

RHODODENDRONS OF NORTH EAST INDIA

A PICTORIAL HANDBOOK



भारतीय वनस्पति सर्वेक्षण
BOTANICAL SURVEY OF INDIA

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INTRODUCTION

The North East Region of India comprising the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura lies between covers approximately an area of 260 thousand sq. km (Map 1) which represents about 8 per cent of total geographic area of India. This region is not only a part of both eastern Himalaya and Indo-Burma biodiversity hotspots but is also of the richest reservoir of biodiversity supporting about 50 per cent of the 18259 flowering plants known from India (Singh & Dash 2016). The entire region is a complex mountainous system with elevations ranging from 10m in natural depression at riverine systems of southern Assam to 7090m in the snow clad peaks of Sikkim, traversed throughout by a number of rivers and rivulets. The varied topographical and climatic conditions have favoured the growth of luxuriant forests which are home to myriad plant and animal forms. All the representative forest types i.e. tropical, subtropical, sub-tropical pine forests, wet temperate forests, mixed coniferous forests, eastern Oak-Hemlock forests, Oak-fir forests, moist alpine scrubs and dry alpine scrubs are found in this region. Besides the rich diversity in wild Balsams, Orchids, Zingibers, Yams, Bamboos, Canes and many primitive families such as Magnoliaceae, Lauraceae, Hamamelidaceae, Degeneriaceae, Trochodendraceae and Lardizabalaceae are well represented in the region. The rich biodiversity of



Map 1. Sketch showing Map of North East India with number of Rhododendron taxa.



A view of Sela Pass, Arunachal Pradesh

the region can be attributed to its peculiar position which is at the tri-junction of the paleoartic, Indo-Chinese, and Indo-Malayan bio-geographic regions. On account of the unique geographical features, based on the distribution of primitive angiosperms in South-East Asia, Takhtajan (1986) considered the area i.e. East Himalaya- Fiji region as the cradle of angiosperms where angiosperms have diversified.

Of the many group of plants found in the region, the genus *Rhododendron* a member of the family Ericaceae is one of the most fascinating with immense horticultural importance for its beautiful flowers and foliage. They are extremely popular worldwide especially in Europe, America, Canada, Australia and New Zealand as garden and avenue plants. Species of *Rhododendron* found in north east India are abundant in subtropical and temperate forests of Arunachal Pradesh and Sikkim with a few species in the states of Manipur, Meghalaya, Mizoram and Nagaland.

Flowering in *Rhododendron* species starts in February and continue up to April-May in lower elevations, while in higher elevations it starts in late May and continue up to June last with some exception in few species like *R. kasoense* and *R. concinoides* which flower in autumn. During the flowering season it gives a spectacular view to hills and mountains slopes. Apart from a few species, most of the species do not have specific names in local dialects. A few common ones popularly known are Gurans (Nepali) in Sikkim and Darjeeling for *R. arboreum*; *Udung minto* (red *Rhododendron* particularly *R. arboreum*) and *Tama minto* (white flower *Rhododendron*) by Monpas of Arunachal Pradesh; *Seniyi Apu* (red *Rhododendron*) and *Gyai Apu* (white *Rhododendron*) in Apatani, and *Adi seni* in Adi of Arunachal Pradesh. *Dieng-tiewthing* (Khasis), *Lidai nipa* (Mao Naga) to mostly red rhododendrons.

Etymology and History

The genus *Rhododendron* was established by Carl Linnaeus in 1753 (Sp. Pl., 392. 1753). The term *Rhododendron* is derived from two Greek words, namely *rhodon* (rose) and *dendron* (tree),





View of Mili village, Kurungkumey, Arunachal Pradesh

referring as rose tree. There are over 1000 taxa recorded so far (Gibbs & al., 2011), mostly native to higher elevations in the Sino-Himalayan regions with preponderance in western China.

The history of Indian Rhododendrons began with the visit of Capt. Hardwick to the Siwalik mountain ranges in Kashmir in the year 1796 where he discovered *R. arboreum*. However, Sir Joseph D. Hooker's visit to the Sikkim Himalaya between 1848 and 1850 unfolded the Sikkim Rhododendron wealth (Hooker, 1849) and its instant acceptance in gardens and parks of nineteenth century Europe generated a lot of interest for Rhododendrons. Clarke (1882) recorded 46 Rhododendron species from India. Since then many species have been described and recorded from north east India by various workers (Griffith, 1847; Watt, 1890; Burkill, 1924, 1925; Calder & al., 1926; Bor, 1938; Kanjilal & al., 1939; Anonymous, 1947; Kingdon Ward, 1929, 1930, 1949, 1953, 1960; Razi, 1959; Nayar & Ramamurthy, 1973; Nayar & Karthikeyan, 1981; Naithani, 1990; Pradhan, 1985, 1986; Ghosh & Samaddar, 1989; Pradhan & Lachungpa, 1990; Long & Rae, 1991; Cox & Cox, 1997; Fang & al., 2005; Giri & al., 2008; Sastry & Hajra, 2010; Pradhan, 2010; Mao & al., 2001, 2009; Mao, 2010; Bhattacharyya, 2014). Revision of the genus at world level was carried out by Cullen (1980) and Chamberlain (1982).

Rhododendrons of Sikkim-Himalayan region have been well documented in Sikkim-Himalayan Rhododendrons (Pradhan & Lachungpa, 1990) and The Rhododendrons of Sikkim (Pradhan, 2010). Singh (2002) provided field identification key to the Rhododendron of Sikkim. Comprehensive account of the Rhododendrons species in the North-eastern states have not been documented except some sporadic publication (Biswas, 1940; Srinivasan, 1959; Panigrahi & Joseph, 1966a, 1966b; Rao

& Joseph, 1965; Sahni, 1969; Cox, 2004, 2006; Dash & Mao, 2011; Mao & al., 2001, 2009; Mao & Bhaumik, 2011, 2012; Mao & Gogoi, 2012) which record the occurrence of different species of *Rhododendron* in this regions, without giving a detailed account. To fill this gap, extensive and intensive field explorations were made to different part of Manipur, Nagaland, Meghalaya, Mizoram, Sikkim and Arunachal Pradesh and huge amount of specimens of *Rhododendron* were collected including several novelties. During this study, many Chinese and Burmese species of the genus were also recorded especially from Arunachal Pradesh.

Based on literature scrutiny, examination of live specimens collected during field surveys, personal field observation of the first author and examination of previous collections in multiple herbaria (ASSAM, ARUN, BSHC, CAL, DD, E, K, BSA), revealed 132 taxa (80 spp., 25 subsp. and 27 var.) of *Rhododendrons* from India, out of which 129 (excluding 3 taxa viz. *R. arboreum* subsp. *nilagiricum* in South India, *R. colletianum*, and *R. rawatii* from western Himalaya) are distributed in north east India. Three taxa viz. *R. abhaya*, *R. hodgsonii* var. *alba*, and *R. lohicense* are treated here as doubtful taxa due to insufficient information, poorly described and non-availability of type specimens. Besides, *Rhododendron blumei* Nutt. and two natural hybrids viz. *R. candelabrum* (*R. campylogynum* × *R. thomsonii*), and *R. imberbe* (*R. barbatum* × *R. arboreum*) were also recorded from north east India. Of the eight states of north east India, the genus is not reported from Assam (Cachar hills ?) and Tripura. 119 taxa are recorded from Arunachal Pradesh which accounts 90.1% of the recorded taxa of *Rhododendron* from India which is the highest for any geographic region of the country. The total number of species found in the region may further increase as more and



The entry point to Tawang



more places of the region are yet to be explored. The details of the species distribution in the six states of north east India are presented in Table-1.

Table-1. Number of *Rhododendron* taxa distributed in the different states of North East India

	Sikkim	Arunachal Pradesh	Meghalaya	Manipur	Mizoram	Nagaland
Species	25	74	0	6	2	6
Subsp.	11	21	-	1	-	1
Var.	6	24	3	3	2	4
Total taxa	42	119	3	10	4	11
Endemic	2(5%)	12(10%)	2(66.6%)	6(60%)	2(50%)	6(54.5%)

Habit Diversity

Rhododendrons are found in varied habitats ranging from subtropical forests ($\pm 800\text{m}$) to alpine scrubs ($\pm 6500\text{m}$). The genus is characterised by wide range of habits from dwarf shrubs to large trees. Some of the smallest species (*R. nivale*, *R. pumilum*) grow to 10-50 cm high while the tallest species (*R. arboreum*) are reported to grow over 40 m high. They may be either evergreen or deciduous. Also, in natural habitats many of the species apparently hybridised freely as many intermediate forms have been observed in the fields indicating continuity of speciation in nature.

Rhododendrons are essentially terrestrial in nature; however, epiphytic habit is also common in favourable condition. Majority of epiphytes generally grow on members of Magnolia, Oak and



Rhododendron bhutanense in natural habitat, Arunachal Pradesh





Rhododendron scrubs in Vadse hills, Kurungkumey, Arunachal Pradesh

Laurels. The exclusive epiphytic rhododendrons distributed in the region are *Rhododendron boothii*, *R. leptocarpum*, *R. megeratum*, *R. camelliflorum*, *R. edgeworthi*, *R. dalhousiae*, *R. lindleyi*, *R. megacalyx*, *R. concinnoides*, *R. kasoense*, *R. pangeanum* etc. About 21 taxa are growing both as epiphytic and terrestrial; while 28 taxa are either large shrubs or medium sized trees. The most widely distributed species in the region is *R. arboreum*. The highest habit variation was observed in *R. johnstoneanum*, *R. maddenii* and *R. lepidotum* in the different natural habitats. For example in West Kameng and Tawang districts of Arunachal Pradesh *R. maddenii* grows as terrestrial habits, whereas in Lower Subansiri district it is mostly growing as epiphytes on big tree trunks.

The genus *Rhododendron* is characterized by a considerable variation in the morphological features among its species. However, the field observation, reveals that, there is no correlation among the macro-morphological attributes such as smooth or peeling nature of bark, type of indumentum in the young and older shoots, size of the leaves, size and colour of flowers or nature of fruits whether straight or curved. But, a particular morphological attribute is common and constant for a infrageneric group and can be relied for infrageneric delimitation.

The size of the leaves ranges from 12 cm to over 50 cm, exceptionally 100 cm in *R. sinogrande*, which is the largest recorded leaf size in *Rhododendron* taxa. The leaves are either lepidote or elipidote. Almost all types of flower colours are found with varying sizes from 1-5 cm across, from single flower to 30 or more flowers in a truss. It is also interesting to note that some of the species are edible, while many are deadly poisonous. Some of the species are aromatic.



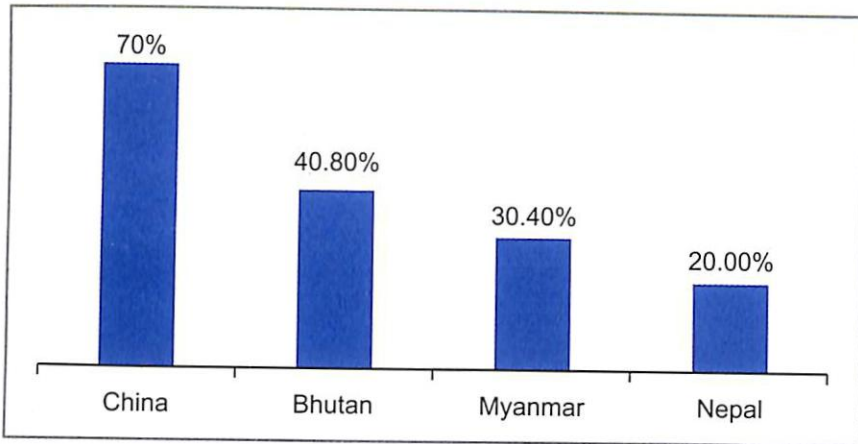


Fig. 1. The percentage (%) of taxa common to neighbouring country(s).

Affinity with flora of neighbouring countries

The rhododendron species that are found in North east India, share close affinity with the neighbouring phytogeographical regions or countries (Fig. 1). Out of the 129 Rhododendron taxa so far recorded from north east India, 88 taxa (70%) are common with China followed by Bhutan (51 taxa), Myanmar (38 taxa), Nepal (25 taxa) and one species each with Thailand, Vietnam, Taiwan, Japan and Malaysia. Many of the species are common to one or more countries. Among all the species *R. moulmainense* is the most commonly distributed species (recorded from China, Myanmar, Taiwan, Japan and Malaysia) followed by *R. maddenii* subsp. *crassum* (China, Myanmar and Vietnam). Species that are found in Arunachal Pradesh and Sikkim share a close affinity among themselves and with China, Bhutan and Myanmar due to the common boundaries with these countries. Conversely, more than 50% of the taxa found in the other four states, viz. Manipur, Meghalaya, Mizoram and Nagaland are endemic and unique to these states.

Endemic taxa

Endemism of species indicates its restricted distribution due to various reasons, natural or geographical barriers, condition of climate or micro-climate in the ecosystems. The present study reveals that, 18 species of Rhododendron are endemic to India (13.9% total taxa). Out of which 16 taxa (13.3%) viz. *R. arunachalense*, *R. concinoides*, *R. coxianum*, *R. dalhousiae* var. *tashii*, *R. elliottii*, *R. formosum* var. *formosum*, *R. formosum* var. *inaequale*, *R. hookerii*, *R. macabeanum*, *R. mechukae*, *R. pangeanum*, *R. santapau*, *R. subansiriense*, *R. triflorum* var. *bauhiniiflorum* and *R. wattii* (except *R. arboreum* subsp. *nilagiricum* and *R. rawatii*) are endemic to north east India. The maximum numbers (12) of endemic taxa occurs in Arunachal Pradesh followed by Manipur and Nagaland (6 taxa each), Meghalaya, Mizoram and Sikkim (2 taxa each). However, in terms percentage of number of taxa occur in different states, Meghalaya has the highest (66.6%); followed by Manipur (60%) and Nagaland (54.5%), Mizoram (50%), Arunachal Pradesh (10%) and Sikkim (5%) (Table. 1).

Ecological Significance and Biological Indicator of Climate Change

The genus Rhododendron is the dominant tree or shrub species in the higher region of the Himalayas, play a very important role in maintaining the rich biodiversity and the fragile ecosystem stability of high altitude. Studies from different parts of the world have shown evidences of the effects of climate change on phenology and persistence of plant species (Baker & Moseley 2007,

McKenny & al. 2007). Phenological responses of plants, particularly the early flowering ones, are considered among the prominent biological indicators of climate change. Scientists from the USA and China analysed the flowering time of 10,295 herbarium specimens of Himalayan *Rhododendron* collected since 1884, to investigate the climate-driven change in flowering time (Hart & al. 2014). They found that the plant starts flowering 2.27 days early with every 1°C rise in annual temperature and 2.54 days later per 1°C warming during the spring season. In the Himalaya the blooming of *Rhododendrons* heralds the onset of spring. However, scientists from the G. B. Pant Institute of Himalayan Environment and Development, Almora, has generated evidences of changes in flowering phenology of *Rhododendron arboreum* flower in Uttarakhand (Rawat, 2008, Kailash & al. 2014). The field observations over last decade revealed considerably higher frequency (47-75 per cent trees) of bloom during February-March, which indicates a strong basis to prove other observational reports of advancement in flowering time of many species from spring to winter.

The important insight of *Rhododendron* taxa response to climate changes in the Indian Himalaya highlights the need for further research on the species. So far data sets or evidences are lacking for majority regions of the climate-sensitive Eastern Himalayan biodiversity hotspots especially of Arunachal Pradesh and Sikkim. The states house the highest number of *Rhododendron* taxa in India and can contribute greatly to better understanding on the effects of climate change on species and consequently on fragile ecosystem of eastern Himalaya.

Uses of *Rhododendrons*

In India, aesthetic uses of *Rhododendrons* are still unknown apart from the few *Rhododendron* sanctuaries set up in Sikkim. It is used mainly as firewood by the local people living in the high altitude especially in Arunachal Pradesh and Sikkim where *Rhododendrons* are available in abundance. There are a few reports on the ethnobotanical uses of *Rhododendrons* from north east India and in particular from the state of Sikkim (Watt, 1892; Sain 1974; Pradhan & Lachungpa,



View of Nurang Valley, Tawang District, Arunachal Pradesh

1990; Mao & al., 2001; Paul & al., 2010; Bhattacharyya, 2011; Mao, 2013). The various uses of Rhododendrons can be grouped into the following heads:

1. Ethnomedicine

Many of the traditional uses of Rhododendron are:

- a. Headaches: Watt (1892) recorded from Sikkim that young leaves of *R. arboreum* are said to be poisonous as well as medicinal and applied on the forehead to alleviate headaches. However, the strong aroma of *R. setosum* leaves unlike *R. arboreum* causes painful headache. Pradhan & Lachungpa (1990) mentioned in their book that the leaves of *R. setosum* called Tallu by Bhuttias and Tibetans, emit a strong heady aroma that causes painful headaches at high altitudes. The author (AAM) experienced the similar types of effect during the survey in Arunachal Pradesh in 2007. He was not aware of the painful headache it causes. When he encountered the interesting plant on the Sela top and when he crushed the leaves with his hand, to his surprise it emit a strong aroma, like that of meat masala.
- b. Decoction of *R. lepidotum* leaves is given in the treatment of cold, cough, chronic bronchitis and asthma. Leaves are aromatic and administered to cause sneezing (Watt, 1892). The tea made from bark is reported to be purgative (Bhattacharjee, 1998).
- c. Cold and hermicrania: Watt (1892) also recorded that *R. campanulatum* which is locally called 'Nilo Chimal' leaves are exported to the plain, where they are ground up with tobacco and used as stuff, which is said to be useful in cold and hermicrania.
- d. Diarrhoea and blood dysentery: Dried flower of *R. arboreum* is believed to be highly efficacious in checking diarrhoea and blood dysentery (Pradhan & Lachungpa, 1990).



Rhododendron flowers ready for juice making.



- e. Fishbone removal: The fresh and dried corolla that is acid-sweet is also advocated when fishbone get stuck in the gullet. Possibly the acid helps in dissolving the bone (Pradhan & Lachungpa, 1990). This practice has also been observed in all the *Rhododendron* growing states in Manipur, Meghalaya, Mizoram and Nagaland. This type of practice might have been brought by the Nepali immigrants, as its uses were not known to the aboriginal people of the region.
- f. Phthisis and chronic fever: The dried twigs and wood of *R. campanulatum* are used in Nepal as medicine in phthisis and chronic fever (Pradhan and Lachungpa, 1990).
- g. Skin diseases: Concentrated liquid extracts obtained from distillation of leaves of *R. edgeworthii* is applied on skin diseases by Monpas of West Kameng and Tawang (Paul & al., 2010).

2. Edible flowers

Rhododendrons are notorious for poisoning humans and animals; however, some of the species flower petals are edible. They are used by the locals for juice, jam, jelly, pickle and wine preparation.

- a. Juice, jam/jelly and pickle.

The flower petals of *R. arboreum* (Lali-Gurans in Nepali and Etukop by Bhutias and Lepchas) which is the most common and widely distributed in the Himalaya is used for making juice, jam, jelly and pickles by locals in Himachal Pradesh, Uttarakhand, Sikkim, Darjeeling in West Bengal, Arunachal Pradesh (juice only) and Meghalaya (for pickle only). Many small cottage processing units are established in these states. In north east India, the first Rhododendron squash processing unit was established in 2009 at Sakpret village, Tawang district of Arunachal Pradesh by a Delhi based NGO InsPIRE funded by Department of Science & Technology, Government of India and Shri Ratan Tata Trust. The unit is active during the flowering season (March May) and produces over 4000-5000 litres of *R. arboreum* juice. More than 38 families are actively involved (part time) and earned about Rs. 3000/- per month as additional income for each family. The petals are only used for the juice and the anthers/stamens discarded.

- b. Local wine

Rhododendron wine is brewed from *R. arboreum* locally called Gurans in the Singalila Mountains at Maney Bhanyang-Meghma, Tonglu and Sandakphu in the Darjeeling Gorkha Hill Council of West Bengal. The wine is pleasant when freshly made and is believed to prevent altitude-sickness (Pradhan & Lachungpa, 1990).

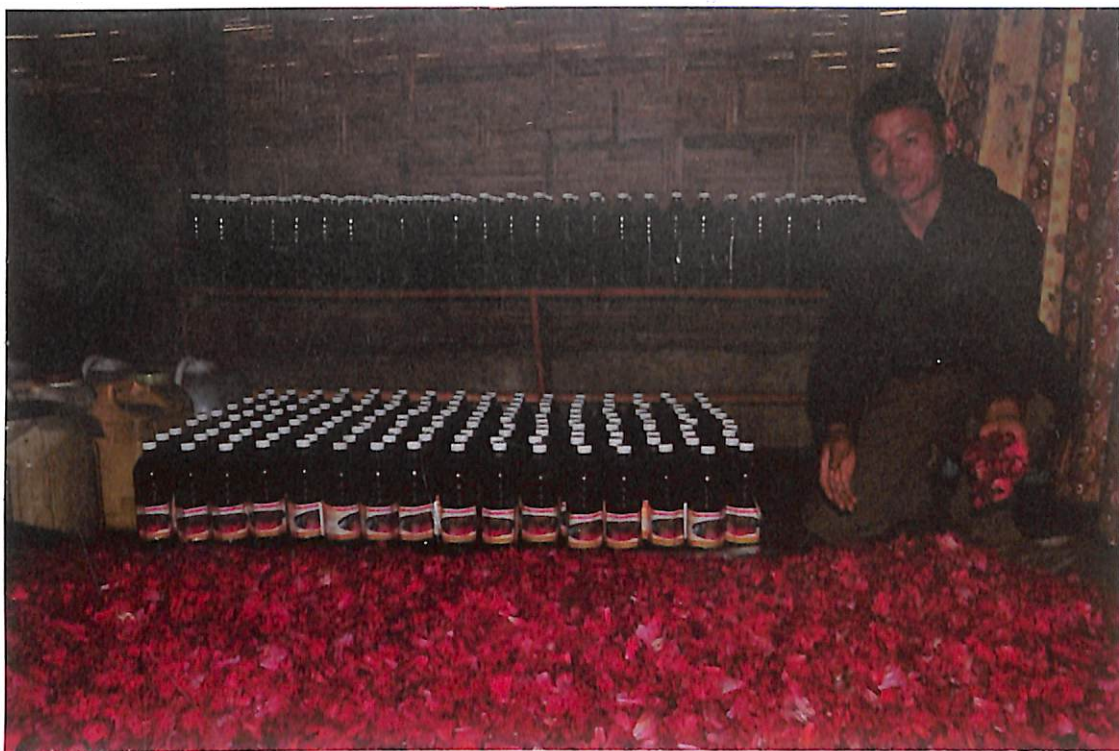
- c. As Vegetable

The petals of *R. cinnabarinum* (called *Bulu* and *Sanu Chimal* in Nepali and *Khema Kechung* in Lepcha) is eaten by the local children as it is sour-sweet to taste. In Lachen and Lacchung, the people fry the petals to a tasty delicacy (Pradhan & Lachungpa, 1990). Sam (1974) had also reported use of *R. cinnabarinum* flower petals for making jams by head Lamas and Tibetan aristocrats.

3. Fragrance & Religious use

R. anthopogon (The Tibetans call this plant Palu) is a small shrub commonly found in the subalpine to alpine forests from at an elevation 3000 m and above. The leaves of *R. anthopogon* are usually mixed with those of juniper and used in Buddhist monasteries for a delicate smell. This mixture is commonly called as *Dhupi* and widely practised in almost all





Rhododendron juice making at Sakpret village, Tawang district, Arunachal Pradesh

Buddhist monasteries of Sikkim, Bhutan and Arunachal Pradesh. Similar use of *R. lepidotum* was mentioned by Watt (1892). The flowers of *R. arboreum* is also considered as sacred and offered in temples and monasteries (Paul & al., 2010).

4. Symbolism

Many Rhododendron species symbolize as the National flowers or trees of many state and countries. In India, *Rhododendron niveum* is the state tree of Sikkim and Uttarakhand, while *Rhododendron arboreum* (Lali Gurans) is the national flower of Nepal. Similarly, *Rhododendron catawbiense*, the predominant Rhododendron in the Appalachian Mountains, is the state flower of West Virginia, and embedded in the National flag of West Virginia. *Rhododendron macrophyllum*, one of the predominant rhododendrons on the Pacific Coast and in the cascade Mountains is the state flower of Washington.

5. Wood crafts

The close and even grained wood of many Rhododendron species such *R. arboreum*, *R. hodgsonii*, *R. falconeri*, etc. are used for Khukri handles, pack-saddles, cups, spoons, ladles, gift boxes, gun-stocks and posts by the Bhutias, Lepchas and Nepalis. The hard, close-grained, smooth and unsplitting wood makes excellent to make khurki handles and walking sticks.

6. Packaging

The leaves of *R. falconeri* are used in packaging apples by local people of north Sikkim. Similarly, the thick leaves with glossy surface of *R. falconeri*, *R. hodgsonii*, *R. kesangiae*, *R. grande* are used for packing mashed pulp of *Arisaema griffithii* for bread, Yak butter and cheese



in the attractive foliage for presentation and transportation by the Monpas in Arunachal Pradesh (Paul & al., 2010).

7. Lighting Fire

The dense tomentum on the underside of the leaves of *R. fulgens* is scraped and used as wick for lighting fires by the inhabitants of north Sikkim and Monpas of Tawang, Arunachal Pradesh (Pradhan & Lachungpa, 1990; Paul & al., 2010).

8. Poisonous Rhododendron species

The Rhododendrons are also infamous for being toxic to animals through ingestion of leaves and man through consumption of honey.

a. Human

There are many reports on Rhododendron poisoning from different parts of the world (Kerkvliet 1981, Leach 1986, Lee & al., 2007, Poon & al., 2008, Sohn & al., 2005). The earliest record of rhododendrons poisoning comes from the army of Xenophon, retreating from Babylon in 401 B. C. (Dillery, 1998). Xenophon described the odd behavior of Greek soldiers after having consumed honey in a village surrounded by *Rhododendron ponticum* during the march of ten thousand in 401 BC. Also, Pompey's soldiers reportedly suffered lethal casualties following the consumption of honey made from Rhododendron deliberately left behind by Pontic forces in 67 BC during the Third Mithridatic War. The suspect rhododendrons are *R. ponticum* and *R. luteum*, both found in northern Asia Minor. One of the common food intoxications encountered in Turkey is caused by toxic honey made by bees from Rhododendron species (Sutlupinar & al., 1993). The Rhododendrons have a toxin called grayanotoxin in their pollen and nectar. People have been known to



Wooden house - near Naga-GG, West Kameng

become ill from eating honey made by bees feeding on rhododendron and azalea flowers. It is also known as mad honey intoxication. Mad honey intoxication symptoms include salivation, perspiration, vomiting, dizziness and low blood pressure. The condition is rarely fatal and usually abates within 24 hrs (Koca & Koca, 2007).

It has been told by villagers from Manipur and Nagaland to the author that some hunters have eaten the flower of *R. macabeaenum* while hunting thinking that it must be edible like that of *R. arboreum* which is also found in the area. It has been told that after consuming the flower they started dizziness, nausea, vomiting and some even fainted. There is no report of people dying but the locals are aware of the poisoning and warned people not to eat.

b. Animals

In Sikkim, *R. dalhousiae* also called *Lahare Chimal* is dreaded by the locals as the leaves cause fatal poisoning in cattle (Pradhan & Lachungpa, 1990). The leaves and pollen of *R. cinnabarinum* are also reported to be poisonous to grazing animals from Sikkim (Pradhan & Lachungpa, 1990). Similarly, *R. campylocarpum* is considered as the most poisonous plants for animals by the Monpas of West Kameng and Tawang districts of Arunachal Pradesh as it causes fatal poisoning. There have been reports of cattle casualty soon after consuming the leaves of *R. campylocarpum*. Many species of Rhododendron have also been reported to extremely toxic to pony or stallion (Puschner & al., 2001; Thiemann, 1991). Therefore, it is believed that, due to its poisonous nature most cattle or herbivores avoid to graze on rhododendron plants. This might have one of the reasons that Rhododendrons are found in abundance in the higher elevation.

9. Insecticide/Insect repellent

The boiled vegetative part extracts of *R. thomsonii* are highly poisonous and usually used as a traditional insecticide in Lachen and Lachung regions of north-east Sikkim (Pradhan & Lachungpa, 1990). Similarly, the leaf extracts of *R. dalhousiae* var. *rhabdotum* is used as insect repellent by the Monpas of Arunachal Pradesh (Paul & al., 2010).

10. Landscaping

Worldwide Rhododendrons are very popular for their aesthetic use. For their beautiful, showy flowers and evergreen nature, many species of rhododendrons along with their hybrids are extensively used as ornamental plants in many parts of the world. It is interesting to note that, almost all the species that are found in the wild in the states of North eastern India are being collected and grown in the western countries. Many of the species are also being subjected to hybridization. The western horticultural industries make multi-million dollar business in Rhododendron cultivation and hybridization. Presently more than 28,000 cultivars of Rhododendron in the International Rhododendron Registry held by the Royal Horticultural Society, U. K. which adequately speak about its popularity and importance in horticultural industry. Though many of the species earning significant reputation in commercial horticultural industries in the western countries are native to Himalayan region, but their potential has not been reaped in the place of origin.

Major threats

North east India is inhabited by more than 200 tribes of different ethnic groups and their cultural entities symbolizes the close association of rich biodiversity. Agriculture is the main occupation





Rhododendron tree cut for firewood

and many of these people practice *jhum* or *shifting* cultivation to grow cereals, vegetables and fruits. In recent past the natural habitats of North-East India has been severely degraded due to many threats like increasing human population, natural calamities, fast deforestation etc. Epiphytic species of rhododendrons with limited population are the most vulnerable group due to loss of host trees. In the high altitude areas of Arunachal Pradesh, Rhododendrons are unsystematically cut for firewood. The frequent forest fire during the dry season particularly in Manipur and Nagaland is another big factor which is threatening the survival of rhododendron species. Many of the north eastern regions are prone to natural calamities, landslides, floods and cloud burst. All these factors are contributing to the quick disappearance of many species of rhododendron from its natural habitat.

During the exploration tours, it has also been observed that the distribution of rhododendrons is highly restricted to small pockets in the states of Manipur, Nagaland, Meghalaya and Mizoram. Detailed population assessments in field need to be undertaken to ascertain the status of the different species found in these two states. Earlier Indian researchers had recorded 46 rare and threatened Rhododendrons (Sastry & Hajra, 1983; Katak, 1983; Rao & Haridasan, 1983) and also in the latest Red List of the world Rhododendron, 44 taxa recorded from India are listed (Gibbs & al., 2011). This number may be on the lower side as lots of developmental activities have taken place in the region in recent years and the natural habitats are shrinking very rapidly. The endemic species *R. wattii* from Dzukou hills of Manipur and Nagaland is one of the critically endangered species. Currently, only a few adult trees are remaining in the natural habitat which required immediate conservation measures.



A view of *Rhododendron wightii* near P. Tso lake, Tawang

Conservation of the taxa

Considering the rich species diversity, economic potential and vulnerability, the genus *Rhododendron* requires urgent conservation measures in situ and ex situ. The endemic taxa in the different states in the region require immediate conservation.

In situ conservation can be brought about by creating public awareness of the importance of the species and establishing gene sanctuaries, National Parks and Biosphere reserves in species rich areas. In Arunachal Pradesh, like Mandala to Naga-GG in West Kameng, Omaling lake West Kameng district, P. Tso Lake area, Tawang, Vadse hill in Kurungkumey and Lale Ane hill in Papum Pare districts can be marked for in situ conservation. This can be achieved only when the local communities are involved as more than 90% of the forest land in the region is owned by communities over which the state government has no control. Therefore, the involvement of the local population is very vital for any conservation measures as they are the people who use the forest in their localities. Fortunately in Arunachal Pradesh some of the *Rhododendron* rich natural habitats falls under different protected areas such as Talle Wild Life sanctuary, Lower Subansiri district, Lale Ane hills (Community protected area), Papume Pare district, Eagle Nest Sanctuary, East Kameng district, Myodia hills under Mehao WLS, Lower Dibang valley, Mouling National Park (West Siang, Upper Siang and East Siang districts), Dihang Dibang Biosphere Reserve Lower Dibang valley, Namdapha Biosphere Reserve, Changlang district.

Sikkim is the only state in India where in situ conservation steps have been taken up for *Rhododendrons* species. With strong political patronage Sikkim government was able to bring 41% of the land under the control of Protected Area Network (PAN) which consists of Biosphere



Reserve, National Parks, Sanctuaries and Protected Areas. All the 40 odd species of rhododendrons found in the state are protected and conserved. The Sikkim forest department and the Sikkim Rhododendron Society have identified nine (9) Rhododendron Ecosystems and Protected area Network in Rhododendron rich areas of the state. The two famous Rhododendron Sanctuaries in the state are Barsey Rhododendron Sanctuary in West district covering an area of 104 sq. km and Shingba Rhododendron Sanctuary in Yumthang valley of the north district with an area of 43 sq. km. The state has also declared Khangchendzonga National Park and Biosphere Reserve to protect and conserved the *Rhododendron* species. Heavy grazing over the century was one of the main factors for degradation of forest in the state. The government of Sikkim has completely banned grazing in the protected forest areas.

There is a urgent need to follow up the Sikkim experiences by other states in the region. Recently the World Heritage Group has taken up to help conserve the Sikkim-Himalayan Rhododendron species. Similar maiden effort has been taken up recently by WWF, Arunachal Field Station and Winrock India for *in situ* conservation of the Rhododendron rich areas in W. Kameng and Tawang districts of Arunachal Pradesh with the local people. The effort is highly commendable.

Ex situ conservation can be brought about by cultivating these species in gardens and parks under suitable climatic conditions in the region through seeds, vegetative cuttings. Rapid mass multiplication of some of the endangered species could be taken up through tissue/ *in vitro* culture. There should not be much difficulty in rehabilitating these species in Botanic Gardens and Parks as most of them have been successfully introduced and growing in Europe and America. Botanic gardens in the hill stations in north east India, Himachal Pradesh, Jammu & Kashmir and Uttarakhand can take up for *ex situ* conservation in appropriate climatic conditions. Botanical Survey



Gateway of Shingba Rhododendron Sanctuary, Sikkim

of India, Eastern Regional Centre, Shillong and G. B. Pant Institute of Himalayan Environment and Development, Sikkim Unit have already taken up tissue culture of some Rhododendron species, such as *R. maddenii*, *R. dalhousiae*, *R. elliottii*, *R. johnstoneanum*, etc. and successfully mass propagated them.

In order to popularise the plant and to promote conservation, many countries in World have societies or organisations, such as Royal Horticultural Society, London, American Rhododendron Society, Rhododendron Society of Canada & Australia, Rhododendron Species Foundation, International Rhododendron Union and formation of Rhododendron society in the North Eastern states can help in building up conservation awareness amongst the people. In India, Sikkim is the only state having Rhododendron Society patronage by the state government is actively engaged in popularizing and conservation of Rhododendrons. The other states of north eastern region may also take up conservation measures and popularisation of the Rhododendrons in line of Sikkim. The involvement of local communities, creating awareness among them and providing alternate livelihood is essential to minimize their dependence on natural resources in and around *in situ* conservation areas. Use of Rhododendrons as fuelwood can be effectively stopped by providing alternative fuel means to the villagers like LPG connections. Similarly, with rising population and increasing numbers of Buddhist monasteries, some species of Rhododendrons (*R. anthopogon*) are being over-exploited for incense. This is one of concerns to conservationists but the respective state Governments' should address the problem. Rather than putting a blanket ban on collection, they should encourage the local people for cultivation at higher altitudes which will forms livelihood for some section of the local people.

Eco-tourism can be taken up in selected Rhododendron rich habitats for generating employment and income for the local unemployed youth. Recently, WWF, Arunachal Field Station and InsPIRE (Delhi based NGO) are working on *in situ* conservation of some Rhododendron rich areas in West Kameng and Tawang districts of Arunachal Pradesh with the local people which must be encouraged and supported. In recent years, with the emergence of eco-tourism as the engine of economic growth, Rhododendrons have gained their due importance. For example, the state of Sikkim earns crores of rupees annually through Rhododendron oriented eco-tourism during the flowering season. The state of Arunachal Pradesh can do the same thing in Tawang and West Kameng districts as they are easily approachable by road to many of the Rhododendron growing natural habitats. It has tremendous scope for developing eco-tourism by careful scientific management in some selected Rhododendron rich natural habitats. Also, there is an urgent need for bio-prospecting of Rhododendrons which may provide many novelties for the benefit of mankind for medicine and bio-pesticide. Till date, India has not tapped this rich potential resource of the region. Hence, there is an urgent need for popularization and conservation of this magnificent group of plants, which has a great potential for the wellbeing of mankind.

Major Rhododendron treks in North East

Arunachal Pradesh

For those who want to see Rhododendrons flowering in natural habitats should visit Shergaon and surrounding hills in West Kameng district and Bomdir to Zimithang in Tawang district during the months of March and April as most of the early flowering species such as *R. arboreum*, *R. virgatum*, *R. grande*, *R. argipeplum*, *R. barbatum*, *R. walongense* (especially *R. arboreum*) will be in full bloom. Otherwise, the majority of the Rhododendrons flowers from the last parts of April to June in the higher altitudes. One can visit Mandala and Naga-GG in West Kameng in the month of May to see *R. arboreum* subsp. *cinnamomum* var. *roseum*, *R. pudorosum*, *R. hodgsonii*, *R. kesangiae*, *R. cinnabarinum*, *R. campylocarum*, *R. kendrickii*, *R. keysii*, *R. megeratum*, *R. wightii*, etc. in full



bloom all over the hills. The area is covered with big leaf Rhododendrons and easily accessible by road from old Dirang village which is about 25 km away. Also, on the way to Sela Pass from Dirang one can see *R. dalhousiae*, *R. cinnabarinum*, *R. triflorum*, *R. keysii*, *R. thomsonii*, *R. glaucophyllum*, *R. arboreum* subsp. *cinnamomum* var. *roseum*, *R. hodgsonii*, etc. in bloom. From Sela Pass on the way to Tawang one can see *R. thomsonii*, *R. campylocarpum*, *R. lanatum*, *R. tsariense*, *R. wightii*, *R. hodgsonii*, *R. keysii*, *R. maddenii*, *R. glaucophyllum*, *R. cinnabarinum*, *R. nerijflorum*, etc. (if you are lucky you may see *R. baileyi* and *R. ciliatum*) in bloom by the road side. The most interesting is the hills from Tawang to Bumla or Sungitsar lake. The hills at the lower elevation are covered with *R. arboreum* subsp. *cinnamomum* var. *roseum*, *R. thomsonii* and as one goes higher up in the hills will come across *R. fulgens*, *R. wightii*, *R. lanatum*, *R. flinckii*, etc. On reaching P. Tso (lake) one can see the hills still covered with snow and *Rhododendron* forest especially *R. wightii*, *R. flinckii* and *R. fulgens* in full bloom. It is amazing to see how Rhododendrons thrive in this cool condition. Surrounding Sungitsar Lake one can see *R. hodgsonii*, *R. campanulatum*, *R. tsariense*, *R. wightii*, etc. in full bloom. However, most of the smaller Rhododendrons such as *R. nivale*, *R. setosum*, *R. lepidotum* and *R. anthopogon* flowers in the months of June to July, when the monsoon already sets in the State, hence difficult to visit. The trip is worth undertaking as the natural beauty of the landscape, apart from the Rhododendrons, is spectacular. The area is accessible by vehicle if one does not want to trek. On the other hand, the hard core adventure lovers can visit the upper reaches of Kurungkumey (Vadse hills beyond Mili village), Upper Siang and West Siang, Anjaw, Upper Debang valley, Papume Pare (Lale Ane hills) districts, etc. These places cannot be approached by vehicle and one has to trek for days to reach the destination.

Sikkim & Darjeeling

The Varshey Rhododendron Sanctuary in West Sikkim and Shingba Rhododendron Sanctuary in North Sikkim are two major areas where more than thirty species of Rhododendrons can be seen. Near Dentam in Varshey Rhododendron Sanctuary one can see *Rhododendron arboretum* var. *campbelliae* followed by *R. triflorum*. The Hilley – Varshey-Kalighar-Uttarey-Dentam trek covers a



View of Shingba Rhododendron Sanctuary, Sikkim



distance of about 30 kms and one can see *R. hodgsonii*, *R. falconeri*, *R. grande*, *R. dalhousiae*, *R. lindleyi*, *R. campanulatum*, *R. campylocarpum* and *R. cinnafarinum*. April – May are best months to visit this region for witnessing magnificent blossoms.

Besides these two Rhododendrons sanctuaries, the most travelled trek routes in Sikkim are Yuksum, Tsokha, Dzongri, Goechala. One can see occasional *Rhododendron nivale* at an altitude of around 5500 m in this region. Another interesting route in Sikkim are Kyangnosla -Chagu, Menmoitsu Lake in East Sikkim and Yumthang – Mome Sandong in North Sikkim.

Similarly in Darjeeling Gorkha Hill Council region the Pedong to Lava peak and Tonglu, Sandakphu and Phalut are interesting routes for Rhododendrons. Near Sandakphu and Phalut one can see *Rhododendron decipiens*, *R. wightii*, *R. barbatum* and *R. lepidotum*.



A. *Rhododendron maddenii* on temperate hill slope
B. Species of *Rhododendrons* in snow clad maountain beyond Tawang.





Rhododendron dalhousiae var. *rhabdotum*

TAXONOMIC TREATMENT

Rhododendron L., Sp. Pl. 1: 392. 1753

Terrestrial or epiphytic shrubs, trees or sometimes creeping shrublets. Plant parts glabrous or often covered with scales or indumentum consisting of various types of hairs. Leaves alternate, often clustered at the ends of branches, rarely subopposite or in pseudowhorls, usually entire, leathery. Flowers fascicled or subcorymbose, terminal or axillary, occasionally solitary. Bracts broad, generally caducous. Bracteoles linear. Calyx 5-lobed, conspicuous or small or obsolete, rarely saucer-shaped, persistent. Corolla campanulate, widely funnel-shaped or rotate or cylindric, tube or saucer-shaped, persistent. Stamens (4) 5 – 20 (27 in subsection *Maddenia*), usually 10; anthers long or short, lobes 5 – 10. Ovary 5 – 20-celled; style long or short, straight or sharply deflexed; stigma capitate; ovules numerous in each cell. Capsule short or long, woody or membranous, septically dehiscent from apex, 4 – 20-valved; valves breaking away from the placentas. Seeds numerous, fusiform or ellipsoid or irregular, albuminous; testa close or loose, often shortly crested or finned or drawn into long tails at the ends.

General distribution: With over a thousand species, the genus is widely distributed in the tropical, sub-tropical forests of Malaysia, Indonesia, Papua New Guinea and in sub-tropical, temperate, sub-alpine mountains of Asia, Europe and North America. It does not occur naturally in Africa and South America.

Classification: In the present treatment the genus *Rhododendron* has been grouped into 04 subgenera (*Rhododendron*, *Tsutsusi*, *Azaleastrum* and *Hymenanthes*), 06 sections (*Vireya*, *Pogonanthum*, *Rhododendron*, *Ponticum*, *Tsutsusi* and *Choniastrum*) and 32 subsections (*Pseudovireya*, *Baileya*, *Boothia*, *Camelliflora*, *Campylogyna*, *Cinnabarina*, *Edgeworthia*, *Glauca*, *Lapponica*, *Lepidota*, *Maddenia*, *Monantha*, *Saluenensis*, *Tephropepla*, *Trichoclada*, *Triflora*, *Uniflora*, *Virgata*, *Arborea*, *Barbata*, *Campanulata*, *Campylocarpa*, *Falconera*, *Fortunea*, *Fulgensia*, *Fulva*, *Glischra*, *Grandia*, *Irrorata*, *Lanata*, *Neriiflora*, *Parishia*, *Taliensia* and *Thomsonia*) in accordance with the classification proposed by Chamberlain & al., (1996). However, the species, subspecies and varieties under the different Sections/subsections of the four subgenera, are arranged alphabetically irrespective of their positions in the taxonomic keys for easy reference.

