R. P. Chaudhary, J. B. Hugo, and G. Barbara. 2013. Collection and trade of wild-harvested orchids in Nepal. *J. Ethnobiol. Ethnomed.*, **9**: 64.
- Suresh, P. K., A. Subramoniam, and P. Pushpangadan. 2000. Aphrodisiac activity of *Vanda tessellata*. *Indian J. Pharmacol.*, **32**: 300-04.
- Tandon, P., Y. P. Abrol, and S. Kumaria. 2007. *Biodiversity and its Significance*. IK International Pvt. Ltd., New Delhi, India.
- Thakur, R. B., R. P. Yadav, and N. P. Thakur. 2010. Enumerating the status of orchid species of Makawanpur district. *Hamro Kalpabricha*.1, **1**: 20.
- Tripathi, R. S., and S. K. Barik. 2003. *National Biodiversity Strategy and Action Plan Report for Northeast India*. Ministry of Environment and Forests, New Delhi, India.
- Vaidya, B.N., M. Shrestha, and N. Joshee. 2000. Report on Nepalese Orchids Species with Medicinal Properties. In: *The Himalayan Plants, Can They Save Us?* Proc. Nepal-Japan joint symposium on conservation and utilization of Himalayan medicinal resources. (ed. T. Watanabe, A. Takano, MS Bista, HK Saiju) pp. 146-52. Society for the Conservation and Development of Himalayan Medicinal Resources (SCDHMR), Nepal.
- Wildeman, E. D. 1892. Presence et localisation d'un alcaloide dans quelques Orchidees. *Bull. Soc. Belg. Microscop.*, **18**: 101-08.
- Xue, Z., S. Li, S. Wang, Y. Wang, Y. Yang, J. Shi, and L. He. 2006. Mono-, Bi-, and triphenanthrenes from the tubers of *Cremastra appendiculata*. *J. Nat. Prod.*, **69**: 907-13.
- Yi, Y., F. Xing, X. Huang, H. Chen, and F. Wand. 2005. Medicinal plants of *Bulbophyllum* species in China. *J. Trop. Subtrop. Bot.*, **13**: 65-69.
- Yoganarasimhan, S. N. 1996. *Medicinal Plants of India*. Vol. 1. Interline Publishing, Karnataka, India.
- Yonzon, R., A. Kamran, and R. B. Bhujel. 2012a. Orchids in Ethnobotany, Ethno-botany and Medicinal Plants. In: *Proc. Volume Intl. Seminar in "Multidisciplinary Approaches in Plant Angiosperm Systematics*, **2**: 661-69.
- Yonzon, R., D. Lama, R. B. Bhujel, K. Gogoi, and S. Rai. 2012b. Terrestrial and semi saprophytic orchid species diversity of Darjeeling Himalaya of West Bengal, India, *The McAllen Inter. Orchid Soc. J.*, **13**(4): 2-20.
- Yumnam, J. Y. 2008. Rich biodiversity of Northeast India needs conservation. *Curr Sci.*, **95**(3): 297.
- Zhang, H. J., J. J. Zhou, and S. S. Li. 2003. Study advance of *Gastrodia elata* b1. *Amino Acids Biotic. Resour.*, **25**: 17-20.