



INDIAN Horticulture

July–August 2019

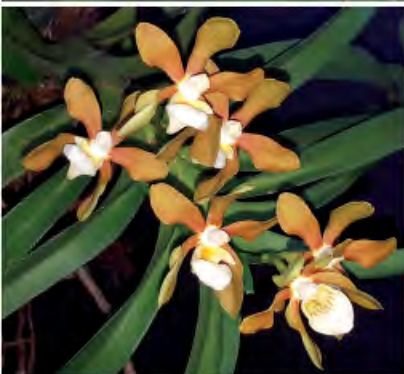
Beautiful World of
Indigenous Ornamental Plants



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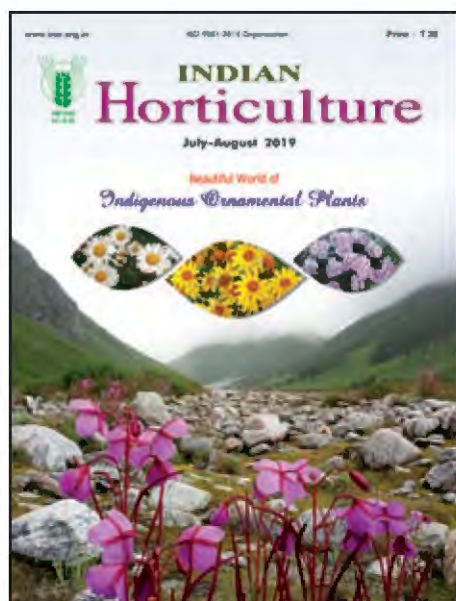
Indigenous Ornamental Plants

India is rich in varied array of ecosystems or habitats like forests, grasslands, wetlands, coastal, marine and deserts along with rich and unique diversity of flora and fauna. The forest cover of the country is estimated to be about 21.05% of India's total geographical area. Sixteen major forest types comprising 221 subtypes have been recognised in the country. These forests are treasure troves to many flora which possess high commercial significance. The ubiquitous Western Ghats, pristine Himalayan hills, serene North Eastern Hills, Tropical Eastern Ghats house many potential flora with enormous potential for their domestication, large scale captive cultivation and subsequent commercialization.



This special issue of *Indian Horticulture* on **Beautiful World of Indigenous Ornamental Plants** is conceptualised to capture the whole gamut of developments made so far. It highlights the R&D initiatives taken by the National Agricultural Research Education System including the ICAR institutes and State Agricultural Universities besides some other organisations including plant and ecosystem enthusiasts. This treatise also highlights some specific interventions made for developing database, online resources etc. that would be a handy kaleidoscope for all the stakeholders to explore the unexplored wealth of ornamentals.





Cover : Valley of Flowers, Uttarakhand
Pics Courtesy : Dr Vijay Rakesh Reddy,
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Message



TRILOCHAN MOHAPATRA, Ph. D.
Secretary & Director General



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FLORICULTURE is entwined in the Indian culture and majority of the ancient scriptures describe a wide range of native flowers that are often used for worship, personal adoration and above all as remedy for some of the ailments. Floriculture remained as homestead farming till early 90's with limited large scale commercial cultivation. Advent of economic liberalisation and proactive policies paved the way for the liberalised seed policy that helped in the establishment of 100% Export Oriented Units in early 90's exclusively for floriculture. The impetus provided helped in expansion of the area (324,000 ha) with a sizeable production of traditional flowers (19.62 MT) and cut flowers (8.23 MT) during 2018-19. Majority of the States and Union Territories cultivate floricultural crops for domestic consumption and few of them for export markets. Major exporting hubs are located in the states of Karnataka, Maharashtra, West Bengal and Meghalaya. Being a low volume and high value commodity, floriculture contributes ₹ 507 crore of export revenue to the exchequer.

Marketing of flowers is mostly unorganised with very few organised flower auction centres at Bengaluru, Mumbai and Noida. A typical marketing chain comprises producer, wholesaler, retailer and consumer. However, with the advent of information technology, B2B and B2C online trade is often taking place in major cities. Online gifting solutions are on the rise both for flowers and potted plants.

The demographic profile of India has transformed in recent years with 60% of the population is in the age group of less than 35 which makes India as one of the youngest nations. The young generation with dispensable income are going to be the driving force to fuel the consumption of floricultural produce. Expanding urban cities (more than 50 cities with one million population by 2030) and increase in per capita consumption of the floricultural produce shall enhance the demand for more novel types. Such booming growth calls for the introduction of new material to sustain the growth.

India is endowed with abundant diversity of native plants that are distributed in 22 Agro-biodiversity hotspots and some of them have great ornamental value. Ecological diversity prevailing in our country is enormous, ranging from sea level to the highest mountainous ranges in the world; hot and arid conditions in the northwest to cold arid conditions in the trans-Himalayan region; tropical wet evergreen forests in Northeast India and the Western Ghats; mangroves of Sundarbans and freshwater aquatic to marine ecosystems. Huge potential exists for identification, domestication and commercialisation of such unique native ornamentals of some of the ecologically diverse regions. An effort has been made by the Indian Council of Agricultural Research to collate and document the resources that are available in ornamental crops in this special volume of the Indian Horticulture.

I compliment the Horticultural Science Division of the Indian Council of Agricultural Research for the initiative and all the contributors who have meticulously compiled the information.



(Trilochan Mohapatra)

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Message



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THE total geographical area of India is estimated to be about 329 million ha with a coastline ranging over 7,500 km. India is bestowed upon the distinction of being the sixth among the 12-mega biodiversity zones of the world. India is blessed with varied agro-climatic zones, altitudinal zones, edaphic conditions and other accompanying micro-climatic conditions that nurture rich and diverse flora. India harbours two mega-biodiversity regions the North Eastern hill regions and the Western Ghats. The geographical area cover of the country represents about 2.4% of the world's total landmass. The major ecosystems in India are forests, grasslands, wetlands, coastal, marine and desert. The forest cover of the country is estimated to be about 21.05% of India's total geographical area. Sixteen major forest types comprising 221 subtypes have been recognised in the country. These forests are major habitats for the native plants that are of ornamental value for their flowers or foliage or plant form.

Research efforts in native ornamentals were initiated way back in 19th Century with extensive documentation of native flora. Targeted documentation of native flora was attempted at Dr. Y S Parmar University of Horticulture and Forestry during late 90's, which resulted in a comprehensive database Himflora. Online resources were also developed by Institute of Forest Genetics and Tree Breeding, Coimbatore; Flowers of India; Sahyadri: Web interfaced Western Ghats Biodiversity Information System; e-floraofIndia by a Google group in recent times.

Research efforts at ICAR are channelized through a project on survey, collection and evaluation of native ornamentals for commercial cultivation through All India Co-ordinated Research Project on Floriculture. The objective is to evaluate the potential of native ornamentals for domestic and export markets. With the advent of Directorate of Floricultural Research at Pune, attempts are being made for collection and conservation of native ornamentals with an objective to evaluate the inherent potential of native ornamental plant species for various applications.

The Horticultural Science Division of ICAR deemed it appropriate to collate and compile the scattered information available across the country in this special issue of the *Indian Horticulture* so as to bring the wealth to the fore. I am sure this treatise would be of great relevance and significance for all the stakeholders. I compliment all the authors for their painstaking efforts in compiling the information in a concise form.

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INDIA is reported to harbour about a total of 47,513 plant species, out of which 400,000 hitherto known in the world, representing as much as 11.4% of the world flora. About 28% of plants that occur in India are endemic to the country. Unfortunately, many people in India are not aware of the rich heritage of floristic diversity that exists in our country. Floristic diversity in India is concentrated mainly in four biodiversity hotspots, namely Eastern Himalayas, Western Ghats (and Sri Lanka), Northeast India and Andaman Islands (Indo-Burma) and Nicobar Island (Sunderland), out of the 34 biodiversity hotspots recognised in the world. Varied types of agro climatic, ecologic and edaphic conditions exist in these regions. These significant areas in floristic diversity are reported to exhibit exceptional concentration of endemic plant species.

The rich plant biodiversity that exists in India has an intrinsic value which needs to be protected and explored for the benefit of our future generations. The native or indigenous ornamental plant species which exist in India offer large amount of genetic diversity for bio-prospecting. Keeping in view the enormity and diversity of indigenous ornamental plant species of India, a networking approach is essentially required which could share the responsibility of germplasm collection, characterization, conservation, evaluation and maintenance of precious genetic resources of indigenous ornamental plant species. Great scope exists for carrying out research in indigenous ornamental plant species of India.

An effort has been made by the Horticultural Science Division of the Indian council of Agricultural Research to document the research and development initiatives taken up by different organisations in different crops in this special volume of the *Indian Horticulture* for the benefit of all the stakeholders. I am sure that this treatise would be of great significance for the researchers, students, amateur growers and commercial nurseries.

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(T. Janakiram)

Native Ornamental Flora Power

FLORICULTURE may be called the Fine agriculture like Fine arts, as it looks after the most aesthetic agricultural produce, the flower. It is the new sunrise industry of India because of high growth and with 100% export oriented status. Floriculture products mainly consist of cut flowers, pot plants, cut foilage, seeds bulbs, tubers, rooted cuttings and dried flowers or leaves. Rose, carnation, chrysanthemum, gargera, gladiolus, gypsophila, liastris, merine, orchids, archilea, anthurium, tulip, gerberas, chrysanthemum, carnation, gaillardia, marigold, aster, tuberose and lilies are the important floricultural crops in the international cut flower trade.

Indian ornamentals must have their pride of place in this changing scenario. The flora of India is one of the richest in the world owing to the wide range of climate, topology and habitat in the country. More than 3,000 Indian plant species are officially documented; and Western Himalayas, Eastern Himalayas, Assam, Indus plain, Gange plain, the Deccan, Malabar and the Andaman Islands are the main eight floristic regions in India.

In this issue of *The Indian Horticulture*, an effort has been made to review the Indian flora in ancient literature (Ramayana and Sangam literature) to showcase the antediluvian appreciation for flora in Indian society. The power of Indian biodiversity in flower, ornamental plants, trees etc. in floristic regions of India has been discussed in detail. Name, family name, morphological characteristics and propagations method of the ornamentals have been included.

Conservation of biodiversity is an important aspect of floriculture sector so that this wealth can be handed over to the next generation without any loss.

Valley of Flowers has been screened before the adventure lovers – trek and find new enjoyment—, may be some flower is smiling in the wild only for you.

नानामनोज्ञकुसुमद्रुमभूषितान्तान्
हृष्टान्य् अपुष्टनिनदाकुलसानुदेशान्।
शैलेयजालपरिणद्धशिलातलौघान्
दृष्ट्वा जनः क्षितिभृतो मुदम् एति सरः॥ ६-२५ (Ritu Samhaaram of Kavi Kalidasa)

(Interiors of the visible horizon comprising mountains are now adorned with diverse and delightful flowery trees; hurly-burly with the singings of kokilas; masses of rock faces hemmed in and enwrapped with fragrant mountainy moss that comes out now when those rocks were fissured during last summer; to see such an environ, all the people are rejoiced – (Ritu Samhaaram of Kavi Kalidasa))

The Indian flora could be a new entrant in national and international ornamental market. They can offer real alternatives to the existing trend of depending on exotic species which may later turn invasive in the native flora. The sheer beauty of these ornamentals has the power to captivate wild imagination of decorators the world over. We have overlooked the native wealth for too long, the issue has been planned to give the readers a glimpse of Indian flowers and ornamentals. The aim is to provide information so that researchers can work on commercial cultivation and conservation of native flora. This technology intervention can encourage young entrepreneurs to utilize this natural resource to craft new avenues for employment in floriculture and flower-based industries like perfumery etc. and create a prosperous rural arena.

Aruna T Kumar

Valmiki Ramayana – the primogenial database

The Ramayana, the original saga of Shri Ram, was written in Sanskrit by Rishi Valmik, during 3rd century BCE. It contains 24,000 verses (shlok) arranged into numerous cantos (sarga) that are contained in six kaand (books). It had been translated into 25 languages including Italian, French, English. Besides, all the techno-cultural reforms and upheavals witnessed by the country, Ramayana's importance, relevance and reverence has neither dimmed nor eroded.

TILL date Ramayana remains as a perpetual source of inspiration, spiritual solace and fountainhead of guidance for the masses. The reading of the Sanskrit version of Ramayana opens up an era narrated with ethnological precision. It appears as a lyrical version of colonial gazetteer detailing the people with their geographic, political, socio cultural characters. The most striking aspect is the introduction of flora of the regions traversed by Ram, after he was vanquished, and in search of his wife Sita. Valmik refers to Srīngavarapur (located in district Prayagraj) and Nandigram as the locations of Ram's residence in Ayodhya.

Ram's travails starts by crossing the rivers Tamsa, Kaushal, Vedshruti, Gomti, Sayandka, finally reaching to Tripathga Ganga. He reaches Chitrakut, Dandakaranya, travels down to Ramtek. Further, he establishes himself on Panchvati. After kidnapping of his wife he reaches Kishkindha, Anobil, Madurai, Rameshwaram and finally to Lanka, where Sita was held in captivity. The above sites cover all the ecological zones, forests, mountains, river basins and describe the flora as per its geographic location. The flora are mentioned in Balkand, Ayodhya Kand, Aranayakand, Kishkindhakand, Sundarkand, Yuddhakand and Uttarkand.

The forests mentioned in *Ramayana* are namely- Chitrakoot, Dandakaranya, Panchavati, Kishkinda (Pampa sarovar) and Lanka. The forests are classified as per their temperament or *rasa*; as *shanta* (calm), *madhura* (sweet), *raudra* (anger) and *vibhatsya* (fearful). The plants range from various kinds of grass, aquatic herbs, climbers, shrubs, small trees and trees. This wide range of vegetation not only had the utilitarian value as source of food, clothing, medicine, cosmetics, decorative, raw material for construction; but primarily they were an integral part of the fine ecological balance existing between man and nature. Each natural phenomenon was venerated as creation of the supernatural. Worship of plants is a fundamental aspect of religions existing in India. The plants described and mentioned in the *Ramayana* can be classified into several categories. However, here only the edible sacred and medicinal plants will be highlighted with brevity, due to paucity of space.

The widely accepted and popular images and

photographs displayed in the homes and temples are that of Shri Hanuman holding a mountain in his hand. This refers to his bringing *sanjeevani buti* from the trans Himalayan region on the orders of Jambavan, the medicine-man. After Lakshman collapses, on being hit by an arrow, Jambavan had actually requested him to bring four plants: *Mrita Sanjeevani*, *Vishalyakarani*, *Suvarnakarani* and *Sandhani*.

मृतसञ्जीवनीं चैव विशल्यकरणीम् अपि।

सौवर्णकरणीं चैव सन्धानीं च महौषधीम्॥ ६-७४-३३

"You can see there, *Mrita Sanjivani* (capable of restoring the dead to life), *Vishalyakarani* (capable of extracting weapons and healing all wounds inflicted by weapons), *Suvarnakarani* (restoring the body to its original complexion) and *Sandhani*, the great herb (capable of joining severed limbs or fractured bone)." (Yuddhakanda, 6-74-33).

Hanuman on reaching Kailash gets confused by the vast array of herbs and lifts up the entire *oshadhi* mountain. The mountains of Kailash had a thick growth of forest on the southern side where the herbal plants with therapeutic properties were found. These plants were described as glowing and immensely aromatic. Valmiki describes this *oshadhi* peak enveloped in a pleasant aroma. Scientists and researchers have put in a lot of efforts to collect and typify the fabled *sanjeevani* herb. Recent researches have arrived at a conclusion that *Selaginella bryopteris* (Asian spike moss) seems to be the closest to it. It is a lithophytic plant native to India and is used medicinally. Scientific opinions differ and requires further enquiry (<https://down to earth.org>).

The advanced weaponry adorned by Ram and Lakshman during their sojourn in the forest was awe inspiring for the forest dwellers as well as for the hermits. The landmark journey of the threesome was punctuated by their halts in hermitages; where they not only reposed in the safety of the ashram but were also guided and instructed by the sages regarding their establishing a safe lodging with abundance of natural resources including routes to be taken to reach such locales. Each hermitage was established by highly venerated Sages who led the life of ascetics for their spiritual upliftment, atonement, along with a large entourage of pupils who came to learn the Veda and Shastra under them. In this context it is important to note that each of the Sages were not only adept in scriptures but

they were virtual storehouses of knowledge; in the modern parlance had a rich database on the biosphere of the area. The *guru* and *shishya* of these hermitages maintained a balance with the nature; sustaining the natural resources in their pristine form.

Ram along with his three brothers was trained in the Ashram of Muni Vashisht. They were adept to the austere life in the ashram surrounded by forests; thus acquiring ample knowledge regarding ecology and its sustainability. The Holy Scriptures further strengthened the bond between man and nature. The natural resources and their etymology led to the fact that they were either God incarnate or their creator. In *Ramayana* the description of different seasons, the varied landscapes and their fauna and flora along with their utilitarian aspects, appears to be to the point, precise and just. They cannot be labelled as sheer figment of imagination of the Adikavi Valmiki.

Ram on entering the Panchvati beside the river Godavari, chooses the spot and Lakshman constructs the cottage. The description of the surrounding area is as follows (along with translation.)

सालैः तालैः तमालैः च खजूरैः पनसैः द्रुमैः।
नीवारैः तिनिशैः चैव पुत्रागैः च उपशोभिताः॥ ३-१५-१६
चूतैर् अशोकैः तिलकैः केतकैर् अपि चंपकैः।
पुष्प गुल्म लता उपेतैः तैः तैः तरुभिर् आवृताः॥ ३-१५-१७
स्यन्दनैः चंदनैः नीपैः पर्णसैः लकुचैः अपि।
धव अश्वकर्ण खदिरैः शमी किंशुक पाटलैः॥ ३-१५-१८

(Book III : *Aranya Kanda*- The forest Trek Chapter [Sarga] 15)

“These mountains are brightly decorated with trees of *Saala* (Sal tree), *Tala* (Palmyra-palm), *Tamaala* (West Indian Bay tree), *Kharjura* (betel nut palm/black catechu), *Panasa* (Jackfruit), *Druma* (tree), *Nivara* (Bur flower), *Tinisha* (Sandon) with *Punnaagaa* (Tamanu, mastwood), with *Chuuta* (Sweet mango); *Ashoka*, *Tialaka* (Red bead tree), even with *Ketaka* (screw pine tree), *Champak* trees (champak), with *Syandana* (a medicinal plant, Queen Crape/Myrtle), Sandalwood, *Niipa* (Palm/mangrove), *Paarnasa* (Red Cedar/Holy basil), *Lakuch* (bread fruit tree), *dhava* (Red Bell Bush), *Ashwakarna* (East Indian copaiba balsam), *Gurjan* (Gurjan an oil yielding tree), *Khadira* (*Khadirkasth*/Cutch tree/Padang/Acacia Catechu, wild *Pennel*, a medicinal plant), *Shamii* (*Jammi*, *Shami*, *Khejri*, *Jand*, *Ghaf*), *Kimshuka* (*Palash*/*Polash*/*dhak*/*chamata*/*palasu*), *Paatala* trees (*Parul*/*dhapatita*/*parole*/*padli*/*para*), and entwined are those trees with flowered shrubs, and along with climbers, and thus they brighten the mountains.

During Ram's exploits down south in search of Sita, Kabandha raves about Lake Pampa to Ram and delineates the course to be adopted to proceed to Mount Rishyamuka to befriend Sugreeva. He describes Matanga hermitage and implores Ram to visit an anchoress named Shabari, who is waiting for ages to have a glimpse of him (Book III : *Aranya Kanda*- Book of Forest, Chapter [Sarga] 73).

एष राम शिवः पन्था यत्र एते पुष्पिता द्रुमाः।
प्रतीचीम् दिशम् आश्रित्य प्रकाशन्ते मनो रामाः॥ ३-७३-२
जंबू प्रियाल पनसाः प्लक्ष न्यग्रोध तिंदुकाः।
अश्वत्थाः कर्णिकाराः च चूताः च अन्ये द पादपाः॥३-७३-३
धन्वना नाग वृक्षा तिलका नक्तमालकाः।

नील अशोक कदंबाः च करवीराः च पुष्पिताः॥ ३-७३-४

अग्निमुखा अशोकाः च सुरक्ताः परिभद्रकाः।

“Oh, Ram, have a recourse to westward, and where the trees of Rose-apple, Priyaala (chiraunji), jackfruit, Plaksha (Grey fig / kamandal / parkatia / pitan/pilkhan/Ram Anjir/plav/paakariya), Banyan, Tinduka (Indian persimmon/Mountain ebony), Pipal, Karnikara (Hathipaila/Muchkund/kanak Champa/Padma pushp/parivyadh), mango, and others... and even trees like Dhanva (Malsauri), Naaga (Ironwood Tree /Mesua), Tilaka (Sesame) , Naktamaala (Indian pongamia /Karanja /aranj/pungai/pungu/ponnu), blue Ashoka, Kadamba (Bur flower tree/Laran/leichhardt pine), Karaviira (Oleander/Rose-laurel/ kaner/karber/ Manja arali/kannaviram, a poisonous plant), Agnimukha (Indian marking nut tree), Ashoka, red-sandalwood trees and Neem trees will be heart-pleasingly shining forth in full blossom, that alone is an optimistic course for you.

The travelogue of Ram takes one through different eco-zones beginning from Ayodhya's Nandigram and ending in Lanka, the emerald island. It also covers the Himalyan ranges traversed by none other than Hanuman. The pace of the journey through forests of Chitrakuta, Dandakaranya, Panchavati, Kishkindha have been depicted as arduous, difficult and challenging. The eco-systems of each zone were different and throughout the text that has been accurately mentioned; along with the natural and supernatural aspects of each plant.

On objectively viewing the text it becomes evident that the botanical aspect of each plant and the additional information provided by Valmiki; goes to prove that he had the complete knowledge about the geography, flora, fauna and the ethnic component of the region which is roughly 5,195 km in length. This epic poetry is nothing less than an ethnographic description. The data amassed by Valmiki is commendable, since this happens to be the primeval source of information on man and his biosphere in that era. Adikavi appears to be a surveyor par excellence. Here one is tempted to ponder, whether, Valmiki had amassed the data from different sages and ashrams or he himself had undertaken the journey from that is Devbhasha-Sanskrit.

As mentioned earlier it has been translated into large number of Indian and foreign languages. Whereby, each translator has taken the liberty to interpret, analyse and add regional information to suit the local ethos. Therefore, Valmiki Ramayana still remains a rich database for conducting multidisciplinary studies, which will not be directed to validate Valmiki's writing on scientific parameters; but to review and retrospect on the contemporary scenario of the flora of the Indian subcontinent. The taxonomical and supernatural continuum of the plants over 2500 years goes to establish the authenticity of Valmiki Ramayan. Further, in depth analyses and research on this epic would pave the way to understand why and how we have lost certain species and varieties of rice, grass, basils and medicinal plants.

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Native ornamentals of the sangam age

Plant wealth of any country can be characterized into wild (native) plants and exotic (plants by introduction) types. India is one of the rich biodiversity hot spots of the world, blessed with ample number of plants, many with ornamental value. The biodiversity spots in India having wide range of plants with diverse adaptability, makes each and every state of the country a rich plant treasure. Tamil Nadu is the first state to have acquired the classical language status for its state language. Tamil has a rich cultural heritage, and is very unique in conserving and maintaining its rich plant diversity since Sangam age (200 BC to 300 AD). The Tamil Brahmi inscriptions deciphered during the recent past have established the contemporaneity of the inscriptions with the Sangam age. From the inscriptions, the association of plants with the people and places during that age is well informed. The mention of about 260 plants shows the association of people in Sangam age with different places of world.

THE major available Tamil literatures of this period are the major eighteen anthology series (*Pathinen melkanaku*) comprising the eight anthologies (*Ettuthogai*) and the ten Idylls (*Pathupattu*), and the minor eighteen anthology series (*Pathinen keelkanaku*) have a clear description of the ornamental plants usage by the people during that period. *Tolkappiyam* believed to be the age old ancient Tamil literature has shown the association of five landscapes (*Thinai*) with the life style of the people who lived in Kurinji, Mullai, Neithal, Palai and Marutham regions.

Importance to ornamental plants during the Chera, Chola, Pandya and Pallava periods

The three main kingdoms of the *Sangam* period were the Cheras, the Cholas, and the Pandyas, and each had a flower as an emblem. The Chola emblem was *aatthi* or *aar* identified as *Bauhinia racemosa* a small tree found in jungles. The Pallavas had as their emblem the *thondai* flower. *Thondai* or *Aathondai* is a large thorny climber bearing white filamentous flowers, which turn pinkish brown. *Nandi Kalambakam*, a post-*Sangam* work of the ninth century, not only mentions the garland of the Pallava king made of the *thondai* flowers but also compares the reddish colour of the *thondai* fruit to lips of beautiful women. During the later period, *thondai* fruit was used in the same way as the more common *kovai* fruit (*Coccinia indica*). During the time of *Silapathikaaram*, a pre-Pallava work, *kovai* was used to describe the lips and *kumizhi* the nose of pretty women. *Kumizhi* (*Gmelina asiatica*) is a common shrub in jungles with yellow flowers and small globular fruits. *Kumizhi* was used to make musical instruments such as the *yaazh* during the early period. The yellow globular fruits were compared to gold coins. The Indian Laburnum (*Cassia fistula*) is the *konrai* of the *Sangam* period. The flowers of *vaahai* are not bright yellow

like the flowers described so far but white which turns to cream yellow. It is the emblem of victorious armies and winners of debates. The flower is compared to the plummy crest of a peacock. It is now called *kaattu vaahai* (*Albizia lebbek*) the most common tree in the tropics. *Punnai* (*Calophyllum inophyllum*) with shiny dark green leaves and sweet scented, pure white flowers with yellow anthers is also referred to a number of times in *Sangam* literature as a tree found on the coastal region. One of the spectacular jungle flowers is the *kaayaa* (*Memecylon edule*) referred to in *Sangam* literature. It is a large shrub with clusters of deep blue flowers arranged like a powder-puff and red berries. The bluish purple flowers of the *nochi* shrub (*Vitex negundo*) was compared to the feet of a peacock. The *murukku* tree is identified with the true Flame of the Forest (*Butea frondosa*). The Scarlet Ixora (*Ixora coccinea*) a common garden plant called *idli poo* in Tamil, was known as *vetchi* during the *Sangam* period. The Ixora buds were compared to the back spur of the fighting game partridge. A beautiful twiner, with deep orange flowers is the climbing glory lily or *kaanthai* (*Gloriosa superba*). The flower has six narrow petals with frilled margins and a changing colour. The *Sangam* poets compared the petals to lanterns, broken bangles, women's fingers and the hooded cobra.

Association of plants with five landscapes of Tamil Nadu

Sangam literature illustrates the thematic classification of five landscapes scheme first described in the *Tolkappiyam*. The classification ties the emotions involved in agam poetry to a specific landscape. These landscapes are called *thinai*. They are *kurinji*, mountainous regions; *mullai* forests; *marutham*, agricultural land; *neithal* coastal regions; *paalai* deserts. Each *thinai* was closely associated with a particular landscape, and imagery associated with

that landscape - its flowers, trees, wildlife, people, climate and geography was woven into the poem in such a way as to convey a mood, associated with one aspect of a romantic relationship. Ornamental plant species like Vengai (*Pterocarpus marsupium*), bamboo, sandal, lotus, sangoo poo, gundumalli, thanakku, nochi, punnai, kurinji, gloriosa, vilvam, *Butea monosperma*, shenbegam, *teminalia*, *aristolochia* sp., *Bambusa arundinaceae*, *Dendrocalamus*, *Cassia* spp., *Caesalpinia*, Thulasi of Mullai, *Lagerstroemia*, *Bauhinia tomentosa*, Plumbago, Peepal, *Cynodon* of Marudham, Thazhampoo (Pandanus) Kalli (*Opuntia dillenii*) of Neidhal and species like acacia, albizia, neem, tamarind, *Aloe vera* of the desert system of Paalai are the well known native plants suitable for landscaping in this modern era too to have a sustainable landscape.

Ornamental plant wealth of Sangam age

Saraca asoca, *Madhuca longifolia*, *Acacia chundra*, *Albizia* spp., *Ficus glomerata*, *Jasminum angustifolium*, *Holoptelea integrifolia*, *Nymphaea pubescens*, *Ficus religiosa*, *Alpinia calcarata*, *Nelumbo nucifera*, *Nerium oleander*, *Bambusa* spp.,

Calotropis gigantea, *Indigofera tinctoria*, *Cyanodon dactylon*, *Adhathoda zeylanica*, *Bauhinia racemosa*, *Ficus benghalensis*, *Cassia auriculata*, *Bauhinia* sp., *Ficus virens*, *Ficus talbotii*, *Cassia fistula*, *Nymphaea* sp., *Jasminum* sp., *Acacia* sp., *Ficus tinctorium*, *Bombax ceiba*, *Cyperus* sp., *Rhododendron nilagiricum*, *Hiptage benghalensis*, *Caesalpinia* sp., *Carissa caandas*, *Clitoria ternatea*, *Bauhinia tomentosa*, *Gmelina arborea*, *Barleria*, *Caryota urens*, *Aegle marmelos*, *Pandanus odoratissimus*, *Plumbago*, *Michelia champaca*, *Hibiscus*, *Gyrocarpus americanus*, *Corypha umbraculifera*, *Bauhinia purpurea*, *Wrightia tinctoria*, *Clerodendron inerme*, *Pongamia pinnata*, *Thespesia populnea*, *Phoenix sylvestris*, *Lagerstroemia reginae*, *Ficus glomerata*, *Delonix elata*, *Ixora coccinea* and *Dendrocalamus strictus* are the important ornamental plants mentioned in the Sangam literature.

Flowers in Kurinjpattu

Mentioning of 99 flowers in Kurinjpattu by the poet Kabilar specifies the relationship of plants in the mountainous region with Lord Muruga, a Tamil god. Among the 99 flowers, synonymous name for some plant

Flower wealth mentioned in Kurinjpattu

Vernacular name in Tamil	Botanical name
Senkanthal	<i>Gloriosa superba</i>
Aambel	<i>Nymphaea pubescens</i>
Anichem	-
Kuvalai (Sengkaluneer)	<i>Nymphaea</i> sp.
Kurinchi	<i>Strobilanthes junthiana</i>
Vetchi	<i>Ixora coccinea</i>
Senkoduvaeri	<i>Plumbago rosea</i>
Thaema	<i>Mangifera indica</i>
Manichigai (Semmani)	<i>Erythroxylum monogynum</i>
Unthool (Peru moongil)	<i>Dendrocalamus gigantea</i>
Koovilam (Vilvam)	<i>Aegle marmelos</i>
Aerulam	<i>Rhododendron nilagiricum</i>
Sulli	<i>Diospyros ebenum</i>
Kooviram	<i>Dolichondrone falcate</i>
Vadavanam	<i>Albizia</i> sp.
Vaagai	<i>Albizia lebbek</i>
Kudasam (Vetapaalai)	<i>Holarrhena pubescens</i>
Eruvai (Korai)	<i>Cyperus</i> sp.
Seruvilai (Sangu)	<i>Clitoria ternatea</i>
Karuvilai	<i>Clitoria</i> sp.
Payini	<i>Vateria indica</i>
Vaani	-
Kuravam	<i>Tarenna asiatica</i>
Pasumpidi (Ilamugil)	<i>Garcinia xanthochymus</i>
Vagulam (Mahilam)	<i>Mimusops elengi</i>
Kaaya	<i>Memecylon edule</i>
Aavirai	<i>Cassia auriculata</i>
Vaeral	<i>Dendrocalamus strictus</i>
Sooral (Thoothuvalai)	<i>Solanum trilobatum</i>
Poolai	<i>Aerva tomentosa</i>
Kanni (Kundrimani)	<i>Abrus precatorius</i>
Kurugilai	<i>Tarenna asiatica</i>
Marutham	<i>Lagerstroemia reginae</i>
Konkgam	<i>Cochlospermum gossypium</i>

Vernacular name in Tamil	Botanical name
Povengam	-
Thilagam	<i>Adenantha pavonina</i>
Paathiri	<i>Stereospermum chelonoides</i>
Serunthi	<i>Ochna obtusata</i>
Athiral (Kattu malligai)	<i>Jasminum angustifolium</i>
Senbagam	<i>Michelia champaca</i>
Karanthai	<i>Sphaeranthus indicus</i>
Kulavi (Kattu mullai)	<i>Jasminum</i> sp.
Kalima	<i>Mangifera indica</i>
Thillai	<i>Excaecaria agallocha</i>
Paalai	<i>Wrightia tinctoria</i>
Mullai	<i>Jasminum auriculatum</i>
Kullai (Kattu thulasi)	<i>Ocimum canum</i>
Pidavam	<i>Randia malabarica</i>
Maarodum	<i>Acacia chundra</i>
Vazhai	<i>Musa paradisiaca</i>
Valli	<i>Ipomoea</i> sp.
Neithal	<i>Phyllanthus emblica</i>
Thazhai	<i>Pandanus odoratissimus</i>
Thalavam	<i>Jasminum</i> sp.
Thamarai	<i>Nelumbo nucifera</i>
Gnazhal	<i>Cassia sophera</i>
Mauval	<i>Jasminum</i> sp.
Kogudi ‘	<i>Jasminum auriculatum</i>
Saedal	<i>Jasminum</i> sp.
Semmal	<i>Jasminum grandiflorum</i>
Sengurali	-
Koedal	<i>Gloriosa</i> sp.
Kaithai	<i>Pandanus</i> sp.
Vazhai (Sura punnai)	<i>Mammea suriga</i>
Kanchi	<i>Trewia polycarpa</i>
Neithal	<i>Phyllanthus emblica</i>
Paankar	<i>Dillenia indica</i>
Mara (Kadambu)	<i>Neolamarckia cadamba</i>
Thanakkam	<i>Gyrocarpus americanus</i>

Vernacular name in Tamil	Botanical name
Eengai	<i>Mimosa intsia</i>
Elavam	<i>Ceiba pentandra</i>
Konrai	<i>Cassia fistula</i>
Adumbu	<i>Ipomoea pescaprae</i>
Aadthi	<i>Bauhinia racemosa</i>
Avarai	<i>Lablab purpureus</i>
Pakanrai	<i>Operculina turpethum</i>
Palasam	<i>Butea monosperma</i>
Pinndi	<i>Saraca asoca</i>
Vanchi	<i>Thespesia populnea</i>
Pithigam	<i>Jasminum spp.</i>
Sinthuvaram	<i>Vitex negundo</i>
Thumbai	<i>Leucas aspera</i>
Thulaai	<i>Ocimum canum</i>
Thondri	<i>Gloriosa superba</i>

Vernacular name in Tamil	Botanical name
Nandhi (Nandhiyavattam)	<i>Tabernaemontana coronaria</i>
Naravam	<i>Caesalpinia spp.</i>
Punnagam	<i>Mammea suriga</i>
Paaram (Paruthi)	<i>Gossypium arboreum</i>
Peeram	<i>Luffa cylindrica</i>
Kurukkathi	<i>Hiptage benghalensis</i>
Aaram	<i>Santalum album</i>
Kaallvai	<i>Aquillaria agallocha</i>
Punnai	<i>Calophyllum inophyllum</i>
Naranthum	<i>Citrus spp.</i>
Nagam	<i>Mammea suriga</i>
Nallirul naari	<i>Jasminum spp.</i>
Kurunthu	<i>Atalantia monophylla</i>
Vaengai	<i>Pterocarpus marsupium</i>
Pulagu (Malai eruku)	-

species are also observed. The list of 99 plants is mentioned below:

The fact that the plants Vaani, Povengam, Sengurali and Pulagu mentioned above remain botanically unspecified till date indicates the complexity of ornamental plant diversity that existed during the Sangam age.

Conclusion

Utilization of indigenous and native plants in any landscape design would ultimately ensure sustainability of the plant species as well as the landscape. As the rural map of the villages connecting metros are getting vanished due to the rapid urbanization, globalization and informatization conserving the native ornamental plant wealth has now become a real challenge for any landscapists in this corporate era. The much required

trend in present day landscape gardening is “going with native ornamental plants” in an aesthetic way. Some of the native ornamentals mentioned during *Sangam* age are finding place in this modern day landscape too, indicating their adaptability to diverse condition apart from their aesthetic value. So identifying the native plants by utilizing the information available in the Sangam literature is the need of the hour as these literatures are the real treasures showcasing the rich cultural heritage of Tamil Nadu and will be useful to the modern contemporary sustainable landscaping.

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Status of indigenous ornamental plants in India

The total geographical area of India is estimated to be about 329 million ha with a coastline ranging over 7,500 km. The ecosystem or ecological diversity prevailing in our country is enormous, ranging from sea level to the highest mountainous ranges; hot and arid conditions in the northwest to cold arid conditions in the trans-Himalayan region; tropical wet evergreen forests in Northeast India and the Western Ghats; mangroves of Sundarbans and freshwater aquatic to marine ecosystems. India is reported to have 12 biogeographical provinces, 5 biomes and 3 bioregion domains. India is rich in varied array of ecosystem or habitats like forests, grasslands, wetlands, coastal, marine and desert along with rich and unique diversity of flora and fauna.

THE geographical location of our country is at the confluence of three major global biogeographic realms, viz. Indomalayan, Eurasian and Afro-tropical, thus allowing the merging of floristic components from these regions also, thus making it one of the 17 mega diversity countries in the world. India is rich in all the three levels of biodiversity such as ecosystem or habitat diversity, genetic diversity and species diversity.

Ecosystem or habitat diversity of India

The geographical area cover of the country represents about 2.4% of the world's total landmass. The major ecosystems in India are forests, grasslands, wetlands, coastal, marine and desert. The forest cover of the country is estimated to be about 21.05% (692,027 km²) of India's total geographical area. Sixteen major forest types comprising 221 subtypes have been recognised in the country. India constitutes about 4.1 million hectares of wetlands (excluding paddy fields and mangroves). An area

of about 6,700 km² is covered by mangroves in India, and it constitutes 7% of the world's mangroves which represent one of the best swamps in the world. Andaman and Nicobar Islands, Lakshadweep Islands, Gulf of Kutch and Gulf of Mannar are rich in coral reef, one of the unique marine ecosystem in the country. The desert ecosystem spreads over the states of Rajasthan, Gujarat, Punjab and Haryana and covers about 2% of the total landmass which are characterised by low precipitation and largely barren arid lands with only scanty or seasonal vegetation cover. An area of about 1,09,990 km² is covered by cold desert which lies in Ladakh (Jammu and Kashmir) and in Lahaul-Spiti of Himachal Pradesh.

Species diversity of India

India is reported to harbour about a total of 47,513 plant species out of about 0.4 million hitherto known in the world, representing as much as 11.4% of the world flora. About 28% of plants that occur in India are endemic



Bauhunia purpurea



Cassia nodosa



Spathodea campanulata

to the country. Unfortunately, many people in India are not aware of the rich heritage of floristic diversity that exists in our country. Floristic diversity in India is concentrated mainly in four biodiversity hotspots, namely Eastern Himalayas, Western Ghats (and Sri Lanka), Northeast India and Andaman Islands (Indo-Burma) and Nicobar Island (Sunderland), out of the 34 biodiversity hotspots recognised in the world. Varied types of agro climatic, ecologic and edaphic conditions exist in these regions. These significant areas in floristic diversity is reported to exhibit exceptional concentration of endemic plant species.

Three mega centres and 25 micro centres of endemic plants in Indian Subcontinent are reported based on the diversity and distribution of endemic species. Mega centres include Eastern Himalaya, Western Ghats and Western Himalaya. Micro centres for endemic Plants include Andaman group of Islands, Nicobar group of Islands, Agasthyamalai hills, Anamalai and High ranges (Cardamom hills), Palni hills, Nilgiris – Silent Valley, Wyanad, Kodagu, Shimoga – Kanara, Mahabaleshwar – Khandala ranges, Konkan – Raigad, Marathwada – Satpura ranges, Tirupati – Cuddappa – Nallamalai hills, Vishakapatnam – Ganjam – Jeypore hills, Southern Deccan (Leeward side), Chotanagpur plateau, Kathiawar Kutch, Rajasthan – Aravalli hills, Khasia – Jaintia hills, Patkoi – Manipur – Lushai hills, Assam, Arunachal Pradesh Himalaya, Sikkim Himalaya, Garhwal – Kumaon Himalaya, Lahaul – Himachal Pradesh Himalaya and Kashmir – Ladak Himalaya. Presence of these endemic centres reflects the significantly high level of endemism in the flora of India.

A great scope exists for carrying out research in indigenous ornamental plant species of India. The rich plant biodiversity that exists in India has an intrinsic value which needs to be protected and explored for the benefit of our future generations. The native or indigenous ornamental plant species, which exist in India offer large genetic diversity for bio-prospecting.

Published works and research done so far

Indigenous ornamental plant species of India plays a very important role which can meet the present and future

needs of various crop improvement programmes. The present paper attempts to highlight the the status of research works carried out so far on Indigenous ornamental plants in India.

In 1832, Roxburgh W described about the phenology of wild and cultivated plants of India. The *Flora of British India* by Sir J.D. Hooker (1872-1897) is considered to be the National Flora of India. Flora of the upper Gangetic plain, and of the adjacent Siwalik and sub-Himalayan tracts was described by Duthie (1905). Collet in 1902 given detailed account of the flowering plants of Shimla and the neighbourhood. Forest Flora of the Chakrata, Dehra Dun and Saharanpur Forest Divisions were compiled by Kanjilal and Gupta in (1928). Mc Cann in 1959 described about 100 Beautiful Trees of India in his descriptive and pictorial handbook. Lelle and Misra in 1961 reported some wild and naturalized flowering plants of Shimla Hills. Pal in 1960 described 39 beautiful climbers of India. A work covering shrubs useful for gardens in Indian and similar climates including Indian natives was reported by Pal and Krishnamurthi in 1967.

Jain in 1976 published an extensive survey of the *Juniperus* populations in various parts of the Himalayas with morphological as well as anatomical characters details. Randhawa in 1957 described the tropical ornamental trees of India on the basis of natural order, botanical and English names, flowering period, flower colour and gardening notes. A book on flowering trees and shrubs in India was compiled by Cowen. Pratibha in 1989 made an attempt to compile 117 shrubs of India. Shrubs from the plains as well as the hills, the shrubs common in different parts of India and the shrubs attractive for their flowers, foliage, fragrance or berries/fruits were reported to indicate their suitability in different areas. Information provided with respect to time of flowering time, sizes etc. is more accurate in respect of central and north Indian regions, specially the hill areas.

Study of native and naturalized ornamental plant species of Himachal Pradesh

Investigations were carried out to study native, naturalized and introduced species of 250 landscape plants during 1997-1999 that were located at Bilaspur, Solan and Shimla in Himachal Pradesh and a database was prepared for the landscape plants.

Wild ornamentals selected for landscaping Sub tropical, low hills (Zone 1)

Wild ornamentals selected for landscaping in different agro-climatic zones of Himachal Pradesh were studied. In Sub tropical, low hills (Zone 1) during February-April; wild ornamental trees like *Albizia chinensis*, *A. julibrissin*, *Ehretia laevis*, *Erythrina indica*, *Wendlandtia exerta*; shrubs like *Adhatoda vasica*, *Eranthemum pulchellum*, *Jasminum pubescens*, *Murraya koenigii*, *Phlogacanthus pubinervius*; climbers like *Abrus precatorius*, *Trachelospermum fragrans* etc burst into blooms. In May-July; trees like *Cassia fistula*, *Erythrina indica*; shrubs like *Clerodendron viscosum*, *Cotinus coggygia*, and climber like *Ipomoea purpurea* come into flowering. In August-October; shrubs like *Ipomoea carnea*, *Nyctanthes arbor tristis*, in November-January; shrubs like

Colebrookia oppositifolia, *Perilepta auriculata* and climbers like *Celastrus paniculata*, *Porana grandiflora* come into flowering.

Wild ornamentals selected for landscaping Sub tropical, mid hills (Zone 2)

Wild ornamentals selected for landscaping for Sub tropical, mid hills (Zone 2) were also reported. During February-April; wild ornamental trees like *Bauhinia variegata*, *Bombax ceiba*, *Butea monosperma*, *Erythrina indica*, *Pistacia integerrima*; shrubs like *Caryopteris bicolor*, *Coriaria nepalensis*, *Deutzia staminea*, *Hypericum oblongifolium*, *Indigofera pulchella*, *Jasminum humile*, *Reinwardtia indica*, *Strobilanthes alatus*, *Woodfordia fruticosa*; climbers like *Jasminum dispersum*, *Trachelospermum fragrans*, *Rosa brunonii*; herbaceous plants like *Gerbera gossypina*, *Ranunculus laetus*, *Salvia lanata*, *Salvia moorcroftiana*; orchid like *Vanda cristata* and bulbous plant like *Gloriosa superba* burst into flowering. During May-July; wild trees like *Albizia chinensis*, *A. julibrissin*, *Aesculus indica*, *Benthamidia capitata*, *Bauhinia variegata*, *Cassia fistula*; climbers like *Ficus foveolata*, *Rosa brunonii*, *Vallaris heynei*; herbaceous plants like *Anthemis coluta*, *Gerbera gossypina*, *Salvia coccinea*, *Senecio nudicaulis*; orchids like *Aerides multiflora*, *Dendrobium amoenum*, *Rhyncostylis retusa*; bulbous plants like *Begonia picta*, *Gloriosa superba*, *Gonatanthes sarmentosus* can be selected for landscaping. During August-October, tree like *Kydia calycina*; shrub like *Barleria cristata*, *Holmskioldia sanguinea*, *Inula cuspidata*; climbers like *Atylosia mollis*, *Clematis grata*, *Clematis nutans*, *Clematis gouriana*; herbaceous plants like *Salvia coccinea*, *Senecio chrysanthemoides* and during November-January; *Bauhinia purpurea*, shrubs like *Inula cuspidata* and climbers like *Smilax aspera*, *Vitis himalayana* can be selected for landscaping.

Wild ornamentals selected for landscaping Wet temperate, high hills (Zone 3)

The wild ornamentals selected for landscaping of Wet temperate, high hills (Zone 3) are as follows. During February-April; wild ornamental trees burst into flowering e.g; *Rhododendron arboreum*, *Pistacia integerrima*; shrubs like *Hypericum oblongifolium*, *Jasminum humile*, *Myrsine africana*, *Reinwardtia indica*, *Strobilanthes alatus*; climbers like *Clematis montana*, *Hedera helix*, *Rosa brunonii*; herbaceous plants like *Primula denticulata*, *P. floribunda*; ferns like *Adiantum capillus veneris*, *Christella dentata*, *Woodwardia unigemmata*; orchid *Vanda cristata*; bulbous plants like *Anemone obtusiloba*, *Bergenia ciliata*, *Iris kaemaonensis*, *Polygonatum multiflorum*, *Tulipa stellata*. During May-July; wild trees like *Aesculus indica*, *Benthamidia capitata*, *Bauhinia variegata*; shrubs like *Cotoneaster microphylla*, *Deutzia staminea*, *Rosa macrophylla*, *Sorbaria tomentosa*; climbers like *Clematis montana*, *Rosa brunonii*; herbaceous plants like *Anthemis coluta*, *Anemone obtusifolia*, *Aquilegia pubiflora*, *Corydalis govaniana*, *Thymus linearis*; ferns like *Cheilanthes albomarginata*, *Christella dentata*, *Polystichum discretum*, *Woodwardia unigemmata* and orchids like *Aerides multiflora*, *Dendrobium amoenum*, *Rhyncostylis retusa*. During August-October; autumn flowering display tree like *Prunus cerasoides*; shrubs like *Hypericum uralum*, *Inula cuspidate*, *Strobilanthes dalhousiae*; climbers like *Clematis nutans*,

Clematis buchananiana; herbaceous plants like *Anaphalis matgaritacea*, *Anemone obtusifolia*, *Anemone vitifolia*, *Aster thomsonii*, *Delphinium vestitum*, *Senecio chrysanthemoides*; ferns like *Adiantum capillus veneris*, *A. venustum*, *Asplenium dalhousie*, *Pteris cretica*, *Woodwardia unigemmata*; bulbous plants like *Anemone vitifolia*, *Asparagus adscendens*, *Gloriosa superba*, *Gonatanthes sarmentosus*, *Hedychium spicatum*. During November-January; trees like *Ilex dipyrrena*, *Prunus cerasoides*; shrubs like *Cotoneaster macrophylla*, *Daphne bholua*, *Daphne cannabina*, *Eunymous tingens*, *Pyracantha crenulata*, *Viburnum cylindricum*, *V. mullaha* and herbaceous plants like *Aconogonum molle*, *Aster thomsonii* are suitable.

Wild ornamentals selected for landscaping Dry temperate, high hills (Zone 4)

It was reported that in Dry temperate, high hills (Zone 4), during May-July; trees like *Acer palmatum*, *Albizia julibrissin*, *Rhododendron campanulatum*; shrubs like *Caragana gerardiana*, *Daphne mucronata*, *Hypericum choisianum*, *Rosa webbiana*; herbaceous plants like *Corydalis govaniana*, *Incarvillea arguta*, *Inula obtusifolia*, *Oxytropis mollis*, *Primula denticulata*, *Thymus linearis*; bulbous plants like *Anemone tetrsepala*, *Asparagus filicinus*, *Iris kaemaonensis*, *I. lactea* can be selected for landscaping. During August-October; *Rosa webbiana* in flowering followed by fruiting and bulbous plants like *Bistorta affinis*, *Cotoneaster microphylla* and *Sedum ewersii* present a great landscape show.

HIMFLORA: Computerized database of native landscape plant species in Himachal Pradesh

A computerized database of important native landscape plant species in Himachal Pradesh was developed. Plants, from their natural habitats, can be selected for the beautification of parks, public and private places in urban as well as in rural areas. With this idea in view, a study on native landscape plants was undertaken in all four agro-climatic zones of Himachal Pradesh. The state is gifted with the wide array of landscape plant species and this diversity in plant species may be due to varying geophysical and climatic conditions prevailing in different parts of the state. Identification and evaluation of native trees, shrubs, climbers and herbaceous plants, orchids and ferns was done on the basis of habit, form, height, spread, bark character, foliage characters (leaf texture, arrangement, colour, shape, size, emergence and fall leaf colour), flowering characters (inflorescence, flower colour, shape, size and flowering period), fruiting characters (fruit colour, shape, size and fruiting period) and their landscape uses. A specific relational database management system (RDBMS) 'HIMFLORA' was prepared in MS Access XP on the basis of data generated on morphological description and landscape values of plant species during this study. HIMFLORA provides information according to the user need for different purposes in desired formats and according to different combinations of stored characters. This computer-aided decision making is not only useful in selecting suitable plant species for landscaping of preferential sites but also for taking quick decisions in landscape designing of other identical agro-climatic zones of the country.

HIMFLORA, the computerized botanical database on

wild ornamental plants of Himachal Himalayas contains detailed records of 250 wild ornamental plants (36 trees, 82 shrubs, 28 climbers, 56 herbaceous plants, 18 ferns, 11 orchids, 19 bulbous plants) having 30 fields (Botanical name, common name, family, plant habit, plant type, life-span, place where found growing, altitude, longitude, latitude, plant form, bark characters, stem characters, leaf texture, leaf arrangement, leaf colour, leaf shape, leaf margin, fall leaf colour, sori and rhizome character incase of ferns, fall leaf duration, inflorescence, flower colour, flower fragrance, flower shape, flowering period, flowering time, fruit colour, fruit shape, fruiting duration, ornamental plant use and other uses) representing four agro-climatic zones of Himachal Pradesh. In this database, desirable plants can be retrieved according to morphological and plant use characters combined with specific zones of the state. Potential users of this database can be landscape architects, botanists, horticulturists, garden entrepreneurs, landscape designers, town and country planners, policy makers, landscape ecologists, in GIS application, plant conservationists, public educators *etc.* Besides having ornamental uses, these plants growing naturally in the state, are of medicinal and economic use also. School children and science graduates can learn about identification of natural wealth of flowers and their potential uses. This database can be extended at country level and can be integrated with worldwide databases and plant resources. There are more opportunities for consumers to add more number of diverse or namental plants in their gardens. Further more, there is a scope of commercialization and bringing up of some potential plants in the market as novelty items in future. (Source: <http://www.jspuniversity.ac.in/dhaulakuan/priyanka1.pdf>).

Flowers of India (FoI): Website providing information about the flowers found in India

A website, Flowers of India (FoI) with address <http://www.flowersofindia.net/>, was developed during 2005. It is aimed at providing information about all the flowers found in India, with their common names, especially in Indian languages, pictures and habitat, easily available in one place. The website developers routinely consult various sources for identifying the flowers, and preparing the information about them on the site. The sources used for FoI data are The Plant List, Flowers of the Himalaya, Oleg Polunin and Adam Stainton, Flowers of the Himalaya: A Supplement, Adam Stainton (OUP: Delhi, 1988), Botany: the Botanical Dictionary, Flora of British India by J. D. Hooker (London :L. Reeve, 1875-97), India Biodiversity Portal, eFlora of India, Wikipedia, Encyclopedia on Indian Medicinal Plants, Names of Plants in India, Multilingual Multiscript Plant Name Database, Flowers of Sahyadri, S. Ingahalikar (Corolla: Pune) 2001, Further Flowers of Sahyadri, S. Ingahalikar (Corolla: Pune) 2007, Medicinal Plants of Manipur, S.C. Sinha (MASS: Imphal) 1996, The Economic Plants of Manipur and their Uses, S. Sukumar Singh (Manipur, 2006), Floridata, Trees of Delhi, Pradip Krishen (DK, New Delhi, 2005), RHS Encyclopedia of Plants and Flowers, Christopher Brickell (DK, 2010), Flora of Ladakh (NW Himalaya), by L. Klimeš and B. Dickoré *etc.* (Source: <http://www.flowersofindia.net>).

Work done by CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora)

CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments and it has come into existence to ensure international trade in specimens of wild animals and plants does not threaten their survival. The species protected by CITES are listed in three Appendices namely Appendix-I, II and III according to the degree of protection required to control overexploitation. About 75 Indian plant species are listed in various CITES Appendices.

Appendix-I: It includes species which are most endangered and are threatened with extinction. 14 plants are listed in Appendix-I.

Appendix-II: It includes species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid over-utilization which is detrimental to survival of the species. 57 plants are listed in Appendix-II.

Appendix-III: It includes a list of species included at the request of a country that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation. Although India has not proposed any plants to be included in Appendix III, 4 plants that are listed in Appendix -III by Nepal have been included in Indian plants list as distribution of these plants overlap between two countries.

Apart from above species, the entire Orchidaceae species (1309 species) and all the species of Cactaceae (excluding *Pereskia* spp., *Pereskopsis* spp. and *Quiabentia* spp.) have been included in CITES appendices. The CITES designation to these plants listed include not only live or dead plants but also plant parts like seeds, vegetative propagules, flowers, leaves and plant or plant part extracts and derivatives. Therefore, apart from plant and plant parts the products prepared from plants, plant parts and extracts are also subjected to CITES control. This checklist of Indian plants in CITES Appendices is a very useful ready reckoner for various CITES enforcement agencies in the country.

efloraofindia – A Database of Indian Plants

efloraofindia (eFI) website – A Database of Indian Plants have been developed by the members of efloraofindia Google Group during 2010. It is one of the biggest non-commercial sites, one of its kind in the world, based on the collection of photographic images of plants. It is documenting flora of India that is being discussed on efloraofindia google e-group along with supplementing the working of the group. It also has the largest database on net on Indian Flora with more than 12,000 species (along with more than 300,000 pictures, from some of the best Flora Photographers of India, at its efloraofindia e-group links). It also includes some species from around the world, which has been posted by the members of group. More than 170,000 images have already been displayed at species' pages along with displaying these at genera and family pages for comparative purposes for easy identification.

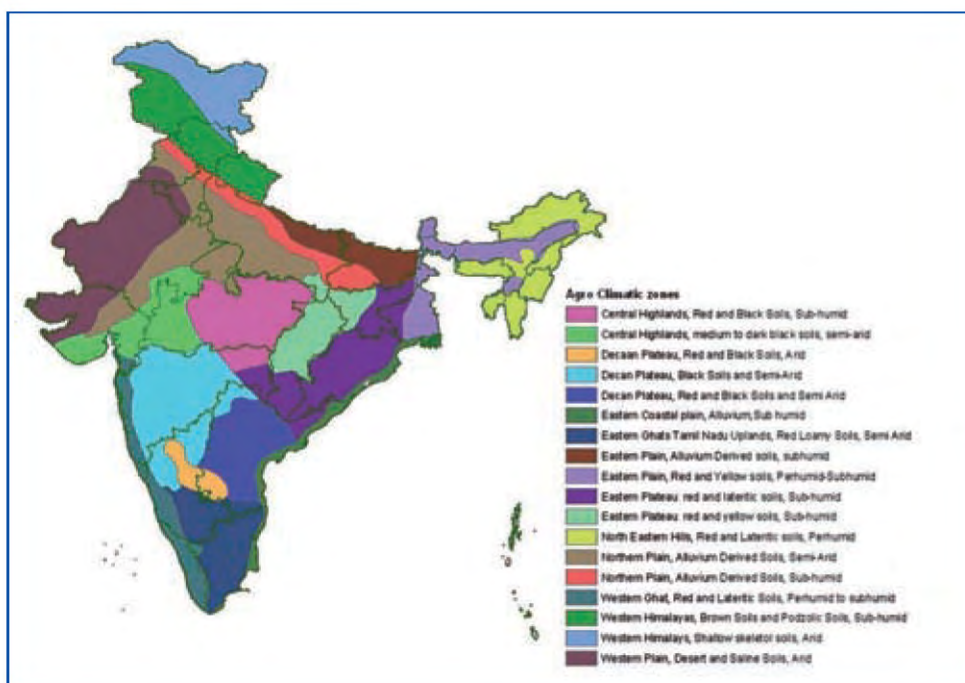
A species database is being maintained on this website family wise, genera wise and then species wise. Intent of this database is compilation of all the posts on 'efloraofindia' e-group along with providing other details so that it is useful to all concerned as all the data about a particular species will be available under a single page and easily searchable. Attempts are also being made to update genera pages so as to incorporate most of the species available in India and nearby areas with details and keys (photographic as well as textual) directly or through links as far as possible. Species database pages contain botanical names with publication details and their synonyms mostly from 'The Plant List'/ GRIN/ eFloras (Flora of Pakistan/ Nepal/ China)/ e-books from India/ other references etc., pronunciation, etymology and nativity, common names in different languages, descriptions (it can also be checked from reference links of eFloras/ e-books/ flowersofindia site etc. given at the bottom), efloraofindia e-group discussion links (which contain full discussions verbatim along with pictures from foremost Flora photographers & experts), summarized discussions from these links, flowering data/ place of pictures, important links, reference links etc.

A study on the assessment of floristic diversity in Northern Western Ghats, Maharashtra

Bhimashankar Wildlife Sanctuary (BWS), northern Western Ghats, Maharashtra is an important protected area in the Western Ghats. A study was conducted on the assessment of floristic diversity in BWS from 2009 to 2016. Bhimashankar Wildlife Sanctuary is located on the crestline of the northern Western Ghats in Pune and Thane districts in Maharashtra. The results revealed that forest types and microhabitats are diverse in the sanctuary. Major forest types are western subtropical broad-leaved hill forest to moist deciduous types with a few included small patches of evergreen forests. The rich flora of the sanctuary is represented by a total of 1,142 angiospermic taxa at species and infraspecific level spread over 619 genera and 124 families. Of these, 1,094 taxa are wild, which belong to 118 families and 586 genera. Rest of the taxa are planted (34), and 14 are introduced. The wild taxa include 20 magnolids, 285 monocots, one Ceratophyllales and 788 eudicots. Out of these, 217 taxa are Indian endemics; which comprise about 19.84% of the total number of wild taxa (1,094) in the sanctuary and 5.04% of total Indian endemics (4,303). Total 53 taxa are under different threat categories according to IUCN. The study established that Bhima Shankar Wildlife Sanctuary harbours a significant extent of angiosperms in a very small geographic area.

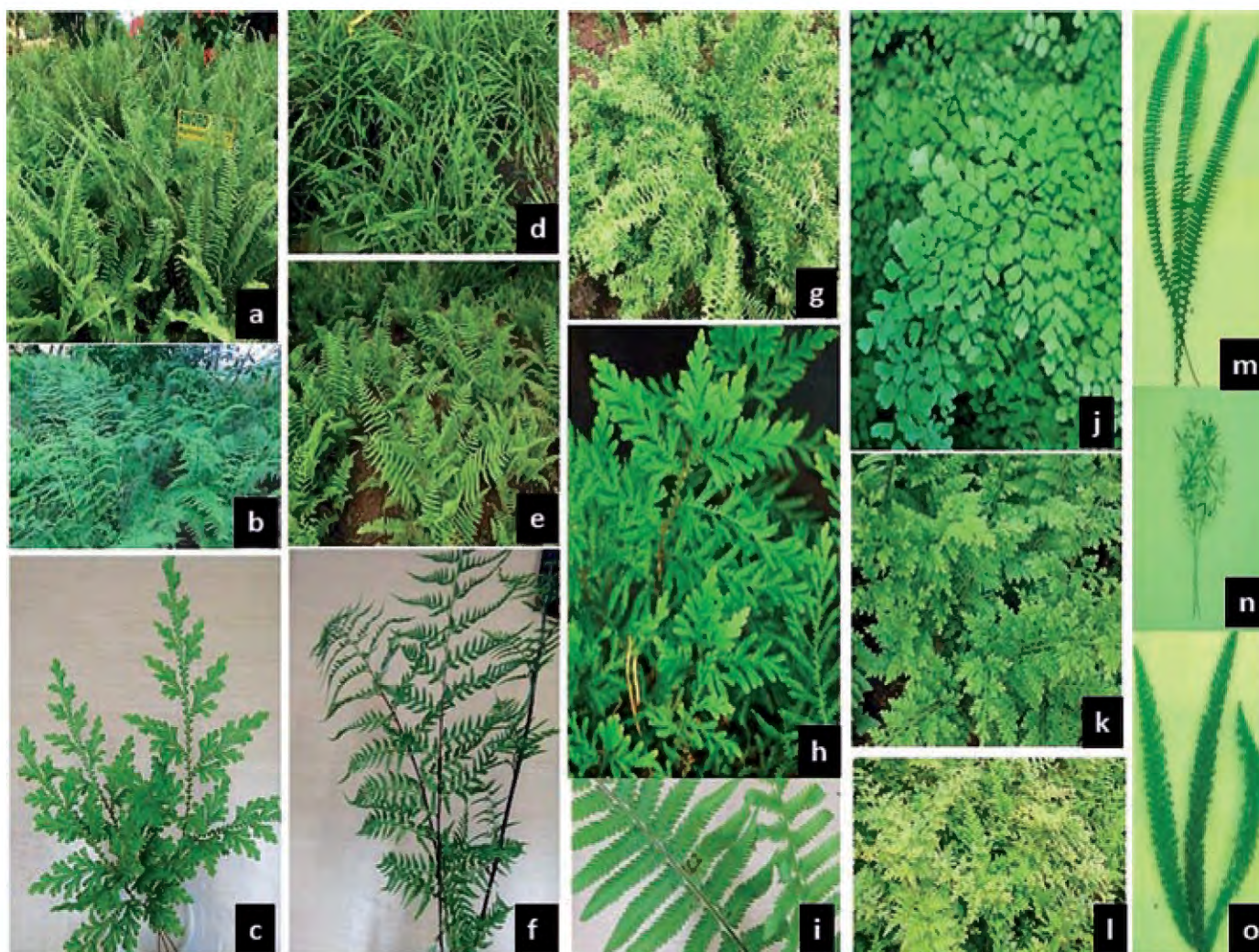
Checklist of endemic flowering plant species of Northern Western Ghats

A checklist of endemic flowering plant species of the northern Western Ghats (Sahyadri Ranges) of India was provided along with their IUCN threatened category. There are 159 flowering plant taxa belonging to 81 genera and 31 families found to be strictly endemic to the Sahyadri Ranges. The genus *Ceropegia* has the largest number (17) of endemic species. Five monotypic genera are restricted to the Sahyadri Ranges. Most of these endemic taxa are restricted to small biogeographical areas and are rare in occurrence. Field assessment has shown that 34 endemic taxa fall into IUCN category Critically Endangered, 18 into Endangered and 20 into Vulnerable. A large number of endemic taxa (34) are known only by their type collection, which could not be recollected even after repeated field explorations undertaken by several workers in their habitat of occurrence in last two decades. Hence, they are put in the category 'Data Deficient'.



Analysis of endemic plant species of Southern Western Ghats

Western Ghats, being one of the global hotspots of biodiversity, supports an enormous vegetal wealth, which over the years is undergoing great stress due to anthropogenic disturbances. The development of the tropical rain forests in the southern Western Ghats and the 'sholas' in the Nilgiris region are the most outstanding features of Western Ghats. Nearly 5,800 species of flowering plants occur here of which 56 genera and 2,100 species are endemic. Karnataka alone harbours 3,900 species belonging to 1,323 genera and 199 families while Nilgiris have 2,611 species of flowering plants. Some dominant families are Poaceae, Leguminosae, Orchidaceae, Acanthaceae, Euphorbiaceae, Asteraceae, Lamiaceae and Rubiaceae. Analysis of endemic species reveals that Western Ghats being much older in age compared to Himalayan mountains, support a large majority of relict or



Ferns conserved at DFR, Pune. **a.** *Nephrolepis exaltata*, **b.** *Pityrogramma calomelanos*, **c.** *Selaginella willdenowii*, **d.** *Nephrolepis cordifolia* 'Duffii', **e.** *Rumohra adiantiformis*, **f.** *Pityrogramma calomelanos*, **g.** *Nephrolepis biserrata furcans*, **h.** *Selaginella delicatula*, **i.** *Christella dentata*, **j.** *Adiantum raddianum*, **k.** *Pteris vittata*, **l.** *Selaginella willdenowii*, **m.** *Nephrolepis exaltata*, **n.** *Asparagus densiflorus* 'Sprengeri', **o.** *Asparagus densiflorus* 'Myers'

palaeoendemics. Another unique feature of the endemic flora of Western Ghats is the prevalence of monotypic genera such as *Adenon*, *Calacanthus*, *Polyzygus*, *Erinocarpus*, *Frerea*, *Griffithella*, *Haplothismia*, *Jerdonia*, *Lamprochaenium*, *Nanothamnus*, *Wagatea* and *Willisia*. Some of the arborescent genera having maximum endemic taxa are *Memecylon* (16 spp.), *Litsea* (15 spp.), *Symplocos* (14 spp.), *Cinnamomum* (12 spp.), *Syzygium* (11 spp.), *Actinodaphne* (9 spp.), *Glochidion* (9 spp.), *Grewia* (9 spp.), *Diospyros* (8 spp.), *Dalbergia* (7 spp.), *Hopea* (6 spp.), *Drypetes* (6 spp.), *Poeciloneuron* (2 spp.), *Blepharistemma*, *Erinocarpus*, *Meteoromyrtus*, *Otonephelium* and *Pseudoglochidion*. The latter five genera are again monotypic. The flora of Western Ghats, particularly southern Western Ghats shows close affinity with the flora of Sri Lanka. Agasthyamalai hills, Anamalai ranges, Nilgiris and the Palni hills are the hyperdiversity areas in Western Ghats which are also the hotspots pockets. Discussing the major strategies for conservation, certain issues for action were prioritized, viz. inventory of base line data and development of computerized databases, assessment of genetic diversity at least in wide spread taxa, identifying and conserving and monitoring the hotspot

pockets of biodiversity, protection of sacred forests and special habitats, establishment of gene bank/seed bank and conservation of critically endangered species.

Agro-climatic zones and native species for each zone in India: Study conducted by TERI

The agro-climatic zones and native species for each zone in India was discussed by TERI (The Energy and Resources Institute).

It was reported that Central Highlands 1 which have red and black soils and sub-humid climatic condition are suitable for shrubs with fragrant flowers like *Lawsonia alba*, *Nyctanthes arborescens*, *Thevetia neriifolia*, *Capparis spinosa* and *Euphorbia nivulia*. Central Highlands 2 which have medium to dark black soils and semi-arid climatic condition are suitable for shrubs like *Tabernaemontana coronaria*, *Lawsonia alba*, *Nyctanthes arborescens*, *Mimusops elengi*, *Murraya exotica*, *Cestrum nocturnum*, *Thevetia neriifolia* and *Euphorbia nivulia*. Ornamental and flowering trees like *Cochlospermum gossypium*, *Terminalia arjuna*, *Lagerstroemia flosreginae*, *L. thorellii*, *Peltophorum inerme*, *Butea frondosa*, *Bauhinia purpurea*, *B. tomentosa*, *B. triandra*, *B. variegata*, *B. acuminata*, *B. corymbosa*, *B. alba*, *Brownea coccinea*, *B. ariza*, *B. grandiceps*, *Cassia fistula*, *C. javanica*,



Jasmine species conserved at DFR, Pune

Caesalpinioideae nodosa, *Poinciana elata*, *Pongamia glabra*, *Hibiscus collinus*, *Kydia calycina*, *Ficus bengalensis*, *Moringa oleifera*, *Madhuka latifolia*, *Pithecolobium dulce*, *Mangifera indica*, *Bamboo* sps, *Bauhinia purpurea*, *Cassia siamea*, *Santalum album*, *Wendlandia exserta*, *Bauhinia variegata*, *Delonix regia*, *Albizia procera*, *Albizia lebbek*, *Schleichera trijuga* and *Erythrina indica* are suitable for Central Highlands 1. Ornamental and flowering trees suitable for Central Highlands 2 are *Jacaranda mimosaeifolia*, *Cochlospermum gossypium*, *Terminalia arjuna*, *Lagerstroemia flosreginae*, *L. thorellii*, *Peltophorum inerme*, *Butea frondosa*, *Bauhinia purpurea*, *B. tomentosa*, *B. triandra*, *B. variegata*, *B. acuminata*, *B. corymbosa*, *B. alba*, *Brownea coccinea*, *B. ariza*, *B. grandiceps*, *Cassia fistula*, *C. javanica*, *Caesalpinioideae nodosa*, *Milletia ovalifolia*, *Poinciana elata* and *Pongamia glabra*. *Hibiscus collinus*, *Kydia calycina*, *Ficus bengalensis*, *Moringa oleifera*, *Madhuka latifolia*, *Pithecolobium dulce*, *Mangifera indica*, *Bamboo* sps, *Bauhinia purpurea*, *Leucaena leucocephala*, *Albizia procera*, *Schleichera trijuga*, *Sterculia villosa* and *Delonix Regia*.

Central Highlands 1 and 2 are suitable for shade trees like *Azadirachta indica*, *Tamarindus indica*, *Ficus religiosa* and *Mangifera indica*. Trees with ornamental foliage like *Tamarindus indica*, *Azadirachta indica*, *Soymida febrifuga*, *Acacia leucophloea*, *Aegle marmelos*, *Ailanthus excelsa*, *Emblia officinalis*, *Terminalia tomentosa*, *Trema politoria*, *Buchanania lanzan* and *Boswellia serrata* are suitable for Central Highlands 1. Central Highlands 2 are suitable for trees

with ornamental foliage like *Tamarindus indica*, *Azadirachta indica*, *Moringa pterygosperma*, *Harpullia eupanioides*, *Acacia leucophloea* and *Ziziphus jujube* according to the study conducted by TERI.

Similarly, Shrubs with fragrant flowers, ornamental and flowering trees, trees with ornamental foliage, shade trees, palm etc. suitable for Deccan Plateau, Eastern Plains, Eastern Plateau, Northern Region and North Eastern Hills, Western Ghats, Western Himalayas, Western Plains etc was listed by TERI. Native species of ornamental plants suited for different cities of India, viz. Mumbai, New Delhi, Chandigarh etc. are also listed in the report 'Agro-climatic zones and native species for each zone in India'.

Sahyadri: Web interfaced Western Ghats Biodiversity Information System

The Sahyadri: Western Ghats Biodiversity Information System, a decision support system was designed and implemented to promote analysis on Western Ghats biodiversity resources (e.g. flora and fauna) based on inventorying, monitoring and mapping. The Sahyadri is a web interfaced Western Ghats Biodiversity Information system for the Western Ghats with vast quantity of biodiversity information. It offers means for accessing, interpreting and querying of information for the purpose of conservation and sustainable management. Objectives of Sahyadri are:

- To collect and supply information on Western Ghats and Biological Diversity
- Identification of information/data gaps in the specified subject areas and action taken to fill these gaps, Web based database creation on Ecology, Environment, Western Ghats and Biological Diversity
- To establish linkages with information users, carriers and providers from among government academia, business and NGO's including that with ENVIS
- To help India in fulfilling the norms of the Convention on Biological Diversity

For the development of biodiversity database, the literature required for the creation of database on flowering plants and fauna of Western Ghats was collected and organized. Data were compiled from the field studies and various secondary data sources like Books on Taxonomy, District Flora and Medicinal Plants. Publications of FRLHT (Foundation for Revitalization of Local Health Traditions, Bengaluru), BSI (Botanical Survey of India, Coimbatore), IUCN (International Union for Conservation of Natural Resources), IFGTB (Institute of Forest Genetics and Tree Breeding, Coimbatore), KFRI (Kerala Forest Research Institute, Peechi). Currently, 3,500 flowering plants information can be retrieved from the Flora database which includes 266 species of orchids, 350 species of medicinal plants, 352 endemic tree species and a few monocots present in the Western Ghats.

This endeavor is an attempt to bring out the enormous amount of floral wealth available in Western Ghats, their distribution and their value for human life and Indian economy. The database also tries to emphasize on the species that are endangered due to their over exploitation. These species require immediate conservation strategies to be employed for their sustenance. Through the database in the information system, an attempt has also been made to help the botanists and biotechnologists to identify the species, to do further research for the sustainability of genetic traits and for exploring more on the chemical composition of the species. Further using the data GIS analysis like habitat wise species distribution can be carried out for widely used species, endangered species, economically important species etc.

Floral diversity of Tamil Nadu and Kerala

To facilitate researchers to inventorise plant-rich areas and to develop strategies for conservation of existing floral diversity in the state of Tamil Nadu, the ENVIS Centre on Floral Diversity, Botanical Survey of India has published "Bibliography and Abstracts of Papers on Flora of Tamil Nadu", which consists a total of 1,482 references with abstract published on general vegetation, diversity of flowering and non-flowering plants, forestry, ecology, ethnobotany, medicinal plants and conservation issues in Tamil Nadu.

Based on interpretation of satellite data, the forest cover of Tamil Nadu is 23,625 km², including 2,948 km² area under very dense forest, 10,321 km² area under moderately dense forest and 10,356 km² under open forest, altogether representing 18.16% of state's total geographical area. The various forest types in the state exhibit great

diversity in different plant groups, ranging from primitive nonflowering plant groups to advanced angiosperms.

There are 712 taxa of bryophytes occurring in Tamil Nadu, comprising 211 taxa in 56 genera and 32 families of liverworts, 8 taxa in 4 genera and 2 families of hornworts, and 493 taxa in 189 genera and 44 families of mosses. In Tamil Nadu, the pteridophytes (ferns and fern allies) are represented by about 275 species in 44 families, of which 33 are endemic to the state and about 80 are recognised as threatened taxa. Terrestrial species constitute more than 46% (about 90 species), whereas, lithophytes constitute 19% (67 species) of the pteridophyte flora of the state. Besides, there are several semi-aquatic ferns and fern allies and five true aquatic ferns, such as *Azolla pinnata*, *Ceratopteris thalictroides* and *Salvinia molesta*, are found in Tamil Nadu. The state has 4 species of indigenous gymnosperms and about 60 introduced species. The Indian conifer, *Podocarpus wallichianus*, distributed in Peninsular India and Andamans, is confined to the Western Ghats of Tamil Nadu. Similarly, *Gnetum ula*, a woody climbing gymnosperm also inhabits evergreen tropical rain forests of Eastern and Western Ghats of Tamil Nadu. *Cycas circinalis*, an Indian endemic cycad species, occurs in fairly dense, seasonally dry, mixed deciduous forest areas of Western Ghats, and grown as ornamental in gardens and parks.

Tamil Nadu harbours about 5,640 species and infraspecific taxa of flowering plants including cultivated species in 1987. After about two decades, in 2007, the state flora analysis was revised and a checklist of angiosperms in Tamil Nadu as a floral database was prepared. According to the list, the angiosperms in the state are represented by 5,547 taxa, comprising 5,239 species, 72 subspecies, 548 varieties in 1,668 genera and 231 families. There are about 5,745 angiospermic taxa in Tamil Nadu, which include 2,757 herbs, 1,365 shrubs, 1,115 trees and 508 climbers, and are distributed in 233 families, of which 43 families are unigeneric. The family Fabaceae ranks first in possessing the largest number of taxa (547), followed by Poaceae (485 taxa), Asteraceae (307 taxa), Rubiaceae (236 taxa) and Orchidaceae (218 taxa). Out of 1,788 genera recorded, about 50% are unispecific. The genus *Crotalaria* with 71 taxa is the largest genus in the state, followed by *Impatiens* (62 taxa), *Fimbristylis* (51 taxa), *Cyperus* (47 taxa), *Acacia* (45 taxa), *Eucalyptus* and *Euphorbia* (44 taxa each) and *Strobilanthes* (43 taxa).

Tamil Nadu possesses about 212 strict endemic taxa, of which 122 are herbs, 51 are shrubs, 36 are trees and 3 are climbers, and around 85% of the endemic taxa are confined to the Western Ghats, 8% from the Eastern Ghats and 6% of the taxa are from coastal regions; families, such as Poaceae (30 taxa), Cyperaceae (24 taxa), Apocynaceae and Acanthaceae (13 taxa each) exhibit high level of endemism. There are about 230 Red Listed species, 1,559 species of medicinal plants and 260 species of wild relatives of cultivated plants in the state. With 5745 angiosperm taxa, Tamil Nadu ranks first among all the states in the country, and it also constitutes nearly 1/3rd of the total flora of India. Out of 32 districts, Nilgiris is the most species-rich (62%) district, followed by Coimbatore (53%), Dindigul and Tirunelveli (47% each).

A total of 138 tree species belonging to 38 families

have been found to be endemic to Waynad district of Kerala. These include *Dillenia bracteata*, *Magnolia nilagirica*, *Goniiothalamus cardiopetalus*, *Meiogyne pannosa*, *Miliusa nilagirica*, *Orophea uniflora*, *Polyalthia fragrans*, *Casearia rubescens*, *Calophyllum austroindicum*, *Ixora elongata* etc.

Rare Endangered and Threatened (RET) plant species of India

Studies were conducted on plant collection and identification of the Rare and Endangered Threatened (RET) plant species of India and are listed below.

RET listed climbing species of the Southern Western Ghats: Plant collection and identification of the Rare Endangered Threatened (RET) listed climbing species of the Southern Western Ghats showed 33 species are RET species like *Ceropegia mannarana*, *Gloriosa superba*, *Celastrus paniculata*, *Aganosma cymosa*, *Passiflora leschenaultii*.

Endangered ornamental plants of Jammu and Kashmir Region and North-West Himalaya: *Habenaria intermedia* (Orchidaceae), *Meconopsis aculeata* (Papaveraceae), *Eremostachys superba* (Lamiaceae), *Gentiana kurroo* (Gentianaceae) etc, were reported as endangered ornamental plants of Jammu & Kashmir Region and North-West Himalaya.

Endangered Rhododendrons of Indian Eastern Himalayas: *Rhododendron pumilum*, *R. maddenii*, *R. kendrickii*, *R. neriiflorum* ssp. *Phaedropum*, *R. falconeri* ssp. *Eximium*, *R. hookeri*, *R. megeratum*, *R. tanastylum*, *R. keysii* etc. were reported as Endangered Rhododendrons of Indian Eastern Himalayas.

Plants of High Conservation Significance in Uttarakhand Himalaya: Some plants of high conservation significance in Uttarakhand Himalaya were listed. These include *Phaius tankervillae* (Orchidaceae), *Wallichia densiflora* (Arecaceae), *Trachycarpus takil* (Arecaceae) and *Cyathea spinulosa* (Cyatheaceae).

Endangered ferns of India: A list of endangered ferns of India include *Adiantum lomesam*, *Cheilanthes duthiei*, *Ampelopteris prolifera*, *Adiantum edgeworthii*, *Anemia wightiana*, *Asplenium anogrammoides*, *Anisocampium cumingianum*, *Botrychium lanuginosum*, *Asplenium affine*, *Cheilanthes dubia*, *Cheilanthes rufa*, *C. persica*, *Dryopteris approximata*, *Osmunda japonica*, *Grammitis attenuata*, *Helminthostachys zeylanica*, *Woodsia andersonii*, *Huperzia hamiltonii*, *Pteris wallichiana*, *Hypodematium crenatum*, *Pellea subfurfuracea*, *Lycopodium japonicum*, *Loxogramme parallela*, *Polystichum subinerme*, *Dennstaedtia wilfordii*, *Tectaria periya*, *D. scabra* etc.

Rare and endemic epiphytic orchid species from Western Ghats: It was reported that *Aerides ringens*, *Bulbophyllum sureum*, *Dendrobium aqueum*, *Liparis elliptica*, *Rhyncostylis retusa*, *Vanda testacea*, *Xenikophyton seemeanum*, *Eria nana* etc. are some rare and endemic epiphytic orchid species from Western ghats.

Threatened and endemic orchids of Sikkim: *Bulbophyllum trichocephalum*, *Calanthe anjanii*, *Calanthe keshabii*, *Coelogyne pantlingii*, *Malaxis saprophyta*, *Cymbidium whiteae*, *Goodyera dongchenii*, *Gastrochilus sonamii*, *Liparis chungthangensis*, *Liparis lydiai*, *Liparis pygmaea*, *Oberonia*

kingii etc. were reported as some threatened and endemic orchids of Sikkim.

NGO's working for the conservation of plant biodiversity in India

A large number of officials and NGO's are working for the conservation of plant biodiversity in India. Some of them include:

- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- Convention on Biodiversity (CBD)
- International Union for Conservation of Nature (IUCN)
- Ramsar Convention on Wetlands, the United Nations Framework Convention on Climate Change (UNFCCC)
- United Nations Convention to Combat Desertification (UNCCD),
- United Nations Commission on Sustainable Development (UNCSD),
- International Treaty on Plant Genetic Resources (ITPGR),
- NGO Foundation for Revitalization of Local Health Traditions (FRLHT) in medicinal plant conservation areas works on *in situ* conservation of medicinal plants

Protected areas for plant biodiversity conservation in India

In India, a network of 668 protected areas has been established comprising 102 national parks, 515 wildlife sanctuaries, 47 conservation reserves and 4 community reserves. Sanctuaries have been established in Tura range in Garo Hills of Meghalaya for the conservation of Rhododendrons and orchids in Sikkim. With an objective of an ecosystem-level conservation, the government of India has established 18 biosphere reserves which protect large land and/or coastal environments and often include several protected areas within. Sacred groove is another form of *in situ* conservation which refers to the small patches of native vegetation traditionally protected and managed by local communities. Himachal Pradesh, Karnataka, Kerala, Maharashtra, Andhra Pradesh, West Bengal and Chhattisgarh are very prominent states for sacred grooves. About 13,928 sacred grooves presently exist in India.

AICRP on Floriculture

A project on survey, collection and evaluation of native ornamentals for commercial cultivation was implemented through All India Co-ordinated Research Project on Floriculture with an objective to evaluate the potential of native ornamentals for domestic and export market. Technical programme for the project comprises explorative survey and data collection in liaison with ICAR-NBPGR, New Delhi, evaluating native ornamentals for commercial potential such as cut flower, cut green, loose flower, pot plant and other landscape uses, maintaining passport data of newly collected species/varieties and obtain the IC/EC number from ICAR-NBPGR, New Delhi for record.

Recommendation of a variety for commercial cultivation in respective region based on extensive evaluation should be submitted to the Director, ICAR-DFR, Pune every year along with the proposal for testing in the other centers, if any. Areas that are covered under the project include Western Ghats, Western Himalayas and NEH region.

As an outcome of the project, during 2016-17, at Horticultural College and Research Institute, Periyakulam centre, two native ornamental species were collected from Usilankaradu area of Periyakulam, Tamil Nadu and identified at Botanical Survey of India, Tamil Nadu and IC No. 598296 was obtained for *Chlorophytum tuberosum* from NBPGR (New Delhi). Apart from that, eight native ornamental species, viz. wild jasmine - *Jasminum sp.*, *Holmskioldia sp.*, *Pterospermum sp.*, *Leucassp.*, *Aristolochia sp.*, *Barleria sp.*, *Crossandra sp.*, and *Symphorema sp.*, were found in the foothills of Western Ghats in and around Theni district of Tamil Nadu during 2015 – 2016. Multiplication and establishment of the demonstration plots of the identified species is being carried out for commercial exploitation of the species. Cytological studies were carried out and found that *Chlorophytum tuberosum* (Roxb.) is a diploid plant species with $2n=14$ chromosomes with 7 bivalents. Abnormal meiosis with multivalent formation and univalent were also observed.

During 2016-17, at Vellanikkara centre, native ornamentals were evaluated and identified for various landscape uses. Survey was conducted in and around Thrissur district, Kerala and native ornamental species were collected. *Clitoria ternatea* was found ideal climber for arches and pergolas. Ideal background plants include *Helicteres isora* and *Thevetia peruviana*. *Clerodendrum phlomidis* is ideal as a component of butterfly and moon garden. For moon garden and flower border, *Leucas aspera* is suitable and as an accent and corner plant, *Melastoma malabarthicum* is ideal. At Solan Centre, 24 native ornamental plants were maintained in native plant block. In 2016-17, six new ornamental plants i.e. *Prunus cerasoides*, *Pistacia integerrima*, *Caesalpinia sepiaria*, *Celosia argentea* (pink), *Aerva scandens* and *Strobilanthes glutinosus* (white) were added to it.

During 2017-18, germplasm collection of native ornamentals at Vellanikkara centre were enriched with eight species of native ornamentals, viz. *Barleria strigosa*, *Exacum bicolor*, *Asystassia gangetica*, *Naregamia alata*, *Ecbolium viride*, *Chassalia curviflora*, *Memecylon edule*, and *Eranthemum capense*. Extensive field evaluation of *Exacum bicolor* was conducted. Field evaluation of *Exacum bicolor* revealed that it is suitable for growing during any season as it flowers freely irrespective of the season. Seed treatment was standardized for the species and it was observed that either GA 350 µm or KNO₃ 50 mm for 24 hrs or NaOCl 4% for 10 minutes are suitable for inducing earliness in seed germination. Fourteen genotypes of the plant were collected from various locations in Kerala. Pollination methods were studied and it was found that the plant is entomophilous as there was no fruit set when flowers were bagged or the entire plant was kept in insect proof cages. It was also revealed that there is no self-incompatibility for the species as there was fruit set when the plants were

selfed. There was significantly high seed weight per fruit in case of controlled crossing when compared to open pollination and selfing and this suggest heterosis. No seed set during bagging and open crossing suggested absence of apomixes.

Initiatives at ICAR-Directorate of Floricultural Research, Pune

Attempts have been made for collection and conservation of native ornamentals at ICAR-DFR, Pune with an objective to evaluate the inherent potential of native ornamental plant species for domestic and export market. The ferns under conservation at the Institute farm for further utilization are Boston fern (*Nephrolepis exaltata*), Button fern (*Nephrolepis cordifolia*), Fish tail fern (*Nephrolepis biserrata furcans*), Hard fern (*Blechnum orientale*), Emerald fern (*Asparagus densiflorus*), Ladder brake fern (*Pteris vittata*), Leather leaf fern (*Rumohra adiantiformis*), Peacock fern (*Selaginella willdenowii*), Silverback fern (*Pityrogramma calomelanos*), Soft fern (*Christella dentata*) and Staghorn club moss (*Lycopodiella cernua*). Specialty flowers like *Heliconia spp*, *Calathea crotalifera* (Rattle snake plant), *Calathea lutea* (Cigar calathea), Torch Ginger (*Etlingera elatior*) pink, Torch Ginger Light pink, *Costus woodsonii* (Red button ginger), *Costus* orange etc. are conserved for enrichment of the germplasm of specialty flowers at ICAR-DFR, Pune. Some of the other ornamental germplasm under conservation include *Eranthemum*, *Sanseveria*, *Bauhinia*, *Nycatanthes arborescens*, *Tabernaemontana coronaria*, *T. divaricata*, *Crinum asiaticum*, *Acalypha hispida*, *Allamanda cathartica*, *Alpinia purpurata* – Ginger lily, *Butterfly Ginger Lily* (*Hedychium*), *Indonesian tall ginger lily*, *Shampoo Ginger*, *Caladium*, *Centratherum intermedium*, *Costus*, *Dombeya spectabilis*, *Malvaviscus*, *Hibiscus mutabilis*, *Codeaum variegatum*, *Solenostemon scutellarioides*, *Nerium* etc. For enrichment of germplasm of aromatic flower crops at the Institute, different Jasmine accessions belonging to *Jasminum sambac*, *Jasminum auriculatum*, *Jasminum grandiflorum*, *Jasminum multiflorum*, *Jasminum nittidum* etc have been conserved.

Conclusion

For the floriculture industry, native species of ornamental plants are especially interesting, since they represent the unexploited source of great potential value. At the same time, mass multiplication and commercial production of native ornamental plant species can represent a way of *ex situ* conservation of endangered plant species. This will serve as a significant model for achieving the conservation of horticulturally potential species of native ornamental plants. Therefore, conservation of these native ornamental plant species will also help in developing strategies to preserve the genetic potential of species that are crucial for crop production and crop improvement programmes.

For further interaction, please write to:

Dr S A Safeena and **K V Prasad** (Scientists), ICAR-Directorate of Floricultural Research, Pune.

Forty Years and beyond: Evolution of JNTBGRI as a pioneer in Plant Genetic Resources Conservation

Global Strategy for Plant Conservation (GSPC) calls for at least 75% of threatened plant species in *ex situ* collections, preferably in the country of origin. Botanic Gardens have a major role in achieving the targets laid out in GSPC and CBD. Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI) was established soon after the Stockholm Convention, which gave seminal status to environment, in 1979 with a twin objective of setting up of conservatory botanic gardens of tropical plant resources and to undertake research programmes for the sustainable utilization of resources for the benefit of the people.

THE GARDEN was established in 300 acres of degraded forest in the foot of the Western Ghats and falls within the later declared Agasthyamala Biosphere Reserve. As in the case of every success story, there was a great visionary, in the establishment of TBGRI, Prof (Dr.) A. Abraham, the founder Director. The institute is aptly the brain child of Prof. Abraham. The Royal Botanic Gardens, Kew played an exemplary and significant role in shaping and designing the layout of the garden and its formative stages. Dr. Hans Fleigner, Curator, Kew Gardens visited the site in 1984 and prepared a Master Plan for the landscaping of the Garden. Later Dr. Roy A. Bee, renowned horticulturist and Director of Park Systems, Manchester visited the garden and trained our staff in Horticulture and Garden based conservation aspects followed by internship

Vision

- Conservation and sustainable utilization of the plant diversity of India, particularly of the Western Ghats for the well-being of her people.

Mission

- To advance knowledge, enjoyment and conservation of plants through excellence in biodiversity research management, horticultural displays and educational programmes.
- To do research on all aspects of plant science and to facilitate sustainable utilization of plant wealth.



Site map of JNTBGRI

for 8 staff from JNTBGRI at Kew Gardens.

Established as a grand-in-aid organization under Govt of Kerala, and presently under the umbrella of Kerala State Council for Science, Technology and Environment (KSCSTE). The state government fund alone was not enough to establish and enrich such a huge collection of living plants, and the garden is mobilizing funds from various national and international agencies and scientifically managed the collection for further R&D activities.

Organizational Structure

JNTBGRI is structured in such a way that garden and R & D activities are carried out in an inclusive manner. Developmental programmes of the Garden are implemented through Garden Management Division and Plant Genetic Resources



Arboretum view in 1985



View in 2019

Division, and the R & D activities through 5 divisions. Presently the Garden also have two subcentres.

Efforts in Plant Conservation

Established years before the inception of Convention on Biological Diversity (CBD), the activities of JNTBGRI is inline with its provisions. The original Flora of the garden site was surveyed and documented in 1986, which consisted of 317 species of flowering plants belonging to 257 genera and 82 families. Presently the Garden is home for over 4,000 species represented by over 50,000 accessions. Apart from the general garden set up for the enjoyment and aesthetics of the Garden, over the time several projects have been implemented to develop exclusive conservatories for diverse group of plants found in the Western Ghats and plants of horticultural importance. The special collections include Zingibers, Ficus, Cycads, Ferns, Wild Fruit plants, Bamboo, Medicinal plants, Cacti and succulants, Aquatic plants, Bromeliads, Balsams, Jasmines, Piper, Andaman plants, Musa, Balsams, Mango, threatened plants, etc. and the collections are grouped accordingly.

Threatened Species

Park: JNTBGRI is recognized as one of the Lead Botanic Garden by MoEFCC in 2009 and as part of which a 6-acre exclusive conservatory was developed for the conservation of red listed and endemic species of the Western Ghats. Presently it holds 1272 accessions of 150 species. The programme was planned as an educative plot and hence the name 'park', with descriptive labels for each species allowing the public to understand them more closely. The institute has initiated the phase 2 of this programme to enrich the collection.

Arboretum: Spread across an area of 20 hectares, the Arboretum, conservatory for woody plants, houses 750 species in an 80:20 ratio of native and exotic species. Most of the exotic species are received through the seed exchange programmes of the JNTBGRI Seed Bank. In

most cases each of these species are represented by 4–5 accessions. All the species are properly identified and labelled for public awareness and their phenological data also been recorded for future reference.

Medicinal and Aromatic Plant Garden: As a step towards the conservation of medicinal plants in the Western Ghats and to act as an interpretation facility for general public, a Medicinal plant Garden is maintained here. A model herbal garden in the name of Itty Achuthan Vaidyan (Itty Achuthan Vaidyan's garden), who was the major contributor of ethno-medical information for this famous compilation – Hortus Malabaricus. Considered as one of the best in the country, the Medicinal Garden is one of the prime attentions among the general public and the researchers which maintains a strong germplasm of 1168 spp./varieties.

Lesser Known Fruit Plants: Initiated in the early 1990 as a programme for the popularization of indigenous wild fruit plants, the conservatory now holds 125 species.

Most of these lesser known species have fruits with high nutrient value. The unit has ongoing programmes on mass multiplication of these species and distribution is also being done through sales and also for restoration programmes.

Bambusetum :

Recognized as the largest in the country spread across an area of 17 acres, 853 accessions, belonging to 80 taxa including 56 identified

species representing 20 genera. The Bambusetum is unique in the exclusive possession of 43 bamboo hybrids (10 inter generic and 33 inter specific) developed at JNTBGRI. We conserve most of the species from Western Ghats, several from North Eastern India, and some from Andaman Islands. Collections from China, Thailand, Singapore, England, South America, etc. also adorn the conservatory. Separate areas were developed for ornamental bamboos, reed bamboos, North Eastern bamboos and hybrids. A nursery is also established for bamboo saplings of commercial, ornamental and ecologically important species. A unique museum is also maintained for dried



Medicinal and Aromatic Plant Garden



Medicinal Arboretum



Conservatory for wild orchids

bamboo offsets, rhizomes, culms, sheaths etc and spirit collections of young sprouts, leaves, flowers and fruits. It also holds handicrafts, utensils, artefacts, etc. made of bamboos.

Orchid Biology Unit: The Orchid biology unit was one of the first exclusive conservatories developed on the keen interest of Prof Abraham in 1983 recognizing its future potential. There are presently five orchidarium housing 500 species and 200 hybrids in over 2000 accessions. JNTBGRI is recognized as a centre for Orchid Taxonomy under the AICOPTAX programme of MoEFCC. As part of the ongoing breeding programme, more than a dozen new hybrids have been registered with striking genetic combinations and colours in hybrids.

Carnivorous plants: This conservatory was developed primarily as a curious to cater interest of children about the trapping mechanisms. The first carnivorous plant *Nepenthes khasiana* was introduced in our garden during eighties. Presently we hold a collection of 30 species and eight hybrids of carnivorous plants from various parts of the world.

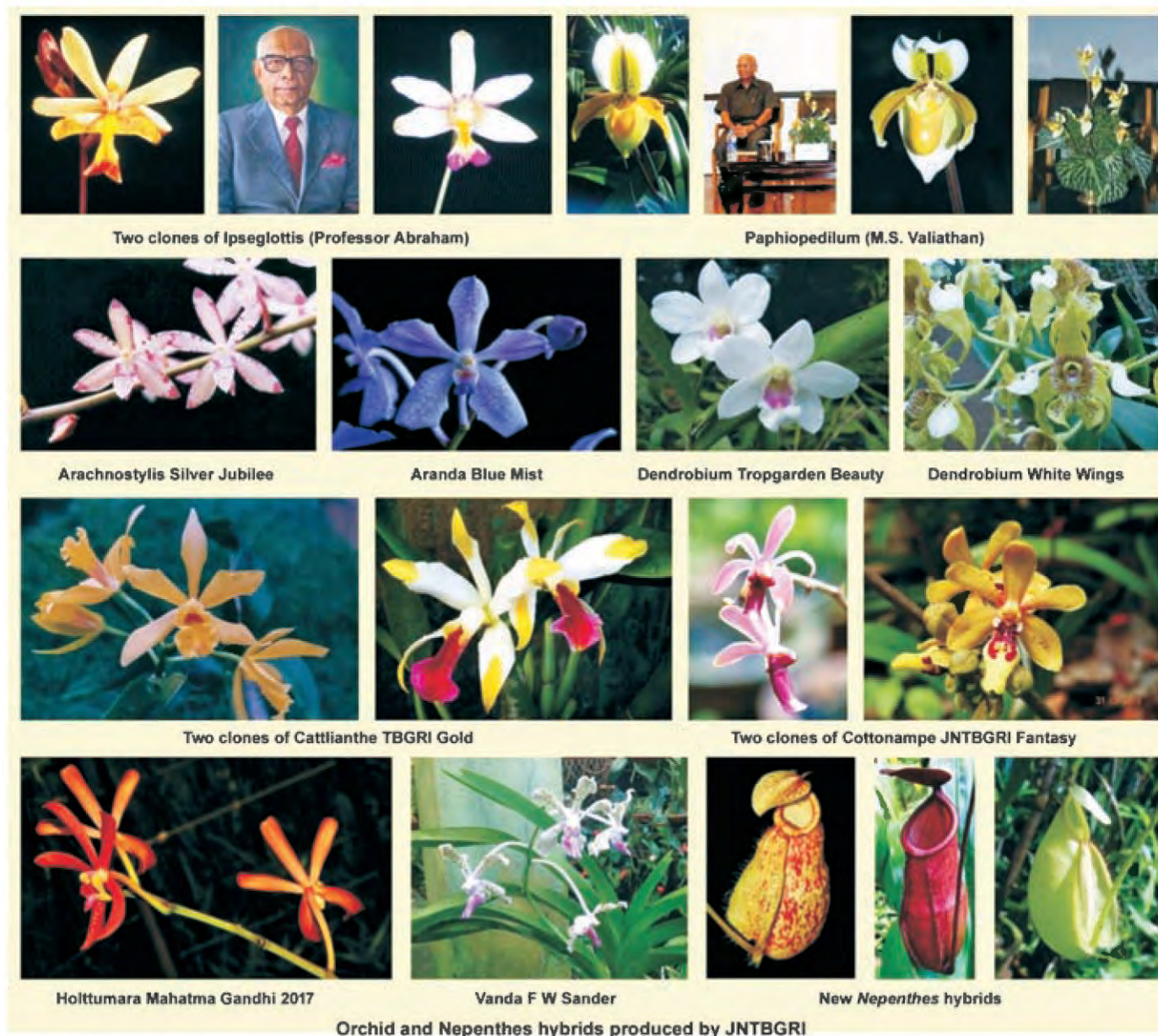
Fernery: Recognized as one of the largest conservatories for ferns in India, it holds 250 species. The conservatory mainly encompasses ferns and fern allies



Tiger orchids



Toperies developed using *Bambusa multiplex*



found in the Western Ghats. Special displays were also made with representatives from all the groups of ferns for educative purpose. Almost 50 species are under various threatened categories. We are undertaking breeding programmes for the pteridophytes in the garden for mass multiplication.

Ficus Garden: Most of the species are displayed in the form of bonsai apart from those planted in the field, which is one of the attractions of JNTBGRI. The garden holds one of the finest collections in India represented by 75 species and few exotics from Africa are also represented here.

Piper Germplasm: Even though the Garden have a conservatory of medicinal and aromatic plants, as the Western Ghats is one of the centre of origin of *Piper* and the region harbours many intraspecific forms, an exclusive field gene bank for the this species was developed. Presently the gene bank harbours 13 native and 5 exotic species and 25 intraspecific variants of *Piper nigrum* including the unique lemony scented variant.

Ginger House: At present, the ginger collection comprises 82 species and 5 varieties belonging to 14

genera in Zingiberaceae and Costaceae. Towards the sustainable utilization of these resources, chemical constituents of 40 species were analysed, antimicrobial properties of 15 species were screened, starch content of 8 species were evaluated, tissue culture protocol for 8 species were standardised and seed germination studies on 15 species were carried out.

Balsam collection: The Western Ghats is one of the centres of diversity for *Impatiens*, which attracts attention of plant lovers due to its variously coloured flowers and peculiar floral structures. Even though most of its species have high ornamental potential only some species and varieties are widely grown due to the delicate nature of most species. Presently 18 species of the Western Ghats are maintained along with several ornamental varieties.

Cacti and succulents: The Garden holds an exclusive climate-controlled glass house named in memory of former Director Prof (Dr) A.N. Namboodiri who played a pivotal role in strengthening the conservatories. Close to this glasshouse, an area was also developed as a habitat of succulents. Presently the collection includes about 350 species of succulents including around 100 species of cacti.



Bromeliads: An exclusive conservatory for the members of the monocotyledonous family, Bromeliaceae represented by over 45 species/cultivars. Mostly a tropical American group of plants with unique morphology is one of the curious for those visiting the garden.

Jasmine collection: About 36 species of jasmines both wild and cultivated are grown in this germplasm collection including various species found in the Western Ghats.

Ornamental garden: Major attraction of each botanic gardens is its landscapes and ornamental garden. JNTBGRI has an undulating terrain incorporating maximum species which highlights the natural landscape. There are limited disturbances to this landscape and for increasing the aesthetic value, suitable ornamental plants are used. Mostly concentrated towards the entrance, main roads and building premises for beautification to attract the general public and inspire them to love the nature. Presently the ornamental plant collection includes 850 taxa, both indigenous and exotics.

Wild ornamental garden: The ornamental section of the Garden Management Division maintains a collection of over 220 species of under exploited wild ornamental plants, especially the ones with landscape applications.

Gymnosperms: A primitive group of plants literally

meaning 'naked seeds' and noted also as flowerless plants are believed to be originated in the Paleozoic Era. With the support of Kew, a unique collection of Cycads was developed in the Garden currently having a strength of 16 species. All the species had coned here and is one of the centres of attraction for visitors. Apart from these, 24 species of conifers are also represented.

Palmetum: Again, developed with the assistance of Kew Gardens with their contribution of 60 species from Madagascar and Malesian regions, spread across a 5 hectare area holds the finest collection of palms within the country. Most of the Rattan species found in the Western Ghats is also represented here. Now about 160 species of Palms and Rattans form part of this conservatory.

Andaman conservatory: Considered as the best field conservatory for Andaman plants in the mainland, it now holds 130 species. All these species are established well having good growth performance. All the species represented here are post tsunami collections and some species which were washed out in

the islands are now present here and adds relevance to this collection.

Systematic garden: Systematic garden established in one hectare encompasses 388 species belonging to 84 families. Bentham and Hooker's system of classification is followed in this demonstration garden. It also demonstrates phytophy beds with examples of living plants with appropriate educational display boards.

Research and Development

Biotechnology and Bioinformatics Division: This is the first R & D division launched at JNTBGRI in 1983, for the conservation and sustainable utilization of plant genetic resources of the nation through biotechnological intervention, knowledge discovery and promoting lab-to-land programme. Several conservation-oriented programmes initiated through this division are worth mentioning. The National Gene Bank for Medicinal and Aromatic Plants Programme, Government of India, helped to establish a national level collection of medicinal, aromatic and spice plants which are facing natural as well as anthropogenic threats in its natural habitats. Several interrelated R&D units are functioning under the Biotechnology and Bioinformatics research programmes namely Functional Genomics and Population Genetics,

Bioproduction of Plant-specific Compounds, Conservation Biotechnology, Bioinformatics, Training and Extension services, etc. During the last four decades of its R & D activities, the division has achieved in developing tissue culture protocols for several threatened and endemic species from the Western Ghats. Training to students and farmers is also offered in the scientific study and farm management, cultivation and package of practices.

Conservation Biology Division: This division broadly targets studies related to scarcity and prospects of diversity with regard to the tropical biota in general and that of the Western Ghats in particular. The division also focused on the conservation biological studies on endemic and endangered species through population structure, reproductive biology, plant-animal interaction and gene flow system; documentation of plant-based information to support practical conservation and conservation policies. There is a pollen related research focused on the plants of the Western Ghats and maintained



Conservatories and its present strength

Conservatory	Present strength
Trees	750 species
Palms	160 species
Medicinal and Aromatic Plants	1168 species
Bamboos	80 taxa + 43 hybrids
Orchids	500 species + 200 hybrids
Ornamental Plants	850 taxa
Wild Fruit Plants	125 species
Wild Ornamentals	220 species
Fern and Fern Allies	250 species
Cacti and Succulents	350 species
RET Plants	150 species
Gymnosperms	38 species
Bromeliads	45 species
Carnivorous Plants	30 species + 13 hybrids
Ficus	75 species
Ginger	87 taxa
Balsams	18 species
Jasmines	36 species
Piperaceae	25 taxa
Water Plants	104 species
Andaman Plants	130 species
Native Mango	126 varieties
Custard Apple Garden	36 species
Memecylon Collection	22 species
Acanthus Garden	15 species



Bromeliad Garden



Heliconia Garden



Shrubs



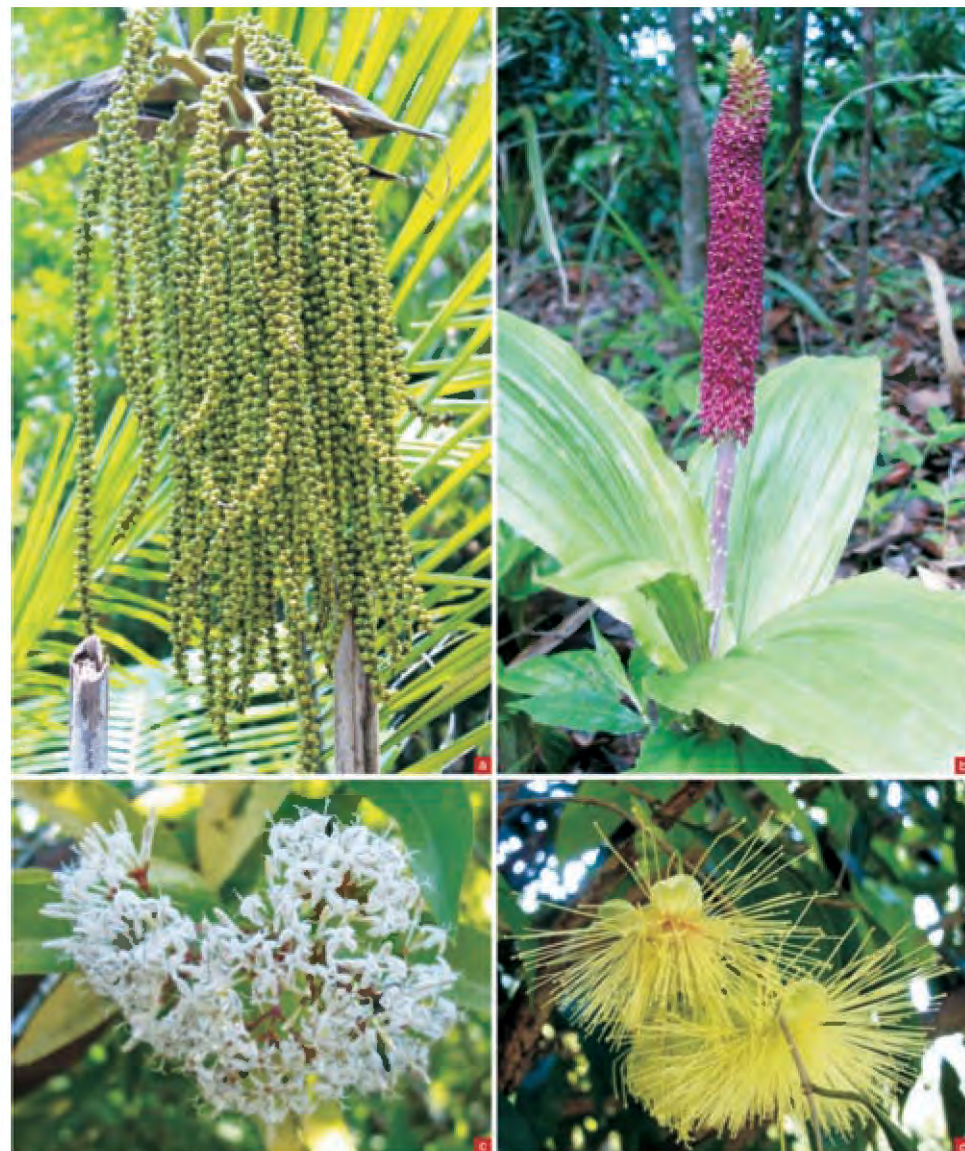
Ornamental Garden

a repository of the pollen herbaria of the Western Ghats. The well-established seed bank in this division primarily targeted for the germplasm collection and seed banking of selected economically and systematically important species and their registration to regeneration as well as

standardization of long-term seed storage and germination studies.

Ethnomedicine and Ethnopharmacology Division:

This established with the objectives to conserve, preserve and sustainably utilize the rich traditional herbal knowledge system of our country. Through an organized ethno-medico-botanical survey and systematic documentation of Traditional Knowledge related to plants used for food and medicine, a wide and in-depth database under *Sui generis* system has been prepared. Comparative studies of Ethno-medico-botanical data with Ayurvedic system of medicine for enriching Ayurvedic Pharmacopoeia, detailed investigation on selected species for their preclinical studies based on molecular-ethnopharmacological-phytochemical approach, integrated drug development programme, technology transfer and commercialization of prospective drugs, pharmacognostic standardization of Ayurvedic raw drugs, etc are the premier R & D activities of the division. The implementation of people participatory programme “Herbs for All and Health for All” received global attention and the TBGRI model of benefit sharing also commented as the best benefit sharing model for IPR issue by the CBD.



Wild Ornamental Garden

Microbiology Division: The division is devoted for the bio-prospecting and sustainable utilization of microbial wealth of Western Ghats. Characterization and bio-processing of enzymes, bioactive metabolites from actinomycetes, fungi and halophytic bacteria; functional analysis of small heat shock proteins; systematic studies on phylloplane fungi and lichens. This division contributed considerably to our understanding of micro fungi by the discovery of 3 new families, 18 new genera and more than 900 new species and varieties. The Lichen flora of Kerala was also enumerated to be a total of 242 species belonging to 62 genera in 29 families, of these 20 species are new distributional report to India and 26 taxa are new to Peninsular India and 51 taxa are new addition to the state. Fungal herbarium holds over 7,000 specimens whereas Lichen herbarium holds over 3,000 specimens.

Phytochemistry and Phytopharmacology Division:

The main objective of the division is to carry out chemical research on plant systems leading to their sustainable utilization. Major research areas include search for



Gymnosperms



Palmetum

new/biologically active molecules; antiviral, antidiabetic, anticancer molecules; elite accessions of medicinal (industrially important) plants; new essential oil sources/constituents with potential applications in flavour,

cosmetics; nutritional components/additives; biologically active plant secondary; metabolites-based nanoparticles; prey capture mechanisms in carnivorous plants and chemical ecology.

Plant Systematics and Evolutionary Science Division:

Research activities of the division mainly focuses on survey, exploration and documentation of floristic wealth of Kerala, molecular and mushroom taxonomy, reproductive biology, ecosystem assessment, assessment of threat status of 'Red listed species' and rescue and restoration of rare and endangered species. Division also holds a well-established Mushroom and Angiosperm Herbarium with a present strength of 17,550 and 37,000 respectively.

The institute has two extension centres in Kerala. Saraswathi Thangavelu Centre at Puthenthope, Thiruvananthapuram concentrating mainly on Bioinformatics studies. The Centre is also involved in the cultivation of ornamental plants as a source of cut flowers and is active in its sales, mass multiplication, popularization and training. Another centre is at Kuzhoor, Thrissur, developed with the financial assistance of Kerala State Industrial Development Corporation as part of an organic green industry project supported

by KSIDC, as a tissue culture laboratory of international standard producing quality planting materials of screw pine, banana and medicinal plants.

Apart from the garden activities and regular R & D programmes, the institute had undertaken several surveys in the Western Ghats and as part of which had familiarized 35 mushroom, 135 angiosperm and 900 micro-fungi as new to science. The institute is also involved in species recovery programmes of threatened species in the Western Ghats.

For further interaction, please write to:

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Movable screens in rose production

- Use movable screen, an important tool for rose cultivation.
- It can help growers manipulate environment conditions — lowers temperature, changes humidity and influences production numbers.
- The movable screens can be used year-round and in a variety of climates — from the Netherlands to India.

Status of indigenous ornamental biodiversity

Biodiversity is the degree of variation of life forms within a given ecosystem, biome, or on an entire planet. This term was popularized by the socio-biologist Edward Wilson to describe the combined diversity at all the levels of biological organization. The word biodiversity was considered more effective in terms of communication than biological diversity. Biodiversity includes diversity within a species and among species, and comparative diversity among ecosystems. India has a rich heritage of species and other strains of flora. It is estimated that India is one of the 17 mega-diversity (11th among these in respect to number of endemic vascular plant species) and 10th among the plant-rich countries of the world as well as 6th among the centres of diversity and origin of agro-diversity.

OUT of the total 35 biodiversity hotspots in the world, India has four, namely Himalayas, Indo-Burma (parts of North East India and Andaman Islands), Western Ghats (and Sri Lanka), and Sundaland (Nicobar Islands) (www.biodiversityhotspots.org). Aspects about earth's biodiversity based on the currently available species inventories revealed that approximately 75% of all the species recorded are animals, while plants (including algae, fungi, bryophytes, gymnosperms and angiosperms) comprise approximately 25% of the total. Out of global plant biodiversity (4,65,688), nearly 49,003 species of plants have been recorded from India and represented in Table 1.

Of the 8,000 reported species of flowering plants from the Himalayas, 5,000 species are found in the north eastern region. Orchids form a dominant group of plants with their attractive and unique blooms. Among the north eastern states, Arunachal Pradesh alone contains 40% of the floral and faunal species, many of which are endemic to the region. There are more than 600 species of orchids, 52 species of rhododendron, 18 species of *Hedychium*, 16 species of oak, 18 species of canes, 45 species of bamboo in addition to large number of medicinal and aromatic plants in Arunachal Pradesh.

At least 40% of the world's economy and 80% of the needs of the poor are derived from biological resources. In addition, rich biodiversity provides greater opportunity for medical discoveries, economic development, and adaptive responses to such new challenges as climate change. A diverse ecosystem is important which provides the basic necessities of life such as food, clean air and water. They offer protection from natural disasters and diseases, shape human cultures and spiritual beliefs, and maintain the planet's essential life processes. Biodiversity actually boosts ecosystem productivity where each species, no matter how small, play an important role.

Biodiversity offers us ecosystem services such as protection of water resources, soil formation and protection, nutrient storage and recycling, pollutant breakdown and absorption, contribution to climate stability, maintenance of ecosystems, recovery from unpredictable events, etc. It provides biological resources, viz. food, medicinal resources and pharmaceutical drugs, wood products, ornamental plants, breeding stocks, population reservoirs, future resources, diversity in genes, species and ecosystems. It gives rewards in terms of scientific and social benefits such as research, education and monitoring, recreation, tourism and cultural values.

Government of India brought Biological Diversity Act 2002, aiming at conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner and through a process. The National Biodiversity Authority was established in 2003



Adiantum edgeworthii-Berlin Botanical Garden



Habenaria intermedia

with head office at Chennai by the Government of India to regulate, conserve and sustainably use bio-resources of India through the Biological Diversity Act, 2002. Knowing the importance of biodiversity and its need of conservation, to create awareness among the people, 'International Day for Biological Diversity' is observed every year on 22nd May and the United Nations General Assembly declared 2011 – 2020, the 'United Nations Decade on Biodiversity'.

Floral/Ornamental Biodiversity

Floral diversity refers to the diversity of naturally occurring indigenous or native plants, occurring in a specific region during particular era. The word "Flora" comes from the Latin, *Flora* – the goddess of plants (*floris* means flower). In India, the floral diversity is concentrated in four phytogeographically unique regions, viz. Himalayas, Western Ghats, Northeast India and Andaman and Nicobar Islands. The Indian Flora accounts for 11.4% of the total recorded plant species of the world and about 28% of the plant species are endemic (species confined to a particular geographical region) to India. Angiosperms are the largest plant group in India comprising a total of 17,817 species, constitutes 38.15% of floral diversity of the entire country, followed by fungi comprising of 14,698 species, representing 31.38%. Most of the ferns and gymnosperms (including cycads, pines, firs, junipers, etc.) grow in cool temperate zones of the Himalayas, and in the mountainous regions of southern India, especially in the Western Ghats. According to

current estimates, the Indian flora represents nearly 12% of the global floral diversity (excluding viruses).

Ornamentals are mainly used for social, spiritual, aesthetic and decorative purposes. Mankind started appreciating the wide diversity available in nature and identified different genera/ species for different uses. Some of them are used for their attractive and colourful inflorescence and fragrance, while others are appreciated for their foliage. They could be in the form of bulbs, cacti, succulents, ferns, orchids, palms and aquatic plants. Ornamentals have a long history of domestication. Initially, the needs were met from the wild. Later, they were grown in home gardens as well as for landscape purpose. New and novel species are continuously introduced and cultivated in the gardens. The role of nurserymen, hobbyists and agri-horticultural societies in their domestication and conservation is creditable in the absence of dedicated gene banks to conserve them.

Wild ornamentals of Western Himalayas

Wild ornamentals are an essential part of the Himalayan landscape. Western Himalaya is a great reserve of unexploited floristic elements. Our valleys and forests harbour wide variety of plants which can be utilized for various ornamental and landscape purposes. Wild flowers come up all over the alpine heights and glades when the high mountains wake up after the long winter slumber. Western Himalaya, with diverse agro-climatic condition has been considered as treasure house of plant genetic resources. These ornamental plants are resistant to insect pests and diseases. These plants are disappearing and are endangered in their habitat mostly due to indiscriminate deforestation and urbanization. The need of the day is to conserve them at their own place of growing i.e. *in situ* and *ex situ* conservation where threatened plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care. Botanical gardens and other parks serve this purpose.

The Valley of Flowers, situated in the Himalayan ranges of Uttarakhand at an altitude of 3,600 m above mean sea level blossoms into a fairyland with the onset of summer every year. The valley is a natural habitat for innumerable kinds of flowers. It has the distinction of being declared a National Park and a World Heritage Site. The valley possesses many rare flowers like the Brahmakamal, the Blue poppy and Cobra lily. The diverse climatic and edaphic factor of the region favour natural habitat of various endangered flora of high hills. This natural wealth of mountainous region was used to cure various ailments in natural, homeopathic, ayurvedic system of medicine. In the traditional system or local folks have traditional knowledge of these valuable plants since ages. Some commonly used floral wealth include, *Lilium poliphyllum*, *Pteracanthus urticifolius* (Phuli) as a remedy for stomach ache, *Rhododendron arboreum* (Buransh) as heart tonic and feminine disorders, *Digitalis lanata* (Tilpushpi) in curing heart disease, *Saussurea lappa* (Brahmkamal) as a health tonic and skin ointment, *Canna indica* (Cana) as skin ointment and to rectify urinal disorder, *Callistemon himlis* (Snow Aster) for spasmodic action etc.



Jasminum gradiflorum

Some of the native diversity in trees, shrubs, climbers, ferns and bulbous ornamentals that can be commercially exploited from the Western Himalayas is summarized here.

Wild ornamental trees: *Aesculus indica*, *Albizia julibrissin*, *Bauhinia variegata*, *Benthamidia capitata*, *Bombax ceiba*, *Butea monosperma*, *Cassia fistula*, *Cedrus deodara*, *Erythrina variegata*, *Llex dipyrena*, *Mallotus philippinensis*, *Ougeinia oojeinensis*, *Pistacia integerrima*, etc.

Wild ornamental shrubs: *Caragana gerardiana*, *Cotinus coggygia*, *Daphne cannabina*, *Deutzia staminea*, *Euonymus tingens*, *Murraya Koenigii*, *Myricaria germanica*, *Rhus javanica* Linn, etc.

Wild ornamental climbers: *Climatis buchananiana*, *Hedera nepalensis*, *Jasminum dispersum*, *Rosa brunonii*, *Schefflera venulosa*, *Vitis himalayana*, *Abrus precatorius*, *Capparis spinosa*, *Climatis grata* etc.

Wild ornamental bulbous plants: *Anemone obtusiloba*, *Anemone tetrasepala*, *Arisaema flavum*, *Asparagus adscendens*, *Begonia picta*, *Iris lacteal*, *Ophiopogon intermedius*, *Ranunculus laetus*, *Tulipa stellata*, etc.

Wild ornamental ferns: *Adiantum capillus-veneris*, *Asplenium dalhousiae*, *Christella dentata*, *Diplazium polypodioides*, *Polystichum discretum*.

The biodiversity available in various parts of the country in some of the commercial flowers was utilized in the earlier breeding programmes. However scope exists for further exploitation in near future. Some of the efforts wherein the native diversity was utilized in the

improvement of important commercial flower crops such as rose, orchids, etc. is summarized in this section.

Rose

There are about 120 species of roses distributed in the North temperate and sub tropical parts of both hemispheres. As far as the garden roses of the world are concerned only eight species namely *Rosa chinensis*, *R. damascena*, *R. foetida*, *R. gallica*, *R. gigantea*, *R. moschata* and *R. wichuraiana* have played an important role. Ornamental roses growing in the Western Ghats are miniature or floribunda types having the colour ranging from pure white to blood red and variegated types. All the roses growing in Western Ghats are either moderately resistant or highly resistant to the major pests and diseases and are hardy to drought and heat. Since the major constraint in breeding for elite indigenous rose varieties is the lack of resistance and hardy parent stock, some of the roses grown in Western Ghats could be excellent starting material in breeding for new rose varieties. *Rosa leschenaultiana* is wildy grown in Western Ghats. India has a good genetic diversity of *Rosa* spp. because as many as 16 species of this genus are found growing wild in different phyto-geographical zones. In India, several *Rosa* species are found growing wild, mostly in the Himalayan ranges. The species growing wild in Himalayan range are *Rosa brunonii*, *R. eglanteria*, *R. foetida*, *R. gigantia*, *R. involucrata*, *R. leschenaultiana*, *R. longicuspis*, *R. macrophylla*, *R. moschata*, *R. rubiginosa*, *R. walpoleana*, *R.*



Rhododendron maddenii

acae, *R. banksiae*, *R. beggeriana*, *R. clinophylla*, *R. webhiana* and *R. sericea*. Utilization is the ultimate aim of the collection and conservation of plant genetic resources. Among so many rose species, only 15 species are associated with the evolution of garden roses. Therefore, tremendous scope lies in rose breeding with the use of species. *R. rugosa*, *R. banksiae*, *R. multiflora* and *R. micrantha* are suitable for ornamental flowers; *R. rubrifolia*, *R. hugonis* and *R. wichuriana* for foliage and *R. eglanteria*, *R. rugosa*

and *R. macrophylla* for beautiful hips/fruits; *R. canina*, *R. indica*, *R. laxa*, *R. multiflora* and *R. rubiginosa* for rootstock purpose.

Orchids: Jewel of North-Eastern states

Orchids are flowering plants belonging to the family Orchidaceae. It is a remarkably a diverse family that contains over 25,000 recognized species divided into more than 800 different genera. Out of 25,000 species, about

Table 1. Total number of plant species (including virus, bacteria, algae, fungi and lichens) and their status in World and India

Type	Number of known species		Percentage of occurrence in India	Number of endemic species in India	Number of threatened species in India
	World	India			
Flowering plants					
Gymnosperms	1021	81	7.93%	12	7
Angiosperms	2,68,600	18,532	6.90%	4,303	1,242
Non-flowering Plants					
Bryophytes	16,236	2,754	16.96%	629	c. 80
Pteridophytes	12,000	1,293	10.76%	66	414
Others					
Virus and Bateria	11,813	1,196	10.12%	Not known	Not known
Algae	40,000	7,396	18.49%	1,924	Not known
Fungi	98,998	15,223	15.38%	c. 4,100	c. 580
Lichen	17,000	2,528	14.87%	c. 520	Not known

Source: <http://www.bsienviis.nic.in/>



Rhododendron campanulatum

17,000 are estimated to occur in India. Almost 50% of country's orchid wealth remains with north-eastern region alone. The region of north-eastern India is perhaps the richest in the world, both in quantity and in the individual species of orchids. An approximate estimate on the occurrence of species in north-eastern India is Sikkim-450, Assam-350, Arunachal Pradesh-300, Meghalaya-350, Manipur, Mizoram and Nagaland-150 each and Tripura-100. Some of the important species that are found in the region are *Aerides fieldingii*, *Aerides multiflorum*, *Anoectochilus sikkimensis*, *Arachnothera cathartii*, *Arundina graminifolia*, *Bulbophyllum cylindraceum*, *Calanthe chloroleuca*, *Coelogyne barbata*, *Coelogyne necorymbosa*, *Coelogyne nitida*, *Cymbidium affine*, *Cymbidium cyperifolium*, *Cymbidium elegans*, *Dendrobium chrysanthum*, *Dendrobium crepidatum*, *Paphiopedilum fairieanum*, *Paphiopedilum hirsutissimum*, *Phaius mishmensis*, *Pleione maculata*, *Renanthera imschootiana*, *Rhynchostylis retusa*, *Vanda coerulea*, etc. Some of threatened species from the north eastern states are *Bulleyia yunnanensis*, *Calanthe mannii*, *Pholidota wattii*, *Vanda coerulea*, *Cymbidium eburneum*, *Cymbidium hookerianum*, *Diplomeris hirsuta*, *Diplomeris pulchella*, *Paphiopedilum wardii*, and *Paphiopedilum fairieanum*. The reason for threatened species might be habitat destruction and greed of orchid collectors for trade in many orchid species.

Indigenous orchids of Andaman and Nicobar Islands

A total of 132 wild indigenous species of orchids from 59 genera have been reported from Andaman and Nicobar Islands owing to its favourable tropical warm and humid climate. The economic importance of orchids lie mainly in their ornamental value, however, many of them are used in the traditional system of medicine for curing a number of ailments. *Eulophia andamanensis* (Pretty Green Bay) is an important medicinal indigenous orchid species which has been registered at NBPGR, New Delhi for its special characteristics, viz. green flower, long spike and duration of flowering. Important genera and species of orchids native to Andaman and Nicobar islands are *Acriopsis indica*, *Aerides emericii*, *A. multiflorum*, *A. odoratum*, *A. ringens*, *Agrostophyllum khasianum*, *A. planiculale*, *Aschocentrum ampullaceum*, *Bulbophyllum careyanum*, *B. crassipes*, *B. lepidum*, *B. lilacinum*, *Calanthe triplicate*,

Cymbidium aloifolium, *C. bicolor*, *C. pendulum pubescens*, *Dendrobium anceps*, *D. aphyllum*, *Eria bractescens*, *Flickingeria sp.*, *Geodorum sp.*, *Luisia amesiana*, *Kingidium sp.*, *Malaxis baurita*, *Oberonia iridifolia*, *Pachystoma pubescens*, *Schoenorchis minutiflora*, *Rhynchostylis retusa*, *Vanilla andamanica* etc.

Ferns

Ferns are known for their typical, intricate leaf patterns, which have made them subject of art, poetry and worship for years. The lack of flowers and the concept of the invisible seed are responsible for their association with folklore, myth, magic, mysticism and indigenous medicine. The long shelf life of the cut as well as potted ferns makes them very popular among the urban masses. They form a significant part of the international trade as cut greens or pot plants because of their exquisite and attractive foliage and have multiple uses as ornamentals, food, and medicinal plants. 90% of ferns are believed to inhabit tropical forests, Andaman and Nicobar Islands is one of them and hosts more than 120 indigenous species of ferns of which 20% are endemic.

Jasmine

Jasmines are the group of perennial ornamental plants of Oleaceae family, comprising about 200 species mostly in tropical and sub-tropical world, out of which 42 are reported to occur in India. Species include *Jasminum abyssinicum*, *Jasminum adenophyllum*, *Jasminum dichotomum*, *Jasminum grandiflorum*, *Jasminum humile*, *Jasminum lanceolarium*, *Jasminum mesnyi*, *Jasminum nervosum*, *Jasminum odoratissimum*, *Jasminum officinale*, *Jasminum parkeri*, *Jasminum polyanthum*, *Jasminum sambac*, *Jasminum sinense*, *Jasminum urophyllum*. However, only four of these, viz. *Jasminum sambac*, *J. auriculatum*, *J. grandiflorum* and *J. pubescens* are grown commonly for oil extraction and loose cut flower trade in our country. The distribution of this genus is pan-tropical but a large number of species are centred around India, China and Malaysia.

Endangered /rare/threatened Ornamental Plants in India

India is home to several endemic ornamental species owing to diverse ecosystems and habitats. Around 33.5 % of Indian flora has been identified as endemic and is distributed predominantly in the Indian Himalayas and Peninsular India. A large number of endemic plants are becoming endangered owing to habitat loss and associated fragmentation particularly in the tropics. Due to rapid urbanization, deforestation and anthropogenic reasons like increasing pollution at an alarming rate and to plants for extinction. Some of the endangered ornamental plants of India are described here.

Ferns from the Western Ghats: *Adiantum lomesam*, *Ampelopteris prolifera*, *Adiantum edgeworthii*, *Anemia wightiana*, *Asplenium anogrammoides*, *Anisocampium cumingianum*, *Asplenium affine*, *Botrychium lanuginosum*, *Cheilanthes duthiei*, *Cheilanthes dubia*, *Cheilanthes rufa*, *C. persica*, *Dryopteris approximata*, *Grammitis attenuata*, *O. regalis*, *Helminthostachys zeylanica*, *Osmunda japonica*, *Woodsia andersonii*, *Huperzia hamiltonii*, *Pteris wallichiana*, *Hypodematium crenatum*, *Pellea subfurfuracea*, *Lycopodium*

japonicum, *Loxogramme parallela*, *Polystichum subinermis*, *Dennstaedtia wilfordii*, *Tectaria periyai*, *D. scabra*.

Rhododendrons from Himalayas: *Rhododendron pumilum*, *R. maddenii*, *R. kendrickii*, *R. neriiflorum* ssp. *Phaetropum*, *R. falconeri* ssp. *Eximium*, *R. hookeri*, *R. megeratum*, *R. tanastylum*, *R. keysii*, etc.

Orchids from Sikkim: *Bulbophyllum trichocephalum* var. *capitatum*, *Calanthe anjanii*, *Calanthe keshabii*, *Coelogyne pantlingii*, *Malaxis saprophyta*, *Cymbidium whiteae*, *Goodyera dongchenii*, *Gastrochilus sonamii*, *Liparis chungthangensis*, *Liparis lydiai*, *Liparis pygmaea*, *Oberonia kingii*.

Other plants from North-West Himalaya: *Habenaria intermedia*, *Meconopsis aculeate*, *Eremostachys superb*, *Gentiana kurroo*, *Phaius tankervilleae*, *Wallichia densiflora*, *Trachycarpus takil*, *Cyathea spinulosa*.

Conservation of Plant Biodiversity

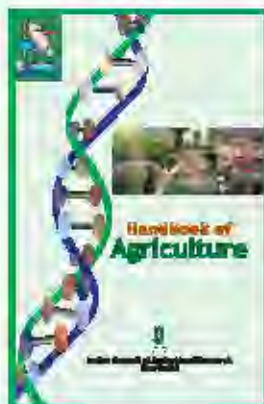
The growing urbanization and industrialization causes decrease of natural habitats, which further results in the loss of biological diversity. Biodiversity has taken millions of years of evolution, to accumulate this rich diversity in nature, but we could lose all that wealth in less than two centuries if the present rates of species loss continues. Biodiversity, once lost cannot be recovered. Biodiversity and its conservation are now vital environmental issues of international concern as more and more people around the world begin to realize the critical importance of biodiversity for our survival and well-being on this planet.

Conservation is a protective measure to prevent the loss of genetic diversity of all species, to save species from extinction and ultimately to protect all the ecosystems from damage so as to promote their sustainable utilisation. Conservation of biodiversity can be done using *in situ* and *ex situ* approaches. *In situ* conservation is the management of species within their natural ecosystems and habitats. This approach includes Protected areas (PAs), Biosphere reserve, National parks, etc. which is mainly used for conserving wild species. Now-a-days, *ex situ* techniques are efficiently used to harmonize *in situ* methods and for conserving certain highly endangered and rare ornamental plant species. The different *ex situ* conservation approaches are Botanical gardens, Arboreta, Field gene bank, Seed gene bank, *in vitro* gene bank, Cryo-gene bank, Pollen bank, DNA bank, etc. With extensive awareness on conservation of plant biodiversity, many organizations have started working towards conservation and management of endemic and threatened plant species. NBPGR, New Delhi; Botanical Survey of India, Kolkata, etc. are some of the organizations which are enriched with the indispensable conservation facilities such as seed gene bank, *in vitro* repository, cryobank, field gene bank, etc.

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Handbook of Agriculture



The Handbook of Agriculture is one of the most popular publication of the ICAR with a wider readership. The present edition presents science-led developments in Indian agriculture, the ongoing research efforts at the national level and with some ideas on the shape of future agriculture. While information in some chapters such as Soil and water, Land utilization, field and forage crops has been updated with latest developments, many new topics such as the Environment, agrobiodiversity, Resource conservation technologies, IPM, Pesticides residues, Seed production technologies, Energy in agriculture, informatics, Biotechnology, Intellectual Property Rights, Agricultural marketing and trading and Indigenous Technical Knowledge have been included in the present edition. For those who take intelligent interest in agriculture – and their number is increasing fast – the present edition would serve as a useful book.

TECHNICAL SPECIFICATIONS

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Native ornamentals for minimal maintenance of landscape gardening

India has a wealth of native plants, colourful wildflowers, grasses, shrubs and trees that are well adapted to our variable climatic conditions, soils, temperatures, and elevations. There are several non traditional and unexploited species available in nature. Plants, from their natural habitats, can be selected for the beautification of parks, public and private places in urban as well as rural areas. This article describes species for minimal maintenance of landscape gardening.

WESTERN Ghats of India, one of the eight hottest hotspots of the world is known for its rich biodiversity. Western Ghats harbor about 4000 flowering plants which includes ornamental trees, shrubs, climbers, herbs, succulents, of which only few are utilized to some extent for their economic values. For sustainable utilization and conservation of these important resources, efforts have been made in the form of exploration, collection, domestication and evaluation. Based on the evaluation we recommend the below listed species for minimal maintenance of landscape gardening.

Jasminum malabaricum (Family : Oleaceae)

Characteristics: *Jasminum malabaricum* is an ever green creeper that can be trained as shrub because of high growth rate and can be trained in any form. It responds well to pruning and has attractive, star shaped white flowers with fruity fragrance. Clusters of white flowers appear in February and are followed by fruits in September. The leaves are dark green.

Landscape uses: *Jasminum malabaricum* comes well in full sun. It can be grown at shrubbery or can be trained

as a climber on pergolas. It can also be grown as a specimen plant in landscape. It will adapt to hot, dry locations when irrigated. *J. malabaricum* is easily multiplied through seeds as well as cuttings.

Size: 2.5 m tall with a spread of 1.5 to 2 m.

Habitat: Grows well in all types of soils.

Native: Western Ghats, India.

Lepturus radicans (Family : Poaceae)

Characteristics: A wild lawn grass which is a blend of low growing native grass that provides lawn-like appearance. Native turf provides deep, fibrous root system that helps build and maintain soil quality. It should be moved once in two months and the height of the vegetation should be 4 to 6 inch. By dibbling method it spreads at a faster rate in a closed spacing and takes about 70 days to cover the area.

Landscape uses: *Lepturus radicans* can replace the regular turf grass requirement. It comes up well in partial to full sun situation. And little hardy requires less water compare to regular turf grass species. And can be easily propagated through runners.

Zones: It grows well under Bangalore conditions.

Habitat: Grows well on loamy soils.

Native: Western Ghats, India.



Artemisia japonica





Senecio belgaumensis

***Clematis gouriana* (Family: Ranunculaceae)**

Characteristics: Evergreen creeper with attractive ovate leaves. Stem is brown and grooved. Oppositely arranged pinnate leaves. Flowers are 1-1.5 cm across, are fragrant, greenish white, appearing in branched panicles 15-25 cm long. The flowers have 4 sepals which look like petals. Mass stamens spread out from the middle of the flower. Flowers from November to February.

Landscape Uses: It is highly suitable creeper for pergolas, trellises, fences, and also can be used for screening purpose in landscaping.

Zones: It grows well under Bangalore Conditions.

Habitat: Hardy, can be grown on all types of soils.

Native: Western Ghats, India.

***Ixora parviflora* (Family: Rubiaceae)**



Characteristics : It is small, much branched shrub of 2-3 m. Leaves vary from ovate-ablong to cuneate-obvate, bluntish or pointed, 3-4 inches long. Flowers are small, numerous, white and distinctly fragrant. Flower tube is short hairless with 4 oblong linear petals with curled margins. Sepal tube has 4 small teeth. Style protrudes out of the flower, with abifurcated stigma. Flowers appear in corymbs or panicles at the end of branches, stalkless or peduncled, berries are round about 6 mm. Flowers in March-April.

Landscape use: It is highly suitable for specimen planting and also can be used for hedge planting also.

Zones: It grows well round the year under Bangalore Conditions.

Habitat: Grows well under well drained soils.



Jasminum malabaricum



Ixora parviflora

Native To: Western Ghats, India.

***Senecio bombayensis* (Family: Asteraceae)**

Characteristics: This is an annual flowering plant and grows to a height of 51 cm. The number of primary and secondary branches was 19 and 180 respectively. This species required 46 days for first flowering. The number of leaves per plant was 428, and 291 flowers per plant were observed. The total duration of flowering period was 3 months. The total crop cycle was 5 1/2 months.

Compared to other species this sets seeds early.

Landscape Uses: It is highly suitable for bedding purpose in landscape.

Zones: It grows well round the year under Bangalore Conditions.

Habitat: Hardy, can grow on all types of soils.

Native: Western Ghats, India.

***Senecio belgaumensis* (Family: Asteraceae)**

Characteristics: The plant grows to a height of 62.51 cm. The number of primary and secondary branches recorded was 12 and 188, respectively. It took 46 days for first flowering under open conditions. The number of leaves recorded were 902 and 494 flowers per plant. The flowering period was 98 days. The total crop cycle was 5-6 months.

Landscape uses: It is highly suitable for bedding purpose in landscape.

Zones: It grows well round the year under Bangalore Conditions.

Habitat: Grows well under well drained soils.

Native: Western Ghats, India.

***Senecio dalzellii* (Family: Asteraceae)**

Characteristics: It is found at high altitudes. The average plant height 48.74 cm. The number of primary branches were 30 and secondary branches 150. The maximum number of flowers per plant (617) were recorded in this species. The total duration of the crop cycle is 5-6 months for this species. The flowering period was for 105 days.

Landscape uses: It is highly suitable for bedding purpose in landscape.

Zones: It grows well round the year under Bangalore Conditions.

Habitat: Grows well under well drained soils.

Native To: Western Ghats, India.

***Turnera ulmifolia* (Family : Passifloraceae)**

Characteristics: Turnera is a perennial small shrub, reaches 2 1/2 feet. Blooms repeatedly. Yellow blooms with nectar glands attract lots of butterflies. Easily multiplied through seeds. It takes 35 days for blooming. Flowering takes place throughout the year.

Landscape uses: It is highly suitable for bedding



Tunera

purpose, hedge, border as well as container purpose and mass planting in landscape.

Zones: It grows well round the year under Bangalore Conditions.

Habitat: Grows well under well drained soils.

Native: Naturalized from Western Ghats, India.

***Artemisia japonica* (Family: Asteraceae)**

Characteristics: A perennial green shrub with attractive grey inflorescence and small green leaves. Easily multiplied through softwood cuttings. Plant grows up to 2 m. Responds well to pruning.

Landscape uses: It is highly suitable for mass planting in landscape.

Zones: It grows well under Bangalore Conditions.

Habitat: Grows well under well drained soils.

Native To: Western Ghats, India.

***Artemisia nilagirica* (Family: Asteraceae)**

Characteristics: A perennial green shrub, with attractive golden inflorescence and small green leaves. Easily multiplied through softwood cuttings. Plant grows up to 2 m. Responds well to pruning.

Landscape uses: It is highly suitable for mass planting in landscape.

Zones: It grows well under Bangalore Conditions.

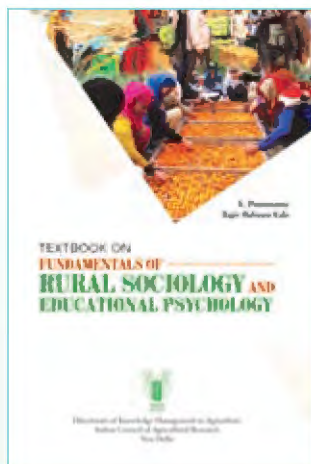
Habitat: Grows well in well drained soils.

Native: Western Ghats, India.

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Textbook on Fundamentals of Rural Sociology and Educational Psychology



India being a land of villages, rural sociology and educational psychology is an essential theme for agricultural students and professionals. Rural sociology deals with rural society and the relations of people who live in villages. Rural sociology presents a scientific picture of rural life.

Extension workers work with farmers very closely in their settings for which their understanding of rural background and farmers' psychology is very essential. Extension professionals should have necessary knowledge of the precise approaches and methods of dealing with farmers. Rural sociology can help professionals in organizing the rural structure in a constructive manner.

This textbook consists of fundamental facts of rural sociology. The book has twenty two chapters covering both rural sociology and educational psychology out of which twelve chapters consist of rural sociology and ten chapters deal with educational psychology. In this text book, emphasis has been given on various aspects of educational psychology also. It provides all the relevant information in the field of rural sociology with special emphasis on Indian culture, merits and demerits of Indian rural societies, the stressful conditions under which farmers live and work. The book will be a good basis of information reference for agriculture students, psychology students besides extension practitioners, research scientists, KVKs and agricultural colleges.

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Epoxy resin encapsulation: A novel drying technique for native flowers

Drying of native flowering plants and their different parts with epoxy resin encapsulation is a novel approach. These are attractively embedded inside resin, avoiding dust, and beauty of native flowers can be cherished forever.

NATIVE ornamentals can be used for specimen, avenue, mass plantations, as excellent emerging and fall leaf coloured plants, bedding purpose, topiary and hedge, shady areas, scented gardens, beautifying walls, gates and unpleasant areas; cut greens, hanging baskets, drying purpose etc. Different types of coloured flowers, foliage, twigs, seeds and fruiting structures of these native ornamental plants are found in hilly areas of Himachal Pradesh and Uttarakhand in various seasons round the year. This seasonal vegetation can be transformed into value added products by using dehydration techniques.

Dry flowers being environmental friendly and biodegradable substitute to fresh flowers, require little care and can be cherished forever. There are several methods by which flowers, foliage and floral parts can be dried, viz. air drying and natural drying, sun drying, press drying, embedded drying and oven and microwave oven drying, glycerine drying, freeze drying etc.

Drying of native flowers done with the help of resins is known as resin encapsulation technique. Epoxy resins are used as adhesives for metal, glass, wood, stone and plastics. Assorted value added items with dry flowers can be created, being transparent or coloured with epoxy resin. This is permanent encapsulated technique in which dry flowers are locked inside resin permanently exhibiting eternal beauty forever. The present work on dehydration of native flowers with different types of resin is being carried out at RHRTS, Dhaulakuan, District (HP) in collaboration with FRI, Dehradun, Uttarakhand.

For making such value added products like pendants, ear rings, rings, paper weights, wall paintings, key chain rings, table top covers etc, the first step is to press dry flowers of native plants, viz. *Aconogonum molle*, *Anaphalis margaritacea*, *A. triplinervis*, *Androsace rotundifolia*, *A.*

sarmentosa, *Barleria cristata*, *Buxus sempervirens*, *Cotinus coggygia*, *Decandrum nanum*, *Delphinium vestitum*, *Hypericum oblongifolium*, *Inula cuspidata*, *Maesa chisia*, *Persicaria capitata*, *Pistacia integerrima*, *Viburnum mullaha*, *V. cylindricum*, *V. cotinifolium*, *Vitis himalayana*, foliage of *Adiantum capillus-veneris*, *Asparagus adscendens*, *Cheilanthes brevifrons*, *Onychium contiguum*, *Polystichum squarrosum*, *Pteris cretica*, *Woodwardia unigemmata* etc, in between blotting paper sheets whereas, naturally dried fruits and seeds of *Abrus precatorius*, *Acer oblongum*, *Hedera nepalensis*, etc. with several designs can be used as such in this technique.



Assorted native flower petals in resin for pendants



Epoxy resin encapsulated native plant parts designs for keyring chains

Second step is to keep ready required resin and hardener which are stirred properly before use. Differently shaped moulds are available to make variety of products. Epoxy resin and hardener in the ratio of 2:1 is poured into the moulds first, then press dried flowers, leaves and seeds are arranged artistically on it and again this solution is poured over the press dried items. These moulds carrying designed native pressed flowers and foliage are kept overnight to dry and harden. The mixture of resin and hardener should be appropriate and designs can be made according to one's own skill and creativity.

For further interaction, please write to:

Dr Priyanka Thakur (Principal Floriculturist), YSP University of Horticulture and Forestry, Nauri, Himachal Pradesh.

Native ornamental bamboos of Western Ghats

The Western Ghats of India is a refuge for many plant species, including bamboos. Among the 16 natural species occurring here, some can be tamed for gardening. Growing native bamboos in homesteads, public gardens or in agroforestry systems satiates its conservation and moreover remediates raw material shortage. Five selected ornamental species, *Ochlandra wightii*, *O. beddomei*, *Munrochloa ritchiei*, *Teinostachyum wightii* and *Dendrocalamus stoksii* are described here. Being monocarpic perennials, offsets are suitable for propagating the species.

BAMBOOS are arborescent grasses, characterized by long years of vegetative growth and monocarpy. They are highly sought raw material for cottage, paper and textile industries. Due to strength, straightness, lightness and extraordinary hardness, bamboos form ideal material for construction. Because of special grace and grandeur, they are good ornamentals as well.

Western Ghats of India is the natural repository of 22 bamboo species, belonging to 6 genera. Among these 17 species are listed as endemics (Seethalakshmi and Kumar 1998). Since many species were merged by later workers and many being reported from Sri Lanka, the list could be updated as 16 natural bamboo species, including 7 endemics. The native commercial species, *Bambusa bambos* with yellow culms is already in use as a landscaping element in many gardens, due to the elegance it creates. Five potential, under-exploited wild ornamental species are described here.

Ochlandra wightii

A graceful green reed bamboo, endemic to southern parts of Western Ghats. Clumps thick, having 2-5 m basal circumference, 5-6 m height (internodes 50-70 cm), with 50 to 150 light green, smooth and arching culms. Culm sheaths are green, turning yellow on maturity, partially covered with brown hairs and

notable by a characteristic papery ligule (2 cm). Its canopy is like a large umbrella, possessing evergreen leaves, second largest in size (40-67.4 cm × 5.5-13.2 cm), among Afro-Asian bamboos.

This species is suited to hill slopes and stream sides, sandy loam; and is propagated by seeds and offsets. Umbrella like canopy, broad leaves and shrubby nature, makes *O. wightii* ideal for gardening and landscaping; in addition to river bank protection and raw material source for cottage industry.

Ochlandra beddomei

A beautiful reed bamboo, endemic to the central part of Western Ghats. Clumps thick, having 2-5 m basal circumference, 3-5 m height (internodes 35-50 cm), constituted of 50 to 100 green, arching culms. Culm sheaths are yellowish green, with brown hairs, turning brownish yellow on maturity. Its canopy is umbrella like, with smaller (16-34 cm × 2-4 cm) evergreen leaves.

This reed is suited to hill slopes and stream sides. It prefers sandy loam and is propagated by seeds and offsets. The umbrella like canopy and shrubby nature makes it ideal for gardening and landscaping. Moreover, it is suitable for river bank protection and supports cottage industry.



Ochlandra wightii



Ochlandra beddomei





Munrochloa ritchiei

Munrochloa ritchiei

An elegant woody bamboo, endemic to Western Ghats; clumps with 2-5 m basal circumference, 3-8 m height (internodes 30-40 cm), constituted of 50 to 100, brownish green, straight, and solid culms, clothed with brown velvet tomentum, when young. Linear-lanceolate leaves (11-24 cm × 1.2-3.7 cm), clustered in bunches, is an addition to its beauty.

It generally prefers red soil, suited to open hilly areas. Its propagation is through offsets. Erect culms and narrow leaves makes the bamboo suitable as a garden plant and an effective landscaping component for larger areas. In addition, it offers long and strong poles.

Teinostachyum wightii

A semi-scandent and straggling bamboo which prefers a support to spread. It is endemic to Western Ghats. New culms are attractive with display of black appressed hairs over sheaths. Long internodes (30-90 cm), a projecting nodal ring and tuft of branches are characteristics of the plant. Leaves are usually 20-30 cm × 3.5-4.4 cm in size.

This species can be used as an effective garden component, when grown adjacent to large branched trees.

Dendrocalamus stocksii

A strong woody bamboo, with tall culms of 10-15 m (internodes 30-40 cm). The culms are dark green with a white band at the nodes. Young culms possess greyish pubescence. The culm sheaths are covered with brown persistent hairs. Leaves are usually 15-30 cm × 1.3-3 cm in size.

Though *D. stocksii* is primarily sought as a construction material; due to its tall, elegant look, it is suitable for landscape gardening as well as in agroforestry.



Dendrocalamus stocksii



Teinostachyum wightii

Significance of Bamboos

The economic giant grass, bamboo, being a versatile renewable resource, is widely used as raw material for the cottage industry, as well as paper and textile industry and also in housing and agricultural sectors. Thus, it is rightly addressed as the “timber of the 21st century”. Bamboos are also very much suitable as ornamental plants, for gardening and landscaping. Moreover, it is much appreciated for eco-restoration and river bank protection. Propagation and dispersal of bamboo species suitable for commercial cultivation in the country is a quite relevant considering its economic and environmental aspects. Many clones of

potential bamboo species referred here are conserved in the Bambusetum of JNTBGRI, of which saplings of *O. beddomei* are currently made available to the public, as part of popularisation.

Gardening Tips

Rare seeding at long unpredictable year's intervals is the major constraint in bamboo propagation. The species listed above are reluctant to respond to vegetative propagation methods, except offset planting. Therefore, offset planting is advised, except when viable seeds are available. Offsets can be best planted just prior to the rainy season. Pit size should be suitable to the size of the propagule (preferably 60 cm × 60 cm × 60 cm). Filling with top soil and farm yard manure is recommended. Regular irrigation once in a day is necessary till establishment. Staking for protection from wind and fencing to prevent herbivory are suggested during initial six months.

For further interaction, please write to:

Dr B Gopakumar (Scientist), Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram, Kerala 695 562.

Indigenous trees – An overview

Man has been fascinated by nature since time immemorial. In India, trees and plants have been respected with devotion, have been affectionately touched and almost treated as members of family. Large numbers of plants, considered sacred in India, are called the Bodhi trees, as certain sages received enlightenment under them. The conservation of plants by worshiping them was very likely an important factor in making them sacred. Plants are repeatedly mentioned in connection with customs, traditions and beliefs. In fact, in India, no ceremony is complete without sacred plant being used. Nature has gifted man with trees for his sustainable livelihood. Trees provide them with food, fuel, shelter, drugs, material like paper for industry, protect from environmental hazards like pollution and soil erosion, and provide a comfortable microclimate apart from beautifying the environment.

NATIVE plants are species that are indigenous to a particular habitat within a specific biogeographic region. Native plants provide multiple benefits to people and wildlife, while contributing greatly to healthy soil and water in urban and rural areas.

Indigenous trees

Important native ornamental trees, many of which are mentioned in ancient literature are kachnar (*Bauhinia variegata*), amaltas (*Cassia fistula*), pink cassia (*Cassia nodosa*), dhak or flame of forest (*Butea monosperma*), Indian coral tree (*Erythrina indica*), pride of India (*Lagerstroemia flos-reginae*), scarlet cordia (*Cordia sebestena*), yellow silk cotton (*Cochlospermum gossypium*), karanj (*Pongamia glabra*), tulip tree (*Thespesia populnea*), barna (*Crataeva religiosa*), chalta (*Dillenia indica*), kadamba (*Anthocephalus cadamba*) and rhododendrons. Various characteristics of some important trees have been described here.

***Acacia catechu* (Khair, Fabaceae):** It is a deciduous, thorny tree which grows up to 15 m (50 ft). Kattha

(catechu), an extract of its heartwood, is used as an ingredient to give red color and typical flavor to paan. Used against throat infections, cough, diarrhoea, chronic ulceration, epistaxis and eruptions of the skin, leprosy, leucoderma and wounds. It is also useful in treating anaemia, diabetes, inflammations and intermittent fever.

***Aegle marmelos* (Bel; Rutaceae):** A medicinal tree, one of the constituents of “Dashmoola”. It is a deciduous shrub or small to medium-sized tree, up to 13 m with slender drooping branches and a shabby crown. Roots and bark used to treat melancholia, intermittent fevers and palpitation of the heart. Fruit pulp is nutritious and prevents heat stroke. Leaf juice extract is applied externally on abscesses.

***Alstonia Scholaris* (Saptaparni, Devil’s tree; Apocyanaceae):** This tree is known for fragrance and pollution control. The bark is regarded as a bitter tonic and a mild febrifuge and possesses astrigent, anthelmintic and galactagogue properties. It is a tall (16-30 m) tree, leaves are elegant, whorled and branches provide plenty of shade. Flowers are produced in October-November in



Delonix regia



Cassia javanica



Lagerstoremia speciosa

greenish white clusters. It is suitable for planting alongside the roads, in groups or as a specimen in parks.

***Anthocephalus cadamba* (Kadamba; Rubiaceae):** It is a large, graceful, deciduous tree with a straight stem about 30 m high and with a girth of 2 m. The spreading crown bears drooping branches and yellow ball like flowers in globose heads. The flowers are used in perfumes. The tree is grown as an ornamental plant and for timber and paper-making. The flowers appear in rainy season. Kadamba has been mentioned in the *Bhagavata Purana*. In North India, it is associated with Krishna while in the south it is known as “Parvati’s tree”.

***Aquilaria agallocha* (Agarwood; Thymelaeaceae):** It is major source of agarwood. Agarwood is formed in the heartwood of the trees, when they become infected with a type of mould (*Phialophora parasitica*). Prior to infection, the heartwood is odourless, relatively light and pale coloured; however, as the infection progresses, the tree produces a dark aromatic resin, called aloes or agar in response to the attack, which results in a very dense, dark, resin embedded heartwood. The resin embedded wood is valued in many cultures for its distinctive fragrance and thus is used for incense and perfumes. It is useful in halitosis, cardiac debility, skin diseases, leprosy, foul ulcer, inflammations, rheumatosis, arthrititis, cough, asthma and hiccups. It is illegally exported from India.

***Azadirachta indica* (Neem; Meliaceae):** Neem is a fast-growing tree that can reach a height of 15–20 m (49–66 ft). All parts of the tree have medicinal value. Neem cake is used as fertilizer which kills harmful insects, termites and nematodes. From landscaping point of view it is good tree for roadside plantation. Flowers are small, white and sweet scented which appear from end of April to mid-May. Propagation is done by seeds.

***Bauhinia* sp. (Leguminosae):** Plants of the genus are easily identified from peculiar leaves composed of two oval shaped leaflets united in the centre. Easily propagated through seeds which are produced in abundance. Flower buds are cooked as vegetable. Different species include *B. variegata*, *B. purpurea* and *B. tomentosa*.

***B. variegata*:** This is a tall tree producing rose coloured flowers variegated with red and yellow colour which appear



Peltophorum ferrugineum

in mid March. Most ideally suited for planting as specimen or in groups in gardens and big parks and as avenue tree alongside the road.

***B. purpurea*:** The beautiful and fragrant, classic, Orchid-like flowers makes this small tree, a favourite of many plant lovers. In fall, before the leaves drop, the is festooned with many showy and delightfully fragrant, five-inch-wide blossoms, the narrow purple, pink, and lavender petals arranged to closely resemble an orchid. These flowers appear on the trees from September through November.

***Betula utilis* (Bhurja, Bhojpatra; Betulaceae):** In its native habitat, *B. utilis* tends to form forests, growing as a shrub or tree reaching up to 20 m (66 ft). The specific epithet, *utilis*, refers to the many uses of the different parts of the tree. The white, paper-like bark of the tree was used in ancient times for writing Sanskrit scriptures and texts. It is still used as paper for writing sacred mantras, with the bark placed in an amulet and worn for protection. Considered useful in dyspepsia, diarrhoea, epilepsy, haemophilic conditions and diseases of the ear.

***Bombax malabarica* (Simul, red silk cotton tree; Bombacaceae):** Often a very large deciduous tree, reaching 40 m or more; trunk and branches covered with warty spines, buttressed. The tree yields a dark brown astringent gum used in medicine. It is considered a sacred tree and is associated with Goddess Kali. Flowers are large, bright red or yellowish red which appear in mid of March. It is propagated through seeds. It is highly suitable for boundary plantation of bigger compounds, national highways and in parks.

***Boswellia serrata* (Salaiguggul; Burseraceae):** It is a plant that produces Indian frankincense, Salai, referred to in Sanskrit as shallaki and in Latin as *Olibanum indicum*. The gum exudate possesses anti-arthritic activity. Used in the treatment of ulcers, cystic breast, piles, skin diseases, convulsions, dysentery, bronchitis, asthma, cough, jaundice, diarrhoea and dysentery.

***Buchanania cochinchinensis* (Chironji; Anacardiaceae):** It is a medium-sized deciduous tree, growing to about 50 ft. It bears fruits that contain a single seed, which is popular as an edible nut, known

Indigenous trees



Acacia



Alstonia



Bauhinia purpurea



Bombax



Boswellia



Buchananio



Canarium



Cassia fistula



Emblica



Erythrina indica



Ficus benghalensis



Ficus glomerata



Ficus religiosa



Gardenia



Holarrhena



Lagerstroemia indica



Lagerstroemia



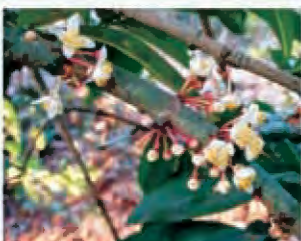
Madhuca indica



Michelia champaca



Mimosa elengi



Ochrocarpus



Oroxylum



Pterocarpus



Rhododendron

as *chironji*. It is common in forests mostly in eroded ravine lands. It can be identified by the dark grey crocodile bark with red blaze. A good species for afforesting bare hill slopes. The roots are acrid, astringent, cooling, depurative and used in leprosy, skin diseases and diarrhoea. The leaves are reported to be cooling, digestive, expectorant, purgative, and aphrodisiac. The fruits are useful in treating leprosy, skin diseases, burning sensation, cardiac debility, abdominal disorders, constipation, cough, asthma, seminal weakness, fever, emaciation, ulcers and as a laxative.

***Butea monosperma* (Palash, Flame of forest; Leguminosae):** It is a medicinal tree. Leaves are trifoliate. It bursts into bloom in deciduous condition during end of the March and whole tree bears scarlet orange crescent shaped flowers. The leaves are useful in treating pimples, boils, flatulence, colitis, worm infestations and in inflammations. Flowers are used to treat leprosy, skin diseases and bone fractures. These are considered very efficacious in birth control. It is an excellent source of lac and natural dye. It is most common in Central India, and the Western Ghats, but also found in the dry, coal districts of Bengal and Bihar and to some extent in the Uttar Pradesh and Punjab.

***Canarium strictum* (Dhup; Burseraceae):** It is found in moist deciduous to semi-evergreen forests. It grows up to 40 m (130 ft) at altitudes of 750–1,400 m (2,460–4,590 ft). The leaves of this large canopy tree are bipinnate. It is known for the medicinal and commercial use of the resin it exudates, called black dammar. Gum is used along with til (*Sesamum*) oil in the treatment of rheumatic pains and chronic skin diseases.

***Cassia fistula* (Indian Laburnum, Amaltas; Leguminosae):** It is an excellent specimen tree suitable for avenue and group plantation. It is state tree of Kerala. Flowering occurs in May in deciduous condition. The dried fruits have a laxative property and useful in constipation. Extract from the root bark is used in the treatment of black water fever. Flowers are useful in skin diseases, burning sensation, drycough and bronchitis. It is grown along small and medium roads, also suitable for planting in parks and gardens. The cattle repellant nature of the plant makes it eligible for open planting.

***Commiphora wightii* (Guggul; Burseraceae):** It is a shrub or small tree, reaching a maximum height of 4 m (13 ft), has thin papery bark. The branches are thorny. It prefers arid and semi-arid climates and is tolerant of poor soil. It is gynodioecious, with some plants bearing bisexual and male flowers, and others have female flowers.

***Dalbergia sissoo* (Shisham, tali; Fabaceae):** It is a fast-growing, hardy deciduous rosewood tree having excellent timber quality. It is the state tree of India's Punjab state and the provincial tree of Pakistan's Punjab province. It is native to the foothills of the Himalayas. It is primarily found growing along river banks below 900 metres (3,000 ft) elevation, but can range naturally up to 1,300 m. Shisham is the best known economic timber species of the rosewood genus sold internationally, it is also used as fuelwood and for shade and shelter. After teak, it is the most important cultivated timber tree of Bihar, which is the largest producer of shisham timber in India. It is

useful as stimulant and appetizer and also for treating dyspepsia, diarrhoea, leprosy, obesity and worms.

***Dillenia indica* (Elephant apple, Chalta tree; Dilleniaceae):** An evergreen tree of moderate size, 6–8 m tall with straight, short trunk, smooth reddish bark peeling off in scales, and spreading branches forming a dense, round, shady head. It prefers a deep soil and humid atmosphere. Flowers appear during June and July, and the fruits mature in September–October. Flowers fall off quickly. The tree is suitable for planting in gardens and parks. It is a good avenue tree, particularly for moist soil and marshy areas. Easily propagated from fresh seeds.

***Emblica officinalis* (Amla; Phyllanthaceae):** The tree is small to medium in size, reaching 1–8 m (3 ft 3 in–26 ft 3 in). Fruits are rich in Vitamin C, are antiviral and excellent liver tonic. Fruits are reported to be good for diabetes, cough, asthma, bronchitis, dyspepsia, colic flatulence, peptic ulcers, skin diseases, leprosy, inflammations, diarrhoea, dysentery, cardiac disorders, intermittent fevers and greyness of hair.

***Erythrina indica* (India coral tree; Leguminosae):** It is a fast growing, densely branched small tree. The erect stem has black spines. The trifoliate leaves give the plant an ornamental look. The tree flowers in a defoliated condition during February to March and even up to April. The scarlet red flowers appear in racemes. It is suitable for specimen and group planting. It can be propagated by seeds and hardwood cuttings.

***Ficus sp.* (Moraceae):** The genus comprises very important trees which are associated with Indian life from ancient period. Important species include *F. religiosa*, *F. benghalensis*, *F. infectoria*, *F. glomerata*, *F. retusa*, *F. benjamina*, *F. benghalensis* var. *krishnae*, *F. elastica* and *F. lyrata*. *F. benghalensis* is the national tree of India. People in India collect the Peepal leaves, clean them, dry them and then paint with the gold acrylic in order to preserve the leaves for years. From the bark of the Peepal tree, reddish dye is extracted.

***Gardenia gummiifera*/ *G. resinifera* (Dikamali; Rubiaceae):** It is a small tree which grows up to 3 m. Gum is antispasmodic, anthelmintic and reported useful in cases of splenomegaly, foul ulcers, wounds and obesity. Also used in veterinary medicine to keep off flies from sores.

***Gmelina arborea* (Gamar, Shivan, White teak; Lamiaceae):** The tree is used for timber, paper and pulp making and other forest based industries. It is a most promising multipurpose tree which is able to fulfil the need of fuel, fodder, wood, medicinal products, other domestic needs etc. The leaf paste is reported to be effective for treating cephalagia and the leaf juice is a good wash for foul ulcers. The flowers and fruits are reported to be effective in treating leprosy, anaemia, ulcers and constipation.

***Holarrhena pubescens* (Kutaja; Apocyanaceae):** It is a deciduous shrub or a small tree, growing up to 3 m. Short stem has pale bark and several branches. The flowers are beautiful with oblong petals which are rounded at the tip, and remind one of frangipani. The bark and seeds are useful in amoebic dysentery, diarrhoea, asthma, hepatopathy, internal haemorrhages, haemorrhoids,

rheumatism, malaria, vomiting, uropathy, and skin diseases. Leaves are used in chronic bronchitis, boils, ulcers and dysentery.

***Lagerstroemia speciosa* (Jarul, Pride of India; Lythraceae):** Most ideally suited as specimen or for group planting. It is the state flower of Maharashtra. This tree is 8-10 m tall, but in its natural habitat, it sometimes grows up to 20 m. During February-March the leaves turn coppery or yellowish in colour. The leaves are purgative and diuretic. The bark is stimulant and febrifuge, and a decoction or infusion is given in abdominal pain and diarrhoea. Propagated by seeds, growth in first year is slow, but faster afterwards. A very good tree for roadside, canal side, group planting along a large lawn, or around water gardens and ponds, used as accent plant, dry fruits used for decoration.

***Madhuca indica* (Mahua; Sapotaceae):** It is a tall, deciduous tree with round crown. Leaves are large, leathery, clustered near the ends of branches. Leaves fall in April and reappear in bright red colour in May. Fruits are consumed in tribal area of central India and used to make delicious brew. Seeds on crushing yield oil which is used as a substitute for ghee, hence the name Butter tree.

***Mallotus philippensis* (Indian Kamla, Kumkum tree; Euphorbiaceae):** It is known as the kamala tree or red kamala or kumkum tree, due to the fruit covering, which produces a red dye. The tree can grow up to 10 m. Male and female flowers occur on different trees. Female flowers are borne in lax spike like racemes at the end of branches or in leaf axils. Male flowers occur in a group of three in the axils of small bracts. Capsule is trigonous-globular, covered with a bright crimson layer of minute, easily detachable reddish powder. Glandular hairs on the fruits, which are reddish brown are reported to be used in constipation, flatulence, wounds, ulcers, cough, renal and vesical calculi, haemorrhages, poisonous affections, scabies, ringworm, herpes and other parasitic skin affections. This red powder is also used as vermilion by women.

***Mesua ferrea* (Nagchampa; Calophyllaceae):** A tree with spiritual, ornamental and medicinal importance. An attractive, Indian evergreen tree often planted as an ornamental for its fragrant white flowers that yield a perfume; source of very heavy hardwood used for railroad ties. In olden time, the very hard timber was used for making lances. It is a small to medium-sized evergreen tree up to 13 m tall, often buttressed at the base with a trunk up to 90 cm in diameter. The flowers are useful for asthma, cough, leprosy, vomiting, dysentery, ulcers, burning sensation of the feet, dyspepsia, impotency, fever and cardiac debility. The seed oil is used for skin diseases. It is the national tree of Sri Lanka.

***Michelia champaca* (Golden champa; Magnoliaceae):** An aromatic, ornamental, medicinal, medium size tree having long leaves with wavy margins. The flowering season is between April and May, and September and October. Flowers are reported to be used in dyspepsia, nausea, fever and also useful as a diuretic in renal diseases. Flower oil used in cephalalgia. Bark is a stimulant, diuretic and febrifuge. Dry roots are reported to be used as a purgative and immunagogue. Trees are largely planted in gardens and can serve as an avenue tree in protected

places. It cannot stand waterlogged condition even for a short period. Flower used for extraction of oil.

***Mimusops elengi* (Bakul, molshri; Sapotaceae):** A large evergreen, aromatic, ornamental and medicinal tree with a dense crown of dark green and shining foliage. It is a slow growing, evergreen, tall, umbrella shaped tree. The bark, flowers and fruits are acrid, astringent, cooling and anthelmintic. It is also useful in urethrorrhoea, diarrhoea and dysentery. Flowers are reported to be used for preparing a lotion for wounds and ulcers, powder of dried flowers is considered a brain tonic and is used as a smuff to relieve cephalalgia. Flowers are of dirty white colour and highly fragrant which appear from May to August. Its propagation is done by seeds.

***Nothapodytes ovata* (*Mappia foetida*; Lcacinaceae):** It is a small tree, 3-8 m tall, with smooth, grey, wrinkled bark, about 5 mm thick. Flowers are bisexual, creamy yellow, foul smelling, about 5 mm across, in flat-topped clusters at the end of branches. Petals are hairy inside. Recent research has identified the presence of an antitumor compound, named "Camptothecin", in this species. This could be the reason for its large scale smuggling out of India.

***Ochrocarpus longifolius* (*Mammea longifolia*, Surangi; Calophyllaceae):** It is an evergreen tree, 12-18 m tall, glabrous, monoecious; wood hard, red or reddish-grey, smooth; bark rough, exfoliating in irregular pieces; sap milky, latex glands scattered; branchlets obscurely 4-angled; terminal bud ovate-triangular, 3-7 mm long. It is an endemic tree confined to Western Ghats. The buds possess mild stimulant, carminative and astringent properties and are used in dyspepsia and haemorrhoids. They are also used for gastritis, leucoderma, headache and snake and scorpion-bite. Flowering and fruiting occur during March-July.

***Oroxylum indicum* (Broken Bones Tree, Indian Trumpet Flower; Bignoniaceae):** It is a native tree often grown as an ornamental for its strange appearance. The long, podded fruits hang down from branches, looking like dangling sickles or swords in the night. The tree is also a night-bloomer and is pollinated naturally by bats. Additionally, after the large leaf stalks wither, they fall off the tree and collect near the base of the trunk, appearing to look like a pile of broken limb bones. One of the constituents of "Dashmoola". Roots are reported to be used to treat rheumatism, diarrhoea and dysentery. Seeds are reported to be used as a purgative. The leaves made into a decoction are reported to be given in stomachache and rheumatism and are used externally for enlarged spleen. Tender fruits are refreshing and stomachic.

***Pongamia pinnata* (Karanj; Leguminosae):** A moderate size tree reaching 15-20 m height. Flowers are of purple colour and produced profusely in May. The fruits remain on the tree till the next lot of new leaves appear. Its seed oil is useful as biodiesel and seed cake as excellent manure. It is planted for shade.

***Premna integrifolia* (Agnimantha; Lamiaceae):** Trees attain 7 m height. It flowers and fruits between May and November. One of the constituents of "Dashmoola". Roots are reported to be useful in treating inflammations, cardiac disorders, diabetes, cough, asthma, bronchitis,

leprosy, skin diseases, flatulence, colic constipation, fever, diabetes and general debility. Leaves are carminative and useful in dyspepsia, flatulence.

***Pterocarpus santalinus* (Rakta, Chandan, Red sanders, Red sandalwood; Fabaceae):** It is a light demanding small tree, growing to 8 m tall with a trunk 50-150 cm diameter. This tree is valued for the rich red color of its wood. The wood is not aromatic. The tree is not to be confused with the aromatic *Santalum* sandalwood trees. The heartwood is reported to be used for treating intrinsic haemorrhage, fracture, chronic fever, diarrhoea, and spider poisoning.

***Rhododendron arboreum* (Tree Rhododendron, Burans; Ericaceae):** It is a large shrub or tree, attaining a height of about 15 m. The leaves are 10-12 cm long, oblong to lanceolate, acute, rugose above, distinctly veined and whitish beneath. The flowers are in dense cluster. This species has red coloured flowers. Flowers are acidic in taste and are used for making chutney by the hill people. It is national flower of Nepal, in India it is the state tree of Uttarakhand.

***Rhododendron campanulatum* (Bell Rhododendron; Ericaceae):** It is a wild species found in Himalayan alpine regions of Northern India, Bhutan and Nepal. Beautiful bell shaped flowers are pale mauve to rosy-purple, rarely white, purple spotted inside. Flowers grow in large clusters, which can be up to 10 inches across. It grows on the stony alpine slopes at altitude of 3000-4400 m. Flowering occurs during April-June. It is state tree of Himachal Pradesh.

***Salvadora persica* (Khakha, toothbrush tree, mustard tree, salt brush; Salvadoraceae):** It is a small tree or shrub with a crooked trunk, seldom more than one foot in diameter, its bark scabrous and cracked, whitish with pendulous extremities. The root bark of the tree is light brown and the inner surfaces are white, the odour is like cress and its taste is warm and pungent. The root bark is a tonic, stimulant and emenagogue and is said to relieve splenalgia. The stem bark is good for gastropathy.

***Santalum album* (Chandan; Santalaceae):** A medicinal and cosmetic plant. The height of the evergreen tree is between 4-9 m. The tree is variable in habit, usually upright to sprawling, and may intertwine with other species. The plant parasitises the roots of other tree species, but without major detriment to its hosts. Its wood is used to manufacture musical instruments like Guitars and Fengshui products. A paste of the wood and oil are reported to be used for treating burning sensation, skin diseases, cardiac debility, jaundice, cough, bronchitis, cystitis, inflammation, gastric irritability, intermittent fever and general debility. The bark is used for malaria. The oil obtained from the heartwood of the tree is reported to be used in the treatment of dysosoeia, systitis (inflammation of bladder), gonorrhoea and cough.

***Sapindus mukorossi* (Indian soapberry; Sapindaceae):** It is a native of Western coastal Maharashtra-Konkan, and Goa in India. It is also known as the ritha or reetha tree in India and Nepal. It is tolerant to reasonably poor soil. The value of the tree mostly comes from its fruit, which can be used for many pharmacological and cleansing purposes.

***Saraca indica* (Sita Ashok; Leguminosae):** An evergreen, shady, 7-10 m tall tree. Young leaflets come out in drooping branches, are greyish white to pinkish in colour and remain folded. The rich orange, slightly fragrant flowers are borne in roundish panicles on the branches and stems. The flowering season is summer. A decoction of the bark is reported to be used in treating uterine infections and gynaecological problems. The seeds taken with water are believed to alleviate suppression of urine and calculus.

***Sterculia urens* (Gum Karaya; Malvaceae):** It is a medium-sized, deciduous tree up to 15 m in height, usually with a clean, crooked, short bole up to 2 m diameter at breast height; branches large, spreading; bark thick, greyish-white or reddish, smooth, shining with a thin, white transparent outer coat, peeling off in papery flakes. It is an excellent edible gum. It is used to cure bone dislocation and fracture, sores, joint pains, stomach disorders, throat infections and as a tonic. It can grow on rocks.

***Stereospermum chelonoides* (Fragrant Padri tree; Bignoniaceae):** It is a large deciduous tree, 10-20 m tall, with velvet-hairy branches. Fragrant Padri tree is globally distributed in Indo-Malesia. Within India, it is found in tropical Himalayas, Assam, Meghalaya and in moist deciduous forests of Western Ghats. It is reported to be used to treat intermittent fevers, dropsy and dyspepsia. The root bark is a constituent of the well-known Ayurvedic formulation "Dashmoola".

***Tectona grandis* (Teak tree, Indian oak; Verbenaceae):** It is a lofty tree, usually found in detached clumps and growing best by the sides of rivers. Many are as much as 45 m high, but they take sixty to eighty years to reach maturity. The bark is ash coloured and scaly. For the greater part of the year the Teak is ugly as the huge leaves are nearly all eaten by a certain type of insect which leaves only the skeletons and, during the dry season, every leaf falls, forming a crisp carpet on the ground beneath. But from June until September, when every tree in a clump is in fresh, new leaf and crowned with a haze of blossom, they are a really splendid sight. Teak wood is highly valued for timber.

***Tecomella undulata* (Marwar Teak, Roheda; Bignoniaceae):** It is a deciduous or nearly evergreen tree of desert or dry regions. It occurs on flat and undulating areas including gentle hill slopes and sometimes also in ravines. It thrives very well on stabilized sand dunes, which experience extreme low and high temperatures. Roheda is mainly used as a source of timber. Its wood is strong, tough and durable. It takes a fine finish. The wood is excellent for firewood and charcoal. Cattle and goats eat leaves of the tree. It acts as a soil-binding tree by spreading a network of lateral roots on the top surface of the soil.

***Terminalia arjuna* (Arjun; Combretaceae):** A large evergreen tree with thick, often buttressed trunk and smooth whitish bark. Flowers are yellow in colour which appear in May and continue up to July. Fruits are five winged. It is propagated through seeds. Trees are suitable for roadside plantation and in groups for shade. Bark is reported to be a cardiac tonic, used in bilious affections, for sores and as an antidote to poisons.



Tebubia rosea

***Terminalia bellirica* (Behada; Combretaceae):** Baheda is a tall tree, with characteristic bark, 12-50 m tall. The bark is reportedly used in treating anaemia and leukoderma. Fruits are reported to be effective in curing cough, bronchitis, insomnia, dropsy, dyspepsia, flatulence, vomiting, skin diseases, leprosy, fevers, ulcers and general debility.

***Terminalia chebula* (Harda; Combretaceae):** It is a flowering evergreen tree called in English the Myrobalan or sometimes the Chebolic Myrobalan. It is native to the Indian subcontinent and the adjacent areas such as Pakistan, Nepal and the south-west of China. This tree yields small, ribbed and nut-like fruits which are picked up when still green and then pickled, boiled with a little added sugar in their own syrup or used in preserves or

concoctions. The fruits are laxative and reported to be used for treating wounds, ulcers, inflammations, gastropathy, flatulence, jaundice, skin diseases, leprosy, intermittent fever and cardiac disorders.

***Thespesia populnea* (Bhendi tree, Indian tulip tree; Malvaceae):** This is a good tree for small gardens or patios. A large evergreen tree with crooked stem and poplar like glossy and dark green leaves. It grows to 40 ft or more with a spread of 10–20 ft. It has heart-shaped leaves and cup-shaped yellow flowers that are produced intermittently throughout the year in warm climates. The flowers are followed by apple-shaped fruit. Flowers large, yellow and cinnamon red, bell shaped, resembling those of the vegetable plant bhendi or cotton plant. Peak flowering is in cold season.

Benefits of native plants

- Native plants are adapted to the region's soil, hydrology, and climate.
- They have evolved defences to many diseases and insect pests found in their habitat.
- They create deep and extensive root systems, which help stabilize the soil column and create an environment favourable for forming fertile soils rich in organic matter.
- They absorb excess nutrients from runoff, enhancing infiltration during periods of heavy rain as well as drought.
- They provide habitat for butterflies, hummingbirds, songbirds, and beneficial insects.

It has been observed that birds usually prefer to build their nest on indigenous tree than exotic species.

- Planting native trees, shrubs, and other vegetation is one of the most effective ways to restore natural habitats and to improve water quality.
- Native plants, once established, save time and money by eliminating or significantly reducing the need for fertilizers, pesticides, water and lawn maintenance equipment.
- Native plants promote biodiversity and stewardship of our natural heritage.

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Indigenous flora of Western Himalayas

The naturally occurring flora in a particular region or time refers to **Indigenous Flora**. The Indian flora represents nearly 12% of the global floral diversity and comprises four biodiversity hot spots in four phytogeographical regions, viz. the Himalayas, Western Ghats, North East India, and Andaman and Nicobar Islands. The number of plant species in the Himalaya is estimated at 25,000 i.e. 10% of the world's known species and 50% of India's endemic flora. This includes 7,020 species of fungi, 1,159 species of lichen and 2,000 species of bryophytes (including mosses and worts) with remainder ferns, angiosperms (flowering plants) and other species (<http://www.greathimalaynnationalpark.org>). A total of 10,503 species representing 240 families and 2,322 genera are reported plant diversity in the Himalayas, out of which number of recorded species in Uttarakhand (4,990), Himachal Pradesh (3,324) and Jammu and Kashmir (2,118) and remaining in Bhutan, Nepal and Arunachal Pradesh.

THE Western Himalayas, “*Abode of Snow*” refers to the western half of the Himalayan Mountain region, which stretches from Badakhshan in north eastern Afghanistan/southern Tajikistan throughout India (Jammu and Kashmir, Himachal Pradesh, Uttarakhand) to central Nepal. It consists of magnificent mountain ranges, beautiful valleys, ravines and gorges covering approximately 2400 km in length and 300 km in width and has different climatic conditions ranging from tropical and temperate forests to semi-arid cold deserts. It has three types of eco-regions, viz. Western Himalayan broadleaf forests, Western Himalayas alpine shrub and meadows and Western Himalayas sub-alpine conifer forests.

The Western Himalayan broadleaf forests is dominated by oaks like *Quercus semecarpifolia*, *Q. leucotrichophora*, *Q. glauca*, Betula and Birches, ferns, mosses, epiphytes etc. Alpine shrubby areas are dominated by Rhododendrons,

these shrublands are alpine meadows known as bugyals, where native herbaceous floral diversity is found e.g; *Anaphalis*, *Cyananthus*, *Potentilla*, *Gentiana*, *Delphinium*, *Aster*, *Anemone*, *Primula*, *Polygonum*, *Saussurea* etc. in spring and summer. *Saxifraga*, *Corydalis*, *Stellaria*, *Cremanthodium* are found on the upper slopes. *Caragana*, *Juniperus*, *Ephedra*, *Hippophae*, *Myricaria*, *Berberis* are found in the drier parts of this region. *Abies spectabilis*, *Abies pindrow*, *Rhododendron campanulatum*, *Pinus wallichiana*, *Picea smithiana*, *Cupressus torulosa*, *Cedrus deodara*, *Pinus gerardiana*, *Taxus contorta*, *T. wallichiana* are found growing in sub-alpine conifer forests.

The mountainous hills of Himachal Pradesh and Uttarakhand provide wide climatic variation for genetic biodiversity of native ornamental flowering plants. The scenic beauty of hills is enhanced by these ornamental plants of different colours, forms and shapes; blooming almost throughout the year, mainly in rainy season.



Anaphalis margaritacea



Anthemis cotula

Table 1. Type of propagule, best responsive growth regulator and its concentration and best responsive rooting medium used for propagation of native ornamentals

Plant	Type of propagule (cutting)	Rooting medium	Growth regulator (ppm)
<i>Adhatoda vasica</i>	Soft wood	Perlite + Vermiculite	NAA-500
<i>Anaphalis margaritacea</i>	Soft wood	Cocopeat	NAA-500
<i>Aster thomsonii</i>	Soft wood	Cocopeat	NAA-500
<i>Barleria cristata</i>	Soft wood	Cocopeat	NAA-500
<i>Barleria cristata</i>	Semi hardwood with apical	Perlite + Vermiculite portion	IBA-1000
<i>Barleria prionitis</i>	Softwood cuttings	Cocopeat + sand	NAA-500
<i>Bergenia ciliata</i>	Root cutting	Cocopeat	NAA-500
<i>Caryopteris bicolor</i>	Semi hardwood	Perlite + Vermiculite	IBA-1000
<i>Cestrum parquii</i>	Semi hardwood cuttings	Vermiculite + sand	IBA-1000
<i>Clematis buechananiana</i>	Semi hardwood	Perlite + Vermiculite	IBA-1000
<i>Cocculus laurifolius</i>	Semi hardwood with apical portion	Perlite + Vermiculite	IBA-1000
<i>Coriaria nepalensis</i>	Semi hardwood with apical portion	Perlite + Vermiculite	IBA-1000
<i>Cotoneaster microphylla</i>	Semi hardwood with apical portion	Sand + Soil + FYM	IBA-1000
<i>Daphne bholua</i>	Semi hardwood	Perlite + Vermiculite	IBA-1000
<i>Deutzia staminea</i>	Semi hardwood	Perlite + Vermiculite	IBA-1000
<i>Eranthemum pulchellum</i>	Semi hardwood	Cocopeat	IBA-1000
<i>Hedera nepalensis</i>	Semi hardwood with apical portion	Perlite + Vermiculite	IBA-1000
<i>Hypericum oblongifolium</i>	Semi hardwood	Perlite + Vermiculite	IBA-1000
<i>Indigofera pulchella</i>	Semi hardwood	Cocopeat	IBA-2000
<i>Inula cuspidate</i>	Semi hardwood	Sand	IBA-1000
<i>Ipomoea carnea</i>	Semi hardwood	Perlite + Vermiculite	IBA-1000
<i>Jasminum dispersum</i>	Semi hardwood	Perlite + Vermiculite	IBA-1000
<i>Jasminum humile</i>	Semi hardwood	Perlite + Vermiculite	IBA-1000
<i>Justicia gendarussa</i>	Softwood	Cocopeat + sand	NAA-500
<i>Kalanchoe integra</i>	Soft wood	Cocopeat	NAA-500
<i>Lawsonia alba</i>	Hardwood	Sand	IBA-1000
<i>Litsea lanuginosa</i>	Semi hardwood with apical portion	Sand	IBA-2000
<i>Myrsine africana</i>	Semi hardwood with apical portion	Cocopeat	IBA-2000
<i>Osyris arborea</i>	Semi hardwood	Perlite + Vermiculite	IBA-2000
<i>Phlogacanthus pubinervius</i>	Semi hardwood	Cocopeat	IBA-1000
<i>Prunus cerasoides</i>	Semi hardwood	Perlite + Vermiculite	IBA-1000
<i>Pyracantha crenulata</i>	Semi hardwood with apical portion	Cocopeat	IBA-1000
<i>Randia tetrasperma</i>	Soft wood	Cocopeat	NAA-500
<i>Reinwardtia indica</i>	Soft wood	Perlite + Vermiculite	NAA-500
<i>Reinwardtia indica</i>	Semi hardwood with apical portion	Perlite + Vermiculite	IBA-1000
<i>Rhododendron lepidotum</i>	Semi hardwood	Sand	IBA-1000
<i>Rosa brunonii</i>	Semi hardwood	Cocopeat	IBA-1000
<i>Salix tetrasperma</i>	Semi hardwood	Perlite + Vermiculite	IBA-1000
<i>Salvia coccinea</i>	Soft wood	Cocopeat	NAA-500
<i>Salvia lanata</i>	Soft wood	Cocopeat	NAA-500
<i>Salvia moorcroftiana</i>	Soft wood	Cocopeat	NAA-500
<i>Sarcococca saligna</i>	Semi hardwood with apical portion	Sand	IBA-1000
<i>Schefflera venulosa</i>	Semi hardwood	Cocopeat	IBA-1000
<i>Skimmia laureola</i>	Semi hardwood	Sand	IBA-1000
<i>Solanum pseudo-capsicum</i>	Semi hardwood with apical portion	Cocopeat	IBA-1000
<i>Strobilanthes alatus</i>	Soft wood	Cocopeat	NAA-500
<i>Strobilanthes alatus</i>	Semi hardwood with apical portion	Perlite + Vermiculite	IBA-1000
<i>Thunbergia fragrans</i>	Semi hardwood	Vermiculite	(IBA: Indole butyric acid, NAA: Naphthalene acetic acid) IBA-500
<i>Viburnum mullaha</i>	Semi hardwood	Sand + Soil + FYM	IBA-1000
<i>Vitis himalyana</i>	Semi hardwood	Cocopeat	IBA-1000



Androsace sarmentosa

Potential uses of Native ornamental plants of the Western Himalayas in landscaping

Application	Species
Native ornamentals can be used :	
For specimens	<i>Albizia julibrissin</i> , <i>Benthamedia capitata</i> , <i>Bombax ceiba</i> , <i>Cassia fistula</i> , <i>Lyonia ovalifolia</i> , <i>Prunus cerasoides</i> , <i>Picea smithiana</i> , <i>Rhododendron arboreum</i> . <i>Barleria cristata</i> , <i>Cocculus laurifolius</i> , <i>Hypericum oblongifolium</i> , <i>Indigofera pulchella</i> , <i>Inula cappa</i> , <i>I.cuspidata</i> , <i>Woodfordia fruticosa</i> , <i>Pteracanthuss alatus</i> , <i>Rhododendron campanulatum</i> , <i>Sophora mollis</i> ;
For avenue	<i>Albizia julibrissin</i> , <i>Benthamedia capitata</i> , <i>Bombax ceiba</i> , <i>Butea monosperma</i> <i>Cassia fistula</i> , <i>Cocculus laurifolius</i> , <i>Erythrina indica</i> , <i>Lyonia ovalifolia</i> , <i>Prunus cerasoides</i> , <i>Rhododendron arboreum</i> <i>Sophora mollis</i> ;
For mass plantations	<i>Adhatoda vasica</i> , <i>Barleria cristata</i> , <i>Cocculus laurifolius</i> , <i>Desmodium tiliaefolium</i> , <i>Ehretia laevis</i> , <i>Hypericum oblongifolium</i> , <i>Indigofera pulchella</i> , <i>Inula cappa</i> , <i>I.cuspidata</i> , <i>Woodfordia fruticosa</i> , <i>Mallotus philipinensis</i> , <i>Pteracanthuss alatus</i> , <i>Rhododendron campanulatum</i> , <i>Acer oblongum</i> , <i>Aconogonum molle</i> , <i>Buxus sempervirens</i> , <i>Cotinus coggygia</i> , <i>Hypericum oblongifolium</i> , <i>Inula cuspidata</i> <i>Persicaria capitata</i> , <i>Pistacia integerrima</i> , <i>Viburnum mullaha</i> , <i>V. cylindricum</i> , <i>V. cotinifolium</i> , <i>Vitis himalayana</i> , <i>Woodwardia unigemmata</i> ;
As emerging and fall leaf coloured plants	<i>Arisaema flavum</i> , <i>Cotoneaster macrophylla</i> , <i>Crotolaria sericea</i> , <i>Ilex dipyrena</i> , <i>Osyris arborea</i> , <i>Murraya koenigii</i> , <i>Euonymus tingens</i> , <i>Eleagnus parviflora</i> , <i>Pyracantha crenulata</i> , <i>Solanum pseudocapsicum</i> , <i>Rosa webbiana</i> , <i>Smilax aspera</i> , <i>Hedera helix</i> , <i>Mallotu philipinensis</i> ;
Coloured fruits	<i>Salvia coccinea</i> , <i>S.moorcroftiana</i> , <i>S.lanata</i> , <i>Ophiopogon intermedius</i> , <i>Scutellaria angulosa</i> , <i>Malaxis wallichii</i> , <i>Kalanchoe integra</i> ,
Bedding purpose	<i>Buxus sempervirens</i> , <i>Myrsine africana</i> , <i>Randtia tetrasperma</i> , <i>Spirea canescens.</i> ,
Topiary and hedge	<i>Salix tetrasperma</i> , <i>Daphne cannabina</i> , <i>Litsea lanuginosa</i> , <i>Maesa chisia</i> ,
For shady areas	<i>Clemtis buchananiana</i> , <i>C.nutans</i> , <i>C.montana</i> , <i>Jasminum dispernum</i> , <i>Rosa brunonii</i> , <i>Smilax aspera</i> , <i>Trachelospermum fragrans</i> , <i>Skimmia laureola</i> , <i>Hedychium spicatum</i> , <i>Jasminum pubescens</i> ,
For scented gardens	<i>Senecio chrysanthemoides</i> , <i>Asparagus adscendens</i> , <i>Inula cuspidata</i> , <i>Prunus cerasoides</i> , <i>Polystichum squarrosum</i> , <i>P. discretum</i> , <i>Christella dentata</i> , <i>Roscoeia purpurea</i> , <i>Ranunculus laetus</i> , <i>Iris lactea.</i> ,
Plants with excellent autumn display	<i>Hedera helix</i> , <i>Ficus pumila</i> and <i>Vitis himalayana</i> , <i>Thunbergia coccinea</i> , <i>Thunbergia fragrans</i>
Plants suitable for moist areas;	areas
For beautifying walls, gates and unpleasant areas	<i>Sarcococca saligna</i> , <i>Cocculus laurifolius</i> , ferns, etc,
Cut greens	<i>Aerides multiflora</i> , <i>Dendrobium amoenum</i> , <i>Rhyncostylis retusa</i>
For hanging baskets	<i>Androsace rotundifolia</i> , <i>Butea monosperma</i> , <i>Erythrina indica</i> , <i>Gerbera gossypina</i> , <i>Randia tetrasperma</i> , <i>Wendlentia exerta</i>
For rockeries;	<i>Anaphalis margaritacea</i> , <i>A.triplinervis</i> , <i>Barleria cristata</i> , <i>Cheilanthes brevifrons</i> <i>Decandrum nanum</i> etc. areasarea
Drying purpose	<i>Aerides multiflora</i> , <i>Androsace rotundifolia</i> , <i>Anemone rivularis</i> , <i>A. vitifolia</i> , <i>A.tetrasepala</i> , <i>Aster thomsonii</i> , <i>Barleria cristata</i> , <i>Bergenia ciliata</i> , <i>Campanula colorata</i> , <i>Curcuma amada</i> , <i>Gerbera gossypina</i> , <i>Habenaria edgeworthii</i> , <i>Osbeckia stellata</i> , <i>Phlogacanthus pubinervius</i> , <i>Rhyncostylis retusa</i> , <i>Satyrium nepalens</i> , <i>Tulipa stellata</i> .
Suitable for pots	



Arisaema flavum

Naturally growing native flowers are so important to these two hilly states, that 'Phulaich' or 'Ookayand' known as flower festival is celebrated during September in Kinnaur district in Himachal and 'Phooldeyi' during spring in Uttarakhand to highlight variety and beauty of native flowers. These ornamentals can be utilized to create landscapes, gardens and parks on commercial scale. Besides, these provide vast opportunity to earn income by the production of pot plants, cut flowers, cut greens, and raising commercial nurseries. There is a great scope of domestication and commercial exploitation of naturally occurring ornamental plants of the hills. Some of the promising plants can be introduced in the floriculture market as exquisite and novelty items.

These native plants have been identified on the basis of different floras classified into different categories i.e trees, shrubs, climbers etc.

Importance of native plants

Native plants in the form of trees, shrubs, climbers, bulbous, ferns, orchids, and herbaceous perennials etc are growing in western Himalayas provide food and shelter for wildlife. These plants play an important role in preserving species and increasing biodiversity, which runs the ecosystem. They are source of all cultivated garden varieties of flowers. The areas can be designed aesthetically



Campanula colorata

and with special purpose by growing native flowers. These plants add vividness to gardens because they are adapted to local climatic conditions. They are very hardy, easier to care for, often more drought-tolerant, and have greater disease resistance than many traditional garden plants.

These native ornamental plants, from their natural habitats, can be selected for the beautification of parks, public and private places in urban as well as in rural areas. These plants can be used for natural landscaping, which deals with the decoration of a tract of land by planting naturally growing flowering plants in such a way that it creates a picturesque and naturalistic effect, which will improve total living environment. Unfortunately, most of the landscape plants available in nurseries are exotic species, from other countries which have become invasive pests, outcompeting native species and degrading habitats in remaining natural areas.

Biodiversity conservation through domestication of native ornamental plants

Keeping in view the importance and uses of native plants and to work out their feasibility in the area of floriculture and landscaping, domestication work including conservation, propagation, evaluation and documentation on native flowering plants has been done at Department of Floriculture and Landscaping, UHF, Nauni and RHRTS, Dhaulakuan (HP). At first instance, propagation studies on potential native ornamentals of Himachal Pradesh and Uttarakhand was carried out during 2005-08 and 2016-18. Explorative field surveys were done in different agro-climatic zones in different seasons (spring, summer, autumn and winter) to collect propagules (softwood, semi hardwood, semi hardwood with apical portions, root cuttings etc.), and by conducting propagation experiments, the propagation technology of about 50 native flowering plants has been standardized (Table 1).



Indigofera pulchella

After standardizing vegetative propagation techniques for native plants, potential native flowers were planted in fields to evaluate their landscape characters' year after year. These native ornamental plants have been conserved in pots and fields and utilized for various landscape uses, in the form of 'Native Ornamental Garden' at RHRTS, Dhaulakuan, District Sirmour (HP) for preserving biodiversity and also to add beauty to the surroundings in the form of natural landscaping. The plant evaluation studies in this garden revealed that *Barleria cristata*, *B. prionitis*, *Caryopteris bicolor*, *Cestrum parquii*, *Eranthemum pulchellum*, *Jasminum humile*, *J. pubescens*, *Hypericum oblongifolium*, *Inula cappa*, *I. cuspidata*, *Maesa chisia*, *Nyctanthes arbor tristis*, *Reinwardtia indica*, *Woodfordia fruticosa* were suitable for mass plantations; *Clerodendron nutans*, *Eleagnus parvifolia*, *Eranthemum purpurascens*, *Hypericum oblongifolium*, proved as specimen shrubs; *Adiantum capillus veneris*, *Bergenia ciliata*, *Cheilanthes brevifrons*, *Cocculus laurifolius*, *Curcuma amada*, *Osbeckia stellata*, *Phlogacanthus pubinervius*, *Polystichum squarrosus*, *Gerbera gossypina*, *Rhyncostylis retusa*, *Schefflera venulosa* were found suitable as potted plants. *Myrsine africana*, *Randtia tetrasperma* and *Justicia gendarussa* proved their superiority for topiary and hedges. *Chonemorpha fragrans*, *Ficus pumila*, *Hedera helix*, *Jasminum dispersum*, *Thunbergia coccinea*, *T. fragrans*,

Trachelospermum fragrans found suitable for beautifying walls and unpleasant areas.

Database management of ornamental native plants of the Western Himalayas

A landscape software named 'HIMFLORA'-A computerized botanical database on wild ornamental plants of Himalayas' was prepared and it has been copyrighted by National Research Development Centre, New Delhi with Registered No. IPR/4.4.8/08058/2008. This is a computerized botanical database on wild ornamental plants of Himachal Himalayas which contains detailed records of 250 wild ornamental plants (36 trees, 82 shrubs, 28 climbers, 56 herbaceous plants, 18 ferns, 11 orchids, 19 bulbous plants) having 30 fields (Botanical name, common name, family, plant habit, plant type, life-span, place where found growing, altitude, longitude, latitude, plant form, bark characters, stem characters, leaf texture, leaf arrangement, leaf colour, leaf shape, leaf margin, fall leaf colour, sori and rhizome character in case of ferns, fall leaf duration, inflorescence, flower colour, flower fragrance, flower shape, flowering period, flowering time, fruit colour, fruit shape, fruiting duration, ornamental plant use and other uses).



Corydalis govanina

Conclusion

Indian native ornamental plants have not been showcased well in global floriculture industry. Native ornamental plant characterization, genetic improvement, propagation and production technology standardization is a must for domestication. Our efforts in this way are negligible considering efforts of Australia, South America, Venezuela, Ethiopia etc. The Western Himalayas, considered as one of the globally recognized biological hotspots, is home to many endemic, rare and endangered plant species. Himalayas is subjected to several anthropogenic activities such as horticulture expansion, hydro-electric projects, timber extraction, fuel wood collection, collection of medicinal plants and minor products resulting in the destruction of several threatened plants. The theft of these species is adding fuel to the fire. Thus, habitat destruction will result in the loss of the species which can never be replaced. Such ecologically fragile areas have become the focus of global conservation efforts. At present we are mostly dependent upon routine exotic ornamental plants, despite of the fact that we have a rich floral diversity. Countries like South America, Australia, Venezuela, Ethiopia and Sri Lanka brought their flowers into global trade. Identification of potential native flowers as per their suitability, domestication and evaluation for their

commercial exploitation will add new ornamental plant species for beautification of outdoor and indoor surroundings.

There is an urgent need for preservation and conservation of native flowers not only for their aesthetic importance but also to restore ecological balance. All over the world, people are literally 'going native' especially The Great Britain, Ireland, England, Scotland, Australia etc. Australia has domesticated their wild flowers like Banksia, Kangaroo Paw (*Anigozanthos*), rice flower etc. and annual sale was more than AUD 150 million. On farms, forests, city parks, suburban gardens, along roadsides - native flowers; trees, shrubs, climbers etc. are being sown and planted on large scale. Encouragements are on a greater use of native flora with good practice in its specification and supply, to ensure that the right native plants are used correctly in the right place. *When Britishers and Australians and other countries can bring forward their native flowers into global trade.....then why can't we??*

For further interaction, please write to:

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Indigenous ornamental palms of Andaman and Nicobar Islands

India is a country known for its floristic wealth, and the rich biodiversity is distributed in 12 hotspots of the country. The Andaman and Nicobar Islands is one such important biodiversity hotspot and is a sanctuary of hundreds of little known or totally unknown wild plants. It is one of the great reserves of unexploited tropical floristic materials in India. The attention given to understand the ornamental wealth of the wild indigenous plants in the Island is almost negligible.

PALMS are one of the important floristic resources which are distributed wild in the tropical rainforest ecosystem. The palms are known as “Princess of Vegetative Kingdom” and belong to the monocot group of plants. They grow tall, have unbranched trunks topped by a crown of fan-shaped or feathery fronds which are sculpturistic in nature. The palm family is economically important because palms yield oil, sugar, fibre, cane, starch, wood, thatch and raw materials for several commercial products. Due to curious shapes and their adaptability to grow *ex situ* or as pot plants they are treated as one of the best ornamental plants for decoration and landscape beautification. The family Palmae comprises more than 200 genera and 3000 species. The maximum diversity of palms is encountered in tropical Asia and tropical America. Total 100 taxa of Palms have been found occurring naturally in India that constitute less than 1% of the total vascular flora of India i.e. about 15,000 species. In addition to indigenous palm flora, about 89 exotic taxa of palms have been recorded from cultivation. These exotic palms are grown as ornamental plants. About 97 species and 3 varieties of wild and semi wild palms in 21 genera occur in India. They are distributed in the 3 major geographical regions of India, viz. Peninsular India (Western Ghats), Eastern and North eastern India, and Andaman and Nicobar Islands. The palm wealth is quite rich and unique in Andaman and Nicobar Island with substantial number of endemic species. The native palm flora of the Islands comprises 49 species under 18 genera (Table 1). The palm flora of Andaman group of islands show striking dissimilarities with that of Nicobar group of islands. Palms such as *Arenga westerhoutii*, *A. pinnata*, *Calamus basui*, *C. baratangensis*, *C. longisetus*, *C. palustris*, *C. viminalis*, *Corypha macropoda*, *D. aurea*, *D. manii*, *D. rarispinosa*, *D. wrightmyoensis*, *Korthalsia rogersii*, *Licuala spinosa*, *Phoenix andamanensis* and *Pinanga andamanensis* occur in Andaman group of Islands and are absent in the Nicobar group of Islands. While *Bentinckia nicobarica*, *Calamus dilaceratus*, *C. nicobaricus*, *C. pseudorivialis*, *C. semierectus*, *C. unifarius* and *Rhopaloblaste augusta* are confined to the Nicobar group of islands, but seldom found in the Andamans. *Areca triandra*,

Calamus andamanicus, *Caryota mitis*, *Korthalsia laciniosa*, *Licuala peltata* and *Pinanga manii* are widely distributed in both the group of Islands.

Palms of genera *Arenga*, *Calamus*, *Daemonorops*, *Korthalsia*, *Corypha*, *Trachycarpus*, *Pinanga*, *Wallichia* and *Nyssa*



Areca triandra



Bentinckia nicobarica

are poorly represented as ornamental palms. Very little scope is available for exploitation of these palms for commercial use. However, these wild palms are exploited by the tribal populations for various uses in their daily life (Table 2).

Though the Island is rich in palm wealth, their commercial exploitation for ornamental use is still in its infancy. Exploratory surveys conducted in different parts of the Andaman and Nicobar Islands resulted in identification of potential species for ornamental use based on their decorative features like grand and spectacular foliage in unusual patterns, shape, branching habit, form/



Bentinckia seedling

texture, spineless nature and colour of the foliage. The ornamental palm species identified are described below.

***Areca triandra*:** It is a tall tree similar to *Areca catechu*. It is an endemic species commonly distributed in the Island. The single stem with lustrous leaves makes the palm species suitable to be utilized as avenue tree and for group planting. At juvenile stage, the species is grown as a house plant in shade condition. Propagation is done through seeds. Flowering period is February to June and fruiting season is September to November.

***Bentinckia nicobarica*:** This is an endemic palm distributed only in the Nicobar group of Islands and not found anywhere else in the world. This is an endangered species. The palm is ornamental due to its morphological characters like slightly arched leaves, exceptionally long, yellow-green crown-shaft with slight bulge at the base. This species is tolerant to drought and is highly suitable to grow in open landscape. It grows to a height of 35–40 m. The inflorescence of the species is highly branched



Bentinckia nicobarica fruits



Caryota mitis



Caryota mitis



Corypha macropoda seedling

and fruits are similar to grape berries with attractive deep purplish black colour. This palm can be utilized as an avenue plant because of its attractive robust nature.

***Caryota mitis*:** It is an elegant palm with a tufted crown. It is exploited from wild for various ornamental uses. This palm species is suitable to grow as a specimen plant in a landscape garden. The serrated and fish tail shaped leaves of the palm give ornamental value to the species. Propagation is by seeds. Flowering and fruiting is observed throughout the year.

***Corypha macropoda*:** It is commonly known as fan palm. The large fan shaped leaves are attractive which make it a good choice for avenue plantation. This species grows to a height of 20 to 25 m. Propagation is by offshoots.

***Licuala peltata*:** A conspicuous and attractive palm with fan shaped leaves that are divided into wedge shaped segments. The leaves are umbrella shaped and of attractive green colour. The species can be used as a pot plant, house plant or as specimen plant because of its short to medium stature. Propagation is by seeds. Flowering season is from October to January and fruiting is from March to

June.

***Licuala spinosa*:** The morphology is similar to *Licuala peltata*, however, the leaves are smaller in size. This species is highly suitable as an indoor plant for growing in pots as it is a shade loving palm. Propagation is by seeds.

***Phoenix andamanensis*:** This palm species is endemic to Andaman. The trunk shows cluster forming habit, stem is slender with smooth surface but it is not delicate. The leaves are 2 m long. It is an attractive palm for growing in shade and is highly suitable for roof top garden. It can also be utilized as a specimen plant due to its clustering nature of trunk. Flowering occurs during July to October and fruiting is observed during November to February. Propagation is by seeds.

Table 1. Distribution of palm flora in Andaman and Nicobar Island

Genus	Number of Species distributed
<i>Areca</i>	02
<i>Arenga</i>	01
<i>Bentinckia</i>	01
<i>Borassus</i>	01
<i>Calamus</i>	15
<i>Caryota</i>	02
<i>Chrysalidocarpus</i>	01
<i>Cocos nucifera</i>	01
<i>Corypha</i>	02
<i>Daemonorops</i>	05
<i>Elaeis</i>	01
<i>Korthalsia</i>	04
<i>Licuala</i>	03
<i>Livistona</i>	01
<i>Nypa</i>	01
<i>Phoenix</i>	04
<i>Pinanga</i>	03
<i>Rhopaloblaste</i>	01
<i>Trachycarpus</i>	01



Collection of *Bentinckia* seedling by Nicobari woman



Corypha macropoda in flowering



Licula peltata

***Pinanga andamanensis*:** This is an endemic and endangered species of the Andaman Island. Slender stem, leaves crowning the stem, opposite leaflets and brownish

pink coloured fruits make the palm species highly attractive as an ornamental plant. This is a water loving palm species and hence, cannot withstand drought.



Licuala spinosa



Phoenix andamanensis



Phoenix andamanensis flowering and fruiting



Pinanga andamanensis seedling

Table 2. Traditional uses of palms by tribals of Andaman and Nicobar Islands

Palm species	Use	Island where it is utilized
Hut construction		
<i>Areca catechu</i>	Split stem for making hut floors, leaves for thatching	Katchal, Car Nicobar, Chowra
<i>Calamus andamanicus</i>	Leaves used for thatching.	Car Nicobar, Katchal
<i>Cocos nucifera</i>	Leaves used for thatching	Katchal, Car Nicobar, Chowra
<i>Nypa fruticans</i>	Leaves used for thatching	Nancowry, Trinket and Katchal
Broom making		
<i>Calamus andamanicus</i>	Strips of stem pieces used for making rough brooms	Nicobar, Katchal, Kamorta
<i>Bentinckia nicobarica</i>	Main ribs of leaves used for making brooms	Car Nicobar
Mat preparation		
<i>Cocos nucifera</i> , <i>Caryota mitis</i>	Leaves weaved into mats Fibers obtained from the base of the leaves used for stuffing mat resses	Car Nicobar, Katchal, Great Nicobar Hutbay, Car Nicobar
Sitting stage preparation		
<i>Areca catechu</i>	Split stems used for making sitting stage	Car Nicobar, Katchal
<i>Areca triandra</i>	Split stems used for making sitting stage	Car Nicobar, Kamorta, Nancowry
<i>Calamus andamanicus</i>	Split stems used for making sitting stage	Car Nicobar, Katchal, Nancowry, Teresa
Plates, covers, basket making and other uses		
<i>Calamus andamanicus</i>	Strips of stems used in basket making	Car Nicobar, Katchal
	Cut stems yield fair amount of water which is used for drinking by Shompens	Campbell Bay
	The Jarawa tribes use the wood to make shafts of their harpoon arrows. Used as shoulder poles.	South Andaman
<i>Caryota mitis</i>	Leaves used for decoration during ceremonies	Hut Bay and Nicobar
	The pithy core of this palm is utilized by the Onge tribes	Little Andaman
<i>Corypha macropoda</i>	Leaves used as plates by all the tribes. Leaf stalks are used as wrapping paper. The seeds are substituted for ivory in ornaments.	Hut Bay and Nicobar
<i>Korthalsia laciniosa</i>	The leaf spines of this palm are used by the Jarawa tribes to make shaft of their arrows	South Andaman
<i>Rhopaloblaste augusta</i>	The trunk of the palm is used for making cot, window frames and door frames	Car Nicobar, Hut Bay and Nancowrie Islands

Flowering and fruiting occurs from November to June. Propagation is by seeds.

***Rhopaloblaste augusta*:** This is a threatened and endemic palm of the Nicobar Island. The palm is tall and can reach upto a height of 30 to 35 m. The soft drooping leaflets of the palm are highly attractive and give ornamental value. The palm species can be grown as a house plant at its juvenile stage till it reaches a height of

4 ft. The club shaped flower stalk is the characteristic feature of the palm with attractive scarlet coloured fruits. Flowering and fruiting occurs during March to June. Propagation is by seeds.

With the modern lifestyle and developed urban culture, demand for ornamental plants is increasing at a fast rate and many people in the country earn their livelihood by either producing or marketing such plants. In the Island,



Pinanga andamanensis



Rhopaloblaste



Broom from *Rhopaloblaste*



Rhopaloblaste leaf sheath used for mat making



Seedling *Rhopaloblaste*



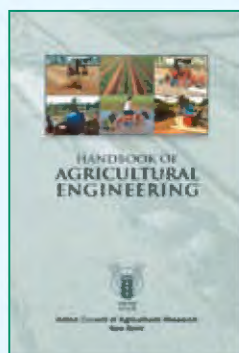
Seeds of *Rhopaloblaste augusta*

the ornamental native palm potential is untapped and if commercialized will catch up with national and international markets. The mentioned ornamental palms have wide utility in both interior decoration and exterior landscape. The palm flora has to be judiciously exploited as species conservation is of great concern and some of these are highly threatened species. Thus, there is an

imperative need for preservation and cultivation of such native palm species not only for their aesthetic importance but also to restore ecological balance.

For further interaction, please write to:

V Baskaran, ICAR-Central Island Agricultural Research Institute, Port Blair 744 101.



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Ornamental fern flora of Andaman and Nicobar Islands

The Andaman and Nicobar Islands stretching from Arakkan Yoma in Myanmar to Sumatra in Indonesia are housed by a rare and distinct fern flora due to the favourable climate and plentiful moisture prevailing in the island. Though the Andaman and Nicobar Islands are rich in fern biodiversity they are neglected, less cultivated and underutilized. Ornamental utilization of fern flora can open up new livelihood sources for economic growth.

FERNS constitute a major group of living pteridophytes that are characterized as non-flowering, vascular and spore bearing plants and are adaptable to a wide range of habitats. The fern flora richness of Andaman and Nicobar Islands is well evident by distribution of 126 species belonging to 60 genera and 37 families. Out of these, seven are endemic to these Islands, viz. *Sphaeropteris albosetacea*, *S. nicobarica*, *Lindsaea andamanica*, *L. rutlandia*, *L. tenera*, *Pronephrium makaikeuim* and *Sphaerostephanos kurzii*. Among the non-endemic fern species, 44 are not found in mainland India, but extend their distribution to South East Asia including Myanmar, Thailand, Malaysia and Sumatra (Table 1). The fern flora of Nicobar group of Islands is essentially Malaysian and it is also called sub continental Island flora. The fern flora of Andaman Islands is distinctly different from that of Nicobars as the genera *Pteridium*, *Pteris*, *Adiantum*, *Marsilea* and *Heterogonium* are common in Andaman Islands but not found in Nicobar group of Islands, similarly the genera occurring in Nicobar Islands are totally absent in Andaman Islands. The dissimilarities between the fern flora of Andaman group and Nicobar group are owing to the reason that the Andaman Islands have more species common to North East India, Myanmar and Thailand while Nicobar Islands have more species common to the Malaysian in the East and Indonesia in the South. The fern flora are again categorized into three ecological groups terrestrial (58 species), Lithophytic (31 species) and epiphytic (37 species) based on their habitat. Ornamental utilization of the native palms of the Island is one of the great avenues for economic growth in the Island. Since many of the ferns are endemic and have wide ornamental utilization, they will open up export opportunities, and the growing demand for indoor plants in the world will fetch higher income both in domestic and international markets. The below listed species have commercial potential.

Adiantum tenerum (Family: Adiantaceae)

This is known as brittle or maiden hair fern; grows to a height of 3 ft; found growing naturally in rocky places. Best suited as an indoor plant for verandah and balcony as it requires partial sunlight. Sufficient moisture is



Adiantum tenerum

essential for the growth of this fern. This fern can be propagated by rhizome cuttings with one or two fronds attached. This fern is distributed in both Andaman and Nicobar group of Islands.

Asplenium falcatum (Family: Aspleniaceae)

This fern is an epiphytic herb with creeping short rhizomes and grows to a height of 75 cm. The fronds are



Asplenium falcatum



Asplenium nidus

attractive, tufted with pinnate lamina. The margins are lobed and serrated with obliquely truncate unequal lower base. This fern is commonly distributed in the Andaman group of Islands. This fern also has medicinal properties and the tribal people of the Island use the fronds for curing enlarged spleen, urinary complaints, jaundice and malaria.

***Asplenium nidus* (Family: Aspleniaceae)**

It is commonly known as Bird nest fern. Its shiny, undivided fronds are arranged in an upward spreading, bowl shaped rosette. These fronds grow to a length of 4 ft. For the first few weeks, new fronds which unroll from a central spongy, fibrous, dark brown core are delicate and easily damaged. This fern does not produce offsets, but can live for years as single crowned rosette. Partial shade is highly suitable for this fern and can be utilized as an indoor ornamental plant. The commercial propagation of this fern is through spore culture.

***Blechnum orientale* (Family: Blechnaceae)**

It is a terrestrial fern. This is a slow growing upright fern that eventually develops a trunk but unlike true tree ferns. Rhizomes are massive, densely covered with dark brown scales. This fern is distributed both in Andaman and Nicobar group of Islands. Best suited as an indoor plant and prefers a warm environment instead of hot. This fern is propagated by rhizome sections and basal offsets.

***Davallia denticulate* (Family: Davalliaceae)**

This fern is distinguished by their furry rhizomes which creep over the surface and root down at regular intervals. The stem rhizomes are covered by long, rusty brown or silvery grey hairs and hence they are commonly



Blechnum orientale

known as Deer's foot and Hare's foot fern. This is a highly potential fern for commercial exploitation in landscape horticulture. It is suitable for hanging baskets and is used as an attractive filler in bouquets and flower arrangements. This fern is distributed in Andaman and Nicobar Islands and commercially propagated by stem rhizome cuttings.

***Lindsaea ensifolia* (Family: Lindsaeaceae)**

A terrestrial herb; creeping rhizome and scaly at apex. The fronds are held close together and simple pinnate. Commonly distributed fern in Andaman and Nicobar Islands. It is highly suitable as an indoor pot plant. Propagation is by division of rhizomes and spore culture.

***Microlepia speluncae* var. *speluncae* (Family: Dennstaedtiaceae)**

This is a terrestrial fern with creeping rhizomes. The fronds are thick and erect with ovate lamina. This species is found in both Andaman and Nicobar Islands. This fern is also distributed in Himalayas and North Eastern region. Nicobarese of the island use this fern for curing high fever. Propagation is through division of rhizomes with two or three fronds. It is highly suitable as a verandah plant and a specimen plant.

***Microsorium punctatum* (Family: Marsileaceae)**

This is a common epiphytic fern in the Island and found growing on tall and well stratified trees in the forests. This fern preferably grows in the moist and shady branches and tree trunks in dense evergreen forests. This is best suited as an indoor potted plant. The fronds are simple and sessile with linear lanceolate lamina. Propagation of this fern is through spore culture. The Nicobari tribes of this Island use this plant for curing snake bites.

***Nephrolepis biserrata* (Family: Nephrolepidaceae)**

This is an epiphytic or terrestrial fern and is rare on moist tree trunks in inland forests. The rhizomes are sub-erect and densely covered with scales. The fronds are spreading with the basal ones gradually shorter and widely spaced. Numerous slender, furry runners grow out from the rhizome and creep along the surface that produces new plants. This is a popular indoor fern which looks attractive when grown on pedestals. Rhizome of this fern is used as a vegetable by the tribes of the Island. Propagation is through offshoots.

***Nephrolepis exaltata* (Family: Nephrolepidaceae)**

This is a popular terrestrial indoor fern. The fronds



Davallia denticulate



Lindsaea ensifolia

rise from an upright underground rhizome the top of which is visible as a short, thick stem. The fronds can grow 4-6 ft long. This is commonly distributed in Andaman group of Islands in moist shady regions. Propagation is by runner shoots and spores.

***Nephrolepis hirsutula* (Family: Nephrolepidaceae)**

This is a popular terrestrial indoor herb. The rhizomes are short and erect with small light green fronds. The extreme tip of each of the pinnae is cut giving a fringed, slightly feathery look to the entire plant. Propagation of this fern is by runner shoots.



Microlepia speluncae var. *speluncae*

Table 1. Fern floral wealth of Andaman & Nicobar Islands

Family	Genera	Species
Huperziaceae	02	03
Lycopodiaceae	02	02
Selaginellaceae	01	05
Psilotaceae	01	02
Helminthostachyaceae	01	01
Ophioglossaceae	02	02
Angiopteridaceae	01	01
Dicranopteridaceae	01	02
Polypodiaceae	06	09
Drynariaceae	01	01
Schizaeaceae	01	02
Lygodiaceae	01	04
Cheilanthesaceae	01	01
Cryptogrammaceae	01	01
Acrostichaceae	01	02
Adiantaceae	01	03
Hemionitidaceae	02	02
Antrophyaceae	01	03
Vittariaceae	01	02
Taenitidaceae	01	01
Parkeriaceae	01	01
Marsileaceae	01	01
Hymenophyllopsidaceae	02	03
Hymenophyllaceae	04	04
Cyatheaceae	01	02
Denstaedtiaceae	01	01
Pteridaceae	01	10
Athyriaceae	01	02
Thelypteridaceae	06	14
Lindsaeaceae	01	14
Aspleniaceae	01	06
Aspidiaceae	03	06
Lomariopsidaceae	03	03
Nephrolepidaceae	01	02
Davalliaceae	02	05
Blechnaceae	01	02
Stenochlaenaceae	01	01
Total	60	126



Microsorium punctatum

***Palhinhaea cernua* syn. *Lycopodium cernua* (Family: Lycopodiaceae)**

A terrestrial herb; the rhizomes are subterranean, producing arborescent lateral stems. This is commonly distributed in Andaman and Nicobar Islands. This fern grows in Inland Hill forests usually in exposed places. The fern is highly suitable for use as filler material in bouquets and flower decorations.

***Phlegmariurus phlegmaria* (Family: Huperziaceae)**

Epiphytic fern on tree trunks and branches in rain forests; stems are pendulous and dichotomously branching

in irregular intervals. Common fern in Andaman and Nicobar Islands. This fern is highly suitable for hanging pots in landscape horticulture.

***Pteris ensiformis* (Family: Pteridaceae)**

A terrestrial herb; rhizome short, creeping and scaly. Nicobarese of the Island consume it, hence is also known as edible fern. It is also used in traditional medicinal practices by the tribal population and leaf juice is used to cure dysentery, diuretic, coolant and malarial fever. It is more common in Nicobar group of Islands. The fronds are shiny and attractive and highly suitable for indoor potted plant. Propagation is through division of rhizomes.

***Pteris vittata* (Family: Pteridaceae)**

A terrestrial herb which is rare in Inland forests. Rhizomes are short and covered with pale brown scales with upright growth. The fronds are with numerous pinnae. The middle ones longest and basal ones gradually reduced. Propagation is by runner shoots and spores. Whole plant is used as vegetable by the tribals of the Island. The rhizome of this fern is used by the Nicobari tribes in tribal medicine as a demulcent. This is best suitable as an indoor pot plant.

***Sphaeropteris albo-cetacea* (Family: Cyatheaceae)**

A gregarious, terrestrial endemic tree fern of the Nicobar group of Islands. Abundantly found in *Pandanus* forest in rocky clay to sandy loam regions. This is a tall fern reaching a height of 10 m with diameter trunk size of 15-20 cm. The fronds are 2.5 to 5.0 m long. Pinnae rachis pale to dull brown and 1 m long covered with shiny hairs. Propagation of this fern is through spore culture. This fern can be utilized as an avenue tree and specimen plant in landscape horticulture. The Nicobarese use the pounded leaves of this fern for curing wounds and sores. Propagation is by spore culture.



Nephrolepis biserrata



Nephrolepis exaltata



Phlegmariurus phlegmaria



Sphaeropteris nicobarica



Pteris ensiformis



Pteris vittata



Sphaeropteris albo-cetacea



Nephrolepis hirsutula



Tectaria melanorachis

***Sphaeropteris nicobarica* (Family: Cyatheaceae)**

An endemic terrestrial tree fern of the Nicobar group of Islands. A rare tree fern along the hill forests on rocky loam region. This fern grows to a height of 3 m with 1.0 to 2.0 m long fronds. The fronds are of chestnut colour with persistent scales and whitish to light brown hairs. *Sphaeropteris nicobarica* along with *Sphaeropteris albo-cetaceae* are the two tree ferns that are endemic to the Island and are distributed in exposed areas of the forest in Great Nicobar Islands forming a conspicuous vegetation of 5 km and is designated as the “Home of *Sphaeropteris*”. This fern can be utilized as an avenue tree and specimen plant in landscape horticulture. Propagation is by spore culture.

***Tectaria melanorachis* (Family: Aspidiaceae)**

A terrestrial herb with a height of 40 cm. Rhizome is short creeping and covered with brown scales. The fern is found growing in rock crevices. Fronds are bipinnate with veins in a network. Propagation is by rhizome cutting and spore culture. This fern is suitable for hanging pots, edge plant and indoor potted plant.

Thus the fern flora of Andaman and Nicobar Islands are the undisturbed patch of vegetation with genetic richness and endemism. This floral wealth of the Island is to be conserved and the whole Island is to be declared as a biosphere reserve. The fern species which have ornamental potential are to be conserved *ex-situ* for further multiplication and commercial exploitation.

For further interaction, please write to:

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Potential indigenous ornamentals of hillocks of Kerala

Hillocks which are a common sight in the midlands of Kerala, are vanishing day-by-day. They provide a beautiful landscape, with plenty of vegetation and most of the hillocks hold the dry grassland ecosystem. Ecologically, hillocks are critical to the region, as they are the main repositories of water resources keeping the millions of wells enriched providing drinking water to the people. As far as the floral wealth is concerned, hillocks are rich abodes of wide variety of flowering plants including grasses, herbaceous perennials, shrubs and trees. This article looks into the variety of indigenous ornamentals and their potential uses.

MOST the floral wealth of hillocks are either nectar or host plants to a variety of butterflies. Many of these plants which were utilized by traditional medical practitioners are either endangered or critically vulnerable due to human interventions. Since most of the hillocks are in private possession, these are subjected to exploitation for soil excavation, laterite mining, quarrying and as sites for educational institutions or coconut/rubber plantations. A great majority of hillock plants have been endangered due to severe habitat destruction. The habitat destruction is extremely fast and a loss of nearly 50% has been observed during last decade. Disappearance of the hillocks will lead these indigenous herbs getting vanished in near future. Either protection of this ecosystem or *ex situ* preservation of plants are to be resorted for conservation of the beautiful indigenous flora of hillocks. Conservation will also widen the repositories of garden plants as well as medicinal and aromatic plants. Illustrated here are some of the unique flora of hillocks of Kerala. In general, the flora can be classified under three main groups, viz.

trees and shrubs, herbaceous perennials and seasonal plants.

Trees and shrubs

***Hopea ponga*:** Commonly known as 'Thingam' in English and 'Ilapongu' in Malayalam, this is an evergreen tree belonging to family Dipterocarpaceae and endemic to Western Ghats. Leaves are alternate and shining. Inflorescence are produced in drooping racemose panicles. Flowers are small, yellowish pink. Sepals are persistent and when mature turn coppery red and very attractive. Flowering and fruiting seen from March to June. This is an endangered tree as per IUCN 1998.

***Tabernaemontana alternifolia*:** Commonly known as 'Nag Kuda' in Marathi; Koonampala/Kuruttupala in Malayalam, this is a small tree belonging to family Apocynaceae. The plant is distributed in Southern Western Ghats. White flowers are born in corymb like cymes and plants are very much attractive for its orange colored, boat shaped fruits. The plant is near threatened as per IUCN red list 1998. The plant is rich in phytochemicals like flavonoids, saponins, steroids, anthraquinones and cardiac glycosides. The plant is suitable for corner planting in a lawn.



Hopea ponga



Tabernaemontana alternifolia



Pogostemon quadrifolius



Naregamia alata



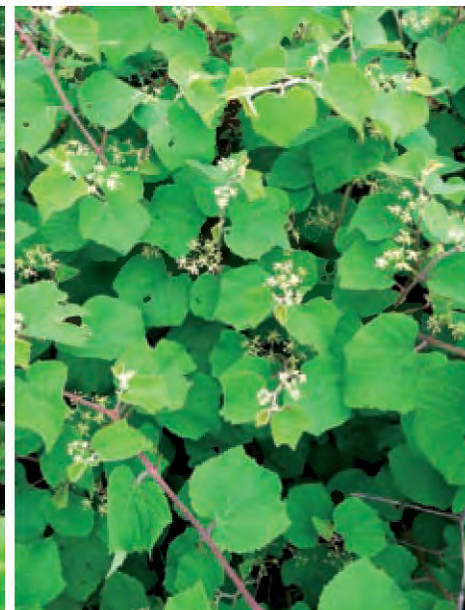
Memecylon malabaricum



Barleria acuminata



Barleria buxifolia



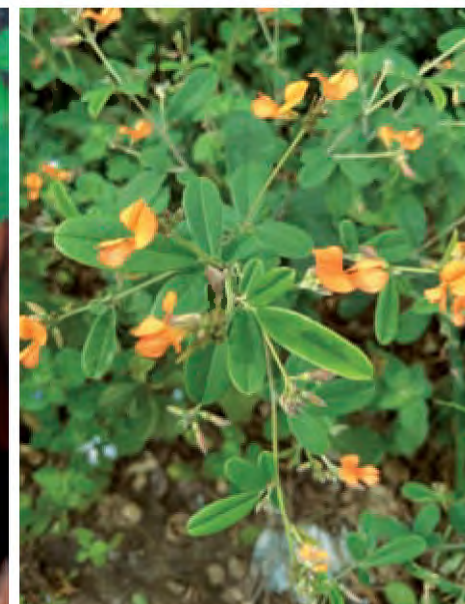
Cissus vitifolia



Cissus vitifolia



Ecbolium viride var. *chandrasekhariana*



Tephrosia pulcherrima



Eranthemum capense var. *concanense*



Capparis baducca



Exacum bicolor



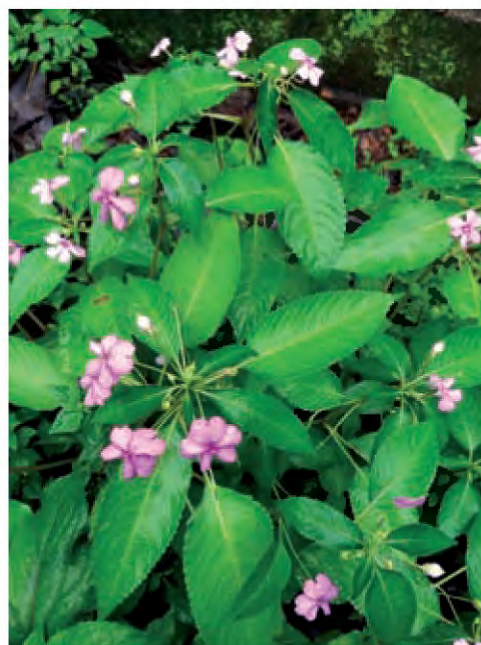
Crotalaria heyneana



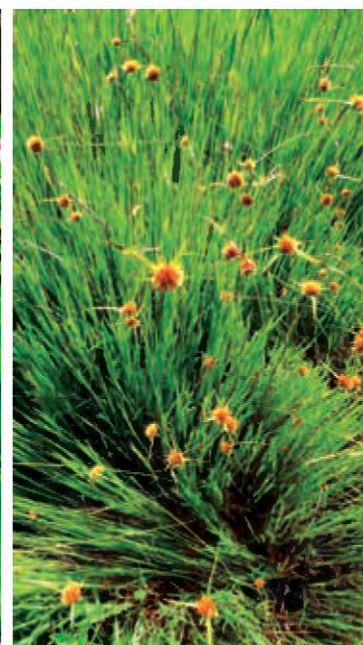
Torenia bicolor



Impatiens minor



Impatiens dasysperma



Rhynchospora wightiana

***Pogostemon quadrifolius*:** Commonly known as 'naithumba' in Malayalam, the plant is a shrub belonging to family Lamiaceae. The plant is distributed in the lateritic hillocks of peninsular India. It is a data deficient plant as per IUCN List 2011. The plant is a shrub usually seen in the lateritic regions of India. It grows to a height of 60–90 cm, the inflorescence is a spike with 100–150 small, light purple or pure white flowers. In the habitat, the plant dries off the upper vegetative parts during summer but put forth new growth during next monsoon. However, when given continuous irrigation new suckers grow and retains growth. The plant is suitable as a flowering border. The plant is used as a folk medicine in India and reported to possess anti-proliferative and anti-oxidant properties.

***Naregamia alata*:** Commonly known as Goanese Ipecac and 'nilanarakam' in Malayalam, this plant belongs to family Meliaceae and endemic to peninsular India. *Naregamia alata* is a prostrate, woody herb usually seen as an under shrub, with dark green shining trifoliate leaves. Flowers are solitary and axillary, white in colour with a yellow tipped staminal tube. The size of the flowers ranges from 3.0–4.0 cm in diameter. Flowering and fruiting season is from August to December. In the habitat, the plant dries out during summer season and seeds germinate during next monsoon. However, when given irrigation, it retains good growth. The plant can be used as a ground cover in shady areas. The plant is used a herbal medicine to treat asthma, dysentery, fever, cough and to prepare hair oil. Also used in conditions of biliousness, arthritis, scabies, etc.

***Memecylon malabaricum*:** Commonly known as Malabar Memecylon, the plant is an undershrub belonging to family Melastomataceae. It is endemic to Southern Western Ghats. Leaves are opposite, ovate and stalkless. Flowers are born in fascicles, in many flowered dense cymes. Flowers are brilliant blue and very attractive. Flowering and fruiting occurs from February–June. Fruits are globose and red when ripen. Though naturally an undershrub, the plant comes up well in sunny situations

and can be included in shrubbery. It is also reported that the plant possess antibacterial and anti-inflammatory properties and is used in skin diseases. Methanolic extract of leaves has got good anti-diabetic activity.

***Eranthemum capense*:** Commonly known as Konkani Eranthemum, the plant is a member of family Acanthaceae and is endemic to peninsular India. This is seen as under shrub. Stem is jointed with soft hairs, leaves are broadly elliptic and dark green. Flowers are blue and very attractive. Flowering and fruiting is seen from December to March. Plants can be propagated through cuttings. This is suited as a pot plant or as a shrub in shady area.

***Barleria acuminata*:** Commonly known as long-flower Barleria, this is a plant endemic to Western Ghats and belongs to family Acanthaceae. This is naturally an under shrub and can be grown in shady area. The plant can be propagated through cuttings. Reports on phytochemical studies show presence of alkaloids, flavonoids, phenols, tannins and terpenoids. Antibacterial inhibitory activity against gram negative bacteria, viz. *Escherichia coli*, *Klebsiella pneumonia*, *Proteus mirabilis*, *Salmonella typhi* and *Shigella dysenteriae*.

***Barleria buxifolia*:** Commonly known as Box-leaved Barleria and 'Karachulli' in Malayalam, this is a plant endemic to peninsular India. It belongs to family Acanthaceae. The plant is densely prickled with small leaves. Flowers are axillary, purple blue. Flowering seen in July–August.

***Capparis baducca*:** Commonly known as Rheed's caper, this is a rare endemic plant of Western Ghats belonging to family Capparaceae. According to studies by Kerala Forest Research Institute on Biodiversity documentation for Kerala, this particular species was assigned with vulnerable status. The plant is a shrub, erect with shoots armed with spines. Flowers are pale blue turning to white on fading. The plant grows in partial shade. Flowering and fruiting seen from February to June. This can be planted as a specimen shrub in a lawn. The plant can be propagated through cuttings.



Lepidagathis keralensis

***Cissus vitiginea*:** Commonly known as South Indian Treebine and 'Kattumutniri' in Malayalam, this is a straggling shrub with densely pubescent branches, swollen at nodes. Flowers are small in umbellate cymes and yellow in colour. Obovoid berries turn purplish blue when ripe. Flowering and fruiting seen in June–December. South Indian Treebine is distributed in South India and Sri Lanka.

***Ecbolium viride*:** Commonly known as green shrimp plant. The plant is a member of family Acanthaceae. This is seen usually as an undershrub. The plant is endemic to South India (Kerala and Tamil Nadu). Leaves are dark green and shiny. Inflorescence on terminal spikes of 2.5 cm long with small greenish yellow flowers. Flowering and fruiting seen from September–February. This is suitable as a hedge plant under shade.

***Tephrosia pulcherrima*:** Commonly known as orange Tephrosia, this is a shrub belonging to family Fabaceae. The plant is native to peninsular India and Sri Lanka. Stem is erect and densely hairy. Orange flowers are seen in few flowered racemes. Flowering and fruiting seen in September–February. The plant is naturally seen in partial shade condition. Reports are there on presence of flavonoids in the plants which had shown antimicrobial activity.

***Crotalaria heyneana*:** Commonly known as Heyne's crotalaria, this is naturally an undershrub which is endemic to South West India. The plant belongs to family Fabaceae. Leaves are dark green and flowers are whitish blue. Flowering and fruiting occurs in September–December.

Herbaceous perennials

***Exacum bicolor*:** A herbaceous perennial belonging to family Gentianaceae. Commonly known as country krait and 'Kannamthali' in Malayalam, this is an excellent ornamental plant. The plant is endemic to peninsular India. Stem is quadrangular and very strong. Stalkless leaves



Sesamum laciniatum

are dark green, shiny and oppositely arranged. Flowers are born in dichasial cyme. Flowers are the size of 4-5 cm in diameter having very good field life of 8-10 days. Flowering and fruiting occurs from August–December. This is an excellent plant for bedding as well as pot plants. The plant can be propagated by seeds and can be grown in any season. The plant is reported to have stomachic, febrifuge properties.

***Torenia bicolor*:** Commonly known as wish born flower and 'Kakkappoo' in Malayalam, this is an endemic plant to Western Ghats. The plant belongs to family Linderniaceae. This is a procumbent herb growing in moist, waterlogged areas. Flowers are 2-2.5 cm long, corolla light purple with deep purple throat. The plant is suitable as a ground cover in shady areas without much canopy dripping. Propagated through cuttings as well as seeds.

***Lepidagathis keralensis*:** Commonly known as 'Paramullu' in Malayalam, this is a perennial herb belonging to family Acanthaceae. The plant is endemic to Kerala, usually seen in the lateritic regions. The plant is procumbent with opposite leaves, tip of the leaves are spiny. Inflorescence in terminal or axillary spikes, pink in colour. The plant can be used in rockeries.

Seasonals

***Sesamum laciniatum*:** A prostrate, much branched



Utricularia sp.



Eriocaulon sp.

herb, belonging to family Pedaliaceae. The plant is seen in the lateritic hills and endemic to peninsular India. Leaves are variously lobed. Flowers are solitary, axillary, purple with a yellow palate, 2.5-4.0 cm size and very showy. Flowering and fruiting from July-November. Capsules are ovate and dehiscent. This plant is suitable as a pot/bedding plant in open areas. Flowering and fruiting seen from August to December.

***Impatiens minor*:** Commonly known as Lesser Balsam, it belongs to family Balsaminaceae and endemic to peninsular India. It is a slender glabrous herb with opposite leaves. Small flowers are seen in light pink and violet colours. Flowering and fruiting seen in July-September.

***Impatiens dasysperma*:** Commonly known as Shining Balsam, this is again a member of Balsaminaceae. The plant is endemic to Southern Western Ghats. It is an erect annual herb seen in shady areas. Leaves are alternate, usually fascicled towards the apex of the stem. Flowers are seen axillary, solitary or in groups of 2-3. The plant grows to a height of 50-60 cm with average of 35-40 flowers on a plant. The size of the flower is 2.75 cm. Flowers are pink in colour with a deep pink throat. Flowering and fruiting is seen from August to December. The plant can be used as a bedding plant in shady areas during the season.

***Rhynchospora wightiana*:** Commonly known as Wight Beak sage, the plant is member of family Cyperaceae. It is a tufted erect herb with basal leaves and inflorescence in reddish brown heads. Usually found in the dry grass lands in lateritic hills during rainy season. Flowering and fruiting seen from August-December. The heads can be utilized for dry flowers.

There are many more seasonal indigenous plants like *Justicia ekakusuma*, various species of *Eriocaulon*, a variety of *Lindernia* species, *Murdannia* species and *Utricularia* species that adorn the lateritic hillocks of Kerala during South-West monsoon.

Disappearance of the hillocks may adversely affect the existence of these unique flora which ultimately would lead to severe damage to our rich, genetically diversified repository of plants. Most of the perennial flora of the hillocks are very hardy and tolerant enough to drought. Exploitation of these indigenous floral wealth would lead to a new concept in gardening ensuring minimum drain of our natural resources coupled with assured conservation of some of the endemic, endangered or rare plants.

For further interaction please write to:

Dr U Sreelatha (Scientist), AICRP on Floriculture, Vellanikkara Centre, College of Horticulture, Vellanikkara.

Floral wealth of Biligiriranga hills

SUSTAINABILITY, biodiversity and low maintenance are the main issues gaining importance in present trends of landscaping. Adding to this, there is an increased demand for native ornamentals from the landscape industry of India. Many Indian landscape architects are keenly interested in incorporating native plants into their gardens and landscape. Native species are of great interest because of their ability to adapt to abiotic stress. Biligirirangana Hills on the eastern border of the Western Ghats lies at a spot where the Eastern and Western Ghats meet and create a diverse ecosystem and is known for its diverse species of flora and fauna. The hills are covered with more than 800 species of plant life, including scrub, dry deciduous, moist deciduous, shola forests and montane grasslands. The forests of the Biligirirangana Hills also have several species of ornamental plants. In spite of great economic potentials of wild flowering plant of BR hills they remain



neglected, and underutilized. There is need to develop horticultural produce tailored to specific end uses from these resources. The Soliga tribe, are the major indigenous tribes of BR hills situated in Chamarajanagar district of Karnataka in south India. Since time immemorial, Soligas have led a semi-nomadic life and were engaged in shifting cultivation. Collection of non-timber forest products (NTFPs) like honey, lichens, soap nut, roots of Magali (*Decalaepris hamiltonii*), fruits of Amla (*Embllica officinalis*), Chilla (*Strychnos potatorum*) and Alale (*Terminalia chebula*), is another important, but relatively recent occupation. Soligas, over centuries, have learnt the art of using forest resources judiciously. In order to empower them, we have established multipurpose ornamental nursery for sustainable utilization and conservation of these important resources and to ensure that the products produced by the tribal people by using modern technology could



Begonia sp.



Impatiens wellarnia



Vernonia arborea



Strobilanthes



Vernonia Arborea

become viable and competitive commercial products. In this project, we have formed group of tribal people and trained them with nursery techniques. A total of 150 multipurpose ornamentals have been collected under this project. Maximum fern diversity was observed and a total of 6 different types were collected out of 15 different types. And further, propagation protocols for 54 different native multipurpose ornamentals having potential of commercial value were developed. All the ornamental plants multiplied will be supplied to the industry and nursery of Bengaluru, Hyderabad and Pune. By introducing

new alternative ornamental crops in nurseries the income of tribal farmers will enhance and become more competitive. We aim for poverty alleviation and sustainable management of their natural and cultural resources.

For further interaction, please write to:

Dr H P Sumangala (Senior Scientist), Division of Floriculture and Medicinal Crops, ICAR-IIHR, Bengaluru 560 098. E-mail: Sumangala.hp@icar.gov.in

Attention authors and contributors of *Indian Horticulture*

To maintain high quality of presentation, designing and print quality of the *Indian Horticulture*, you are requested to provide:

- Good quality photographs of your work/article in **original form, i.e. high resolution jpeg files or bromides** only.
- Please provide photographs in its original form, i.e. high resolution jpeg files without any effects/enhancements/alterations at your end.
- **No PDF files** of photographs and **No internet pictures** please.
- The text of articles with photographs and captions may also be provided in the **MS Word** for reference purpose.

Good quality photographs provided in the form of high resolution jpeg files have bearing in the selection of articles for *Indian Horticulture*, your cooperation in this regard will be appreciated.

– Editor

Collection, conservation and utilisation of indigenous ornamental crops

Ornamental crops are the commodities of multi faceted enterprises in India, comprising traditional flower cultivation, indoor plants, loose flower production mainly for worship and dry flower decoration industry. These also include the ornamental foliage plants which contribute a lot towards the national income of various countries worldwide due to their striking appearances. India has a great diversity of these plants inhabiting varied agro-climatic zones from Leh-Ladakh to Rajasthan and from northeast to down south.

NATURE has a treasure of wild flowers and ornamental plants. Out of 406,700 plant species available on Earth, ornamental plants comprise approximately 85,000–99,000 species including trees, shrubs, climbers and creepers, palms, ferns, succulents cacti and, grasses, bamboos annuals, orchids, and reeds, bulbs, and other flowering crops, distributed all over the world.

Cultivating these beautiful plants in gardens/lawn is not new to India. Since the dawn of 16th century through various travellers/invaders who came to India, large number of ornamental plants have been introduced, of which many in due of course of time have naturalized and established themselves in India. Not only



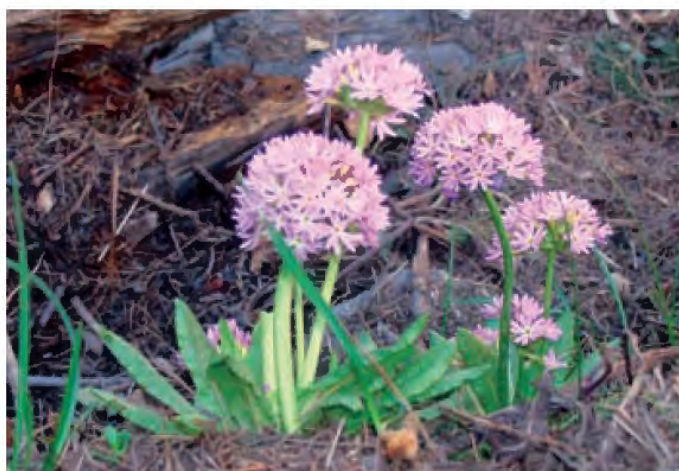
Hypericum perforatum growing in wild

these cultivated species, India is a home of vast wealth of genetic resources of wild species spread over various habitats like forests, gardens, hilly tracts and wild habitats.

Genetic diversity in ornamental crops

Indian sub-continent is a rich repository of ornamental trees, shrubs, herbs and succulents. Literature survey based on published information in the form of floras, books or reports by different organization and Botanical survey of India enumerates a large number of species (Table 1) present in India which also represent many indigenous ornamental plants.

Ornamental plants are grown for decorative purposes in gardens and landscape design, for cut flowers and



Wild *Primula denticulate*



Wild Jacaranda tree

Registered germplasm (Ornamentals Plants)



Gladiolus (P-16-1 x Eurovision)
Gladiolus hybridus (IC0611879; INGR 14052) with early blooming flowers (76-80 days after planting); florets colour in red group.



Chrysanthemum (Selection IIHR-2)
Dendranthema grandiflora (IC568709; INGR10115) selection for early and off-season flowering.



Gerbera (CSIR-IHBT-Gr-E-3) (HIM Peace)
Gerbera jamesoni (IC0613966; INGR15018) with double flower shape; medium size (~8 cm flower diameter) and white flower colour (RHS 155D).



China aster (IIHR CA H13A)
Callistephus chinensis (IC0610420; INGR14048) with Rose like sweetly aroma and Synthesizes highest hexanol & 1-2 hexanol.



China aster (IIHR-42)
Callistephus chinensis (IC0610423; INGR14051) with resistant to rootknot nematode (*Meloidogyne incognita* race 1).



China aster (IIHR-35)
Callistephus chinensis (IC0610422; INGR14050) with violet (83.A) flower colour and Pompon flower type.



China aster (CA J 17)
Callistephus chinensis (IC0610421; INGR14049) early flowering with higher number and weight of flowers/plant.

specimen display and as house plants and are associated with the mankind from time immemorial. Most of the present-day flowers have originated from the wild progenitors, which have existed in natural habitat. Many plants that were once abundant are now hard to find in their usual habitats. Unfortunately, many of them have been destroyed to an extent that several have become extinct and survival of many is endangered due to over exploitation by human beings. Hence, collection of this valuable germplasm is necessary.

The market for ornamental plants is continuously growing day by day with periodic trend-driven changes. Every year hundreds of new cultivars are being developed which are replacing the current one. Plant Genetic Resources (PGR), the only source of plant genetic diversity, provides valuable traits needed for meeting the challenges of adapting crop varieties. Hence, this diversity in ornamentals is required for new genes as a source for development of novel varieties. For this reason, the exploration, conservation and documentation of these potential genetic resources is of enormous importance to meet market demands. Conservation of ornamental crops diversity is arising to meet the changes in consumer preferences.

Presently, ornamental germplasm is conserved through *in situ* and *ex situ* methods in forests, national parks, botanical gardens, and arboreta. Recently new biotechnological tools, ranging from the drying of seeds to cryopreservation of embryos, pollens, etc., has served

as a boon in preserving the diversification of ornamentals and also in producing quality planting material

Table 1. Species diversity present in India

Name of Taxa	Total no. of species reported in world	No. of species in India
Rhododendrons	1024	43
Orchids	140 (genera)	1300
Primula	1300	43
Lonicera (honeysuckle)	180	20
Aster	180	14
Begonia	1600	64
Impatiens	1000	241
Iris	300	73
Jasminum	200	43
Hedychium	80	24
Pandanus	750	7
Ixora	400	37
Gardenia	140	14
Crinum	180	12
Lilium	100	11
Barleria	300	26
Ipomoea	500	37
Tabernaemontana	100	114
Thunbergia	302	110
Bauhinia	352	37

Table 2. Ornamental species conserved at National Genebank, ICAR-NBPGR

Species name	Acc.no	Species name	Acc.no	Species name	Acc.no
<i>Ageratum conyzoides</i>	1	<i>Cardiocrinum giganteum</i>	1	<i>Loranthus longiflorus</i>	1
<i>Artemisia gmelinii</i>	1	<i>Canna indica</i>	2	<i>Nelumbo nucifera</i>	3
<i>Brachiaria</i> sp.	1	<i>Dianthus sinensis</i>	1	<i>Calendula arvensis</i>	1
<i>Bothriochloa odorata</i>	1	<i>Cayratia auriculata</i>	2	<i>Tagetes erecta</i>	140
<i>Bupleurum falcatum</i>	1	<i>Cayratia pedata</i>	3	<i>Tagetes minuta</i>	186
<i>Canna edulis</i>	1	<i>Cayratia</i> sp.	1	<i>Tagetes patula</i>	18
<i>Caraytia auriculata</i>	1	<i>Cayratia trifolia</i>	3	<i>Asteracantha longifolia</i>	3
<i>Dichrostachys ceneszens</i>	1	<i>Callistephus chinensis</i>	12	<i>Hygrophila auriculata</i>	2
<i>Ipomoea aquatica</i>	1	<i>Ardisia solanacea</i>	1	<i>Hygrophila schulli</i>	2
<i>Knema attenuata</i>	1	<i>Chrysanthemum morifolium</i>	1	<i>Mimosa cinerea</i>	1
<i>Meyna laxiflora</i>	1	<i>Synedrella nodiflora</i>	1	<i>Mimosa himalayana</i>	1
<i>Mycorrhiza</i> sp.	1	<i>Arisaema caudatum</i>	2	<i>Mimosa indica</i>	1
<i>Nerium oleander</i>	2	<i>Arisaema leschenaultii</i>	1	<i>Mimosa invisa</i>	1
<i>Nerium</i> sp.	1	<i>Arisaema propinquum</i>	1	<i>Mimosa rubicaulis</i>	1
<i>Paris polyphylla</i>	1	<i>Celosia argentea</i>	17	<i>Mollugo pentaphylla</i>	1
<i>Peperomia pellucida</i>	1	<i>Celosia cristata</i>	5	<i>Tragia cannabina</i>	1
<i>Picrorhiza scrophulariiflora</i>	1	<i>Coldenia procumbens</i>	1	<i>Oldenlandia corymbosa</i>	1
<i>Pogostemon heyneanus</i>	1	<i>Centaurea cyanus</i>	2	<i>Pinda concanensis</i>	1
<i>Potentilla atrosanguinea</i>	1	<i>Crossandra infundibuliformis</i>	2	<i>Papaver dubium</i>	1
<i>Premna serratifolia</i>	1	<i>Baliospermum montanum</i>	5	<i>Papaver pseudo-orientale</i>	1
<i>Quassia amara</i>	1	<i>Pentapetes phoenicea</i>	2	<i>Papaver rhoeas</i>	1
<i>Setaria viridis</i>	1	<i>Ehretia laevis</i>	1	<i>Calendula eckerlenii</i>	1
<i>Solanum erianthum</i>	1	<i>Erinocarpus nimmonii</i>	1	<i>Calendula officinalis</i>	2
<i>Stephania japonica</i>	1	<i>Eulophia nuda</i>	1	<i>Calendula suffruticosa</i>	1
<i>Tridax procumbens</i>	3	<i>Neptunia oleracea</i>	2	<i>Ludwigia octovalvis</i>	1
<i>Viburnum corylifolium</i>	3	<i>Chrysanthemum coronarium</i>	1	<i>Ludwigia parviflora</i>	1
<i>Viburnum mullaha</i>	1	<i>Cuscuta reflexa</i>	1	<i>Ruellia rosea</i>	1
<i>Angelica archangelica</i> var. <i>himalaica</i>	1	<i>Naregamia alata</i>	1	<i>Rivea ornata</i>	1
<i>Angelica glauca</i>	9	<i>Hedychium spicatum</i>	25	<i>Rosa macrophylla</i>	3
<i>Anisomeles heyneana</i>	1	<i>Lonicera japonica</i>	1	<i>Rosa microphylla</i>	1
<i>Anisomeles indica</i>	5	<i>Dodonaea viscosa</i>	26	<i>Rosa sericea</i>	5
<i>Aster peduncularis</i>	1	<i>Urginea indica</i>	3	<i>Waltheria indica</i>	1
<i>Impatiens balsamina</i>	1	<i>Randia dumetorum</i>	8	<i>Justicia betonica</i>	1
<i>Impatiens sulcata</i>	3	<i>Belamcanda chinensis</i>	1	<i>Illicium verum</i>	2
<i>Elephantopus scaber</i>	3	<i>Vernonia anthelmintica</i>	11	<i>Anacyclus pyrethrum</i>	2
<i>Blepharis madraspatensis</i>	1	<i>Knoxia corymbosa</i>	1	<i>Spilanthes acmella</i>	16
<i>Blepharis sindica</i>	1	<i>Bistorta affinis</i>	1	<i>Spilanthes paniculata</i>	2
<i>Bryonia cordifolia</i>	1	<i>Launaea sarmentosa</i>	1	<i>Trichodesma indicum</i>	2
<i>Triumfetta pilosa</i>	2	<i>Loranthus longiflorus</i>	1	<i>Tecoma grandiflora</i>	2

Table 3. Trait specific germplasm of ornamental crops registered at ICAR-NBPGR

Crop Name	No. of acc.	Botanical Name	Developing Institute	Novel Unique Features
Balsam	1	<i>Impatiens walleriana</i>	Tropical Botanic Garden & Research Institute (TBGRI), Palode, Thiruvananthapuram, Kerala	Variegated leaves
Canna	1	<i>Canna generalis</i>	CSIR-National Botanical Research Institute (NBRI), Rana Pratap Marg, Lucknow, Uttar Pradesh	Unique new flower colour, flowers in cluster form
Carnation	3	<i>Dianthus</i> sp.	ICAR-Indian Institute of Horticultural Research (IIHR), Hassaraghatta Lake Post, Bengaluru, Karnataka	Inter-specific hybrid with mass bloom effect, good spray type. Micro-carnation genotype. Inter-specific hybrid, good for potted plant.
Casuarina	1	<i>Casuarina junghuniana</i>	Lakshmi Narayana's Hybrid Crossandra Innovation Centre, Near Perumal koil, Koodapaakkam & Post, Pondicherry	Hybrid (Drought tolerant, fast growing and high yielding)

Contd.

Table 3. (Continued)

Crop Name	No. of acc.	Botanical Name	Developing Institute	Novel Unique Features
China aster	4	<i>Callistephus chinensis</i>	ICAR-IIHR, Bengaluru, Karnataka	Early flowering. Higher number of flowers/plant. Higher weight of flowers/plant Early flowering. Higher number of flowers/plant. Higher weight of flowers/plant Flower colour: Violet (83.A). Flower type: Pompon Flower colour: Creamy white Flower type: Powderpuff. Resistant to rootknot nematode (<i>Meloidogyne incognita</i> race 1)
Chrysanthemum	4	<i>Dendranthema grandiflora</i>	ICAR-IIHR, Bengaluru, Karnataka	Flower colour: 77.B. Purple group, Fan 2. Stellate ray florets (Cylindrical shape) Flower colour: 162.D. Gray yellow group, Fan 4. Stellate ray florets (Cylindrical shape) Early and off-season flowering, suitable for pot and garden use. Early and off-season flowering, suitable for pot and garden use Flower colour and fragrance
Delphinium	1	<i>Delphinium malabaricum</i>	Shivaji University, Vidya Nagar, Kolhapur, Maharashtra	
Firecracker flower	3	<i>Crossandra infundibuliformis</i> <i>Crossandra undulaefolia</i>	CIC, Pondicherry ICAR-IIHR, Bengaluru, Karnataka	High yield, triploid Bigger flower and higher yield Novel in colour (golden yellow) and bigger size
Geranium-Scented Rose	1	<i>Pelargonium graveolens</i>	ICAR-National Bureau of Plant Genetic Resources (NBPGR) Regional Station, Bhowali, Uttarakhand	Quality aroma
Gerbera	6	<i>Gerbera jamesonii</i>	ICAR-IIHR, Bengaluru, Karnataka CSIR-Institute of Himalayan Bioresource Technology (IHBT), Palampur, Himachal Pradesh ICAR-IIHR, Bengaluru, Karnataka	Floriferous and double type Floriferous and good for open cultivation For double flower shape. Medium size (~8 cm flower diameter). White flower colour (RHS 155D) For double flower shape. Standard size (>10 cm flower diameter) Yellow orange flower colour (RHS 16C) Flower head colour: 68D. Red purple group (as per RHS colour chart). Double type flower head Flower head colour: 50A. Red group (as per RHS colour chart). Double type flower head.
Gladiolus	11	<i>Gladiolus hybridus</i>	ICAR-Indian Agricultural Research Institute (IARI), Pusa Campus, New Delhi	Early blooming which flowers 76-80 days after planting and florets colour in red group (41 C, RHS colour chart) with dark red stripes on inner two tepals (42A, RHS colour chart), and also red spots on outer throat. Spike length is 93 cm with more than 16 florets. At a time 5-6 florets remain open on the spike. From each mother corm, it produces more than 2 corms. Very early in flowering (74 days after planting) and florets colour in red group (50C, RHS colour charts). Two red spots on two central tepals. Number of florets is 18.44 and spike length is more than 100 cm. Corm

Contd.

Table 3. (Continued)

Crop Name	No. of acc.	Botanical Name	Developing Institute	Novel Unique Features
		<i>Gladiolus spp.</i>	ICAR-IIHR, Bengaluru, Karnataka	multiplication rate is higher and produces more than 2 corms from each mother corm. Floret colour: Purple (78.A) middle (based on RHS colour chart) Red-purple (72.A) margin with Green Yellow (1.D) blotch. Floret type is open faced and floret placement is in double rows Floret colour: Purple violet (82.A) having purple (77.A) margin (based on RHS colour chart) Green-White (157.C) line on lower lip. Early flowering (61.54 days). Hybrid, with capsicum red (RHS-33A) flowers, lip petals chartreuse yellow (RHS-2D), petals ruffled, average spike length 138 cm, mean number of florets 18.5 and flower diameter 10.2 cm. Hybrid, with brick red petals having dresden yellow on lip petals nicely, ruffled, average spike length 115 cm mean number of florets 18.3 and flower diameter 11.8 cm. Hybrid, with white petals having deep purple violet (RHS80A) edges, average spike length 125.4 cm, mean number of florets 17.1 and flower diameter 10.5 cm. Hybrid, with reddish purple (RHS-74D) petals and dark reddish purple (RH-66A) blotches on the edges of both sides of the petal, lip petal magenta coloured with white stripes.
		<i>Gladiolus grandiflorus</i>	ICAR-IIHR, Bengaluru, Karnataka	Floret colour: Purple-violet (82.C) having Red-Purple (72.B) margin with Yellow-Green (154.D) blotch (Based on R H S colour chart). Floret colour: (Based on R H S colour chart) Yellow (4iop[C) lower lip with Red (39.A) blotch. Resistant to <i>Fusarium</i> wilt disease cause by <i>Fusarium oxysporum</i>. Floret colour:(Based on R H S colour chart) Red (46.D) having Red (45.B) margin and white (155.B) line on tepals with Yellow (2.C) blotch.
Ground orchid	1	<i>Spathoglottis plicata</i>	University of Kalyani, Nadia, West Bengal	Milk white flower colour, green bract in contrast to lilac bract.
Jasmine	2	<i>Jasminum ritchiei</i>	TBGRI, Palode, Thiruvananthapuram, Kerala	Variegated leaves.
		<i>Jasminum malabaricum wight</i>	ICAR-IIHR, Bengaluru, Karnataka	High concrete recovery (0.375%) and high (17%) ester group of volatile in flowers.
Marigold	1	<i>Tagetes erecta</i>	ICAR-IIHR, Bengaluru, Karnataka	Petaloid sterile flowers, ability to be multiplied by cuttings.
Orchid	3	<i>Eulophia andamanensis</i>	ICAR-Central Island Agricultural Research Institute (CARI), Port Blair, Andaman and Nicobar Islands	Pretty green flowers with stripped lip.
		<i>Dendrobium sp.</i>	TBGRI, Palode, Thiruvananthapuram, Kerala	Profuse flowering.
		<i>Dendrobium hybrid</i>	ICAR-National Research Centre for Orchids, Pakyong, East Sikkim	Phalaenopsis type hybrid, broad and flat petals, purple colour and big size flowers.

Contd.

Table 3. (Concluded)

Crop Name	No. of acc.	Botanical Name	Developing Institute	Novel Unique Features
Red Vanda	1	<i>Renanthera imschootiana</i>	ICAR-NRC for Orchids, Pakyong, East Sikkim	Red colour flower, open broad sepals; endemic to NE region.
Rose	9	<i>Rosa multiflora</i>	CSIR-Institute of Himalayan Palampur, Himachal Pradesh	Suitable strain for rootstock.
		<i>Rosa brunonii</i>		Suitable strain for rootstock.
		<i>Rosa cathayensis</i>		Suitable strain for rootstock.
		<i>Rosa alba</i>	ICAR-IIHR, Bengaluru, Karnataka	Suitable strain for rootstock.
		<i>Rosa indica</i>		Ideal rootstock resistant to powdery mildew.
		<i>Rosa multiflora</i>	Ideal rootstock resistant to powdery mildew.	
Rose geranium	1	<i>Pelargonium graveolens</i>	ICAR-NBPGR Regional Station, Bhowali, Uttarakhand	Shining foliage, unique bicolour consisting vermillion red shading towards orient pink.
				Less thorns, straight stalk of cut flower quality, light pink flowers with pointed bud and high centre.
				Fragrant and field tolerance to thrips.
Tail flower	1	<i>Anthurium ornatum</i>	ICAR-IIHR, Bengaluru, Karnataka	Quality aroma.
Trumpet bush	1	<i>Allamanda neriifolia</i>	ICAR-IIHR, Bengaluru, Karnataka	Emits fragrance during stigma receptivity, easy to grow.
			TBGRI, Palode, Thiruvananthapuram, Kerala	Variegated leaves, pale green colour with creamy patches and white streak along the margin.

available to the actual market of ornamental plants.

The ICAR-National Bureau of Plant Genetic Resources (NBPGR) is the nodal institute for collection and conservation of plant genetic resources. Till now a total of 633 accessions of different ornamental crops have been conserved in National Genebank (Table 2).

Registration of trait specific genetic resources of ornamental crops in India to enhance the utilization

Ornamental crops have not been priority area in the recent past, but now emphasis is given to the ornamental crop genetic resources because of the high remuneration. So far, 56 genotypes of ornamentals belonging to 20 genera and 27 species have been registered. The major genera are *Gladiolus*, *Rose*, *Gerbera* and *China aster* (Table 3).

Gladiolus have mostly been registered for different hues of flower colour and one germplasm for resistance to *Fusarium* with disease caused by *Fusarium oxysporum*. Though, there are a wide range of colours, true green and blue colours are still lacking. The performance of the rose varieties depends on its rootstock, as ideal rootstock can overcome soil and climatic drawbacks to a great extent. Some rose species which are exclusively used for rootstock have been registered, such as *Rosa alba*, *R. brunonii*, *R. cathayensis*, *R. indica* and *R. multiflora*. *Chrysanthemums* are registered for early and off-season flowering, suitable for pot and garden use in addition to flower colour. Although, developing novelty colour and flower types, thermo-zero and photo-insensitive cultivars are the priority areas which need attention of the breeders. In carnations, cultivars with fragrance and resistance to diseases and insect pest are thrust areas. IIHR and IHBT have been the major contributors in developing and registering ornamental germplasm. Potential users of the germplasm collections should be provided with information

on trait specific germplasm of ornamental genetic resources conserved to enhance utilization of the same.

Potential wild ornamental plants

Most of the present day ornamental plants have come from the wild progenitors and a few of these wild native plants are still in natural habitat. In India, there is great scope in exploring ornamental potential of these beautiful native wild plants. Wild plants are a striking feature of the land surface. They vary greatly in composition and density in marked contrast with domesticated plants. Cultivation of these species may be beneficial, both commercially and to help conserve rare, vulnerable, endangered endemic plant species. Some of the wild species with potential of being used as ornamental are given here.

Meconopsis aculeata - A blue-flowered thorny species of the genus *Meconopsis* (Family Papaveraceae) with a small geographical distribution restricted to west Himalayas. The species is highly valued as a medicinal plant and the resulting demand for the plant as medicine has placed pressure on wild populations due to over-collection. Because of the attractive blue color, it is well adored by the florists.

Primula denticulata - Belongs to family Primulaceae is a small herb found wild in the Himalayan region upto an altitude of 2,000 to 3,500 meters. Short stout rhizomes are of medicinal value. It bears denticulate leaves and purple to pinkish purple flowers in compact head (fig.2). Once domesticated it will have an immense potential both as medicinal and ornamental value.

For further interaction, please write to:

Veena Gupta (Scientist), Division of Germplasm Conservation, ICAR-NBPGR, New Delhi. E-mail: veena.gupta@icar.gov.in

Native conservatory at ICAR-IIHR



REALISING the potential of native ornamentals, the work on native ornamentals was initiated at ICAR-IIHR in 2006. In recent years under Tribal Sub Plan, the project on 'Economic upliftment of Soliga tribes by establishing multipurpose ornamental nursery at BR Hills near Mysore' was initiated in 2016. To evaluate the feasibility and adaptability of the species, around 41 species collected from BR hills were established at field gene bank ICAR-IIHR in the shade net house.

With conservation in mind, creation of native conservatory was mooted at the Division of Floriculture and Medicinal Crops, Indian Institute of Horticultural Research (ICAR-IIHR), Bengaluru and multipurpose ornamentals species of BR Hills (where the Eastern and Western Ghats meets up) were sought to be evaluated for their performance in Bengaluru. A shade net of 120 sq meters in the campus was chosen for planting ornamental saplings from BR Hills that came to be known as the "Conservatory of Native

Ornamentals". Ornamental plants (200) belonging to 41 species (Table 1) which were raised at the nursery at BR hills were obtained and planted. The objective was to evaluate their adaptability to a habitat and conditions apparently alien to these species. The study was also meant to understand the linkages of these plant species with the surrounding environment. Contrary to the belief that plant species are very sensitive to change of location and conditions, the introduced plants have grown as good as they would do in their native habitat and maintained their phenology.

Flora of BR Hills belongs to diverse vegetation types. The species diversity is enormous and as such, there is no dearth for



Table 1. List of species in the conservatory

Name of plant	Family
<i>Pandanus tectorius</i>	Pandanaceae
<i>Leea indica</i>	Vitaceae
<i>Adhatoda vasica</i>	acanthaceae
<i>Brugmansia suaveolens</i>	Solanaceae
<i>Begonia grandis</i>	Begoniaceae
<i>Bischofia javanica</i>	Phyllanthaceae
<i>Spondias pinnata</i>	Anacardiaceae
<i>Clerodendrum serratum</i>	Lamiaceae
<i>Cinnamomam malabatrum</i>	Lauraceae
<i>Grewia tiliifolia</i>	Malvaceae
<i>Schefflera actinophylla</i>	Araliaceae
<i>Ficus talbotii</i>	Moraceae
<i>Costus speciosus</i>	Costaceae
<i>Lycopodium phlegmaria</i>	Lycopodiaceae
<i>Curcuma neilgherrensis</i>	Zingiberaceae
<i>Talinum fruticosum</i>	Talinaceae
<i>Smilax aspera</i>	Smilacaceae
<i>Cyperus rotundus</i>	Cyperaceae
<i>Antidesma menasu</i>	Phyllanthaceae
<i>Litsea monopetala</i>	Zingiberaceae
<i>Fuchsia tripylla</i>	Onagraceae
<i>Platyserium bifurctum</i>	Polypodiaceae
<i>Persea macrantha</i>	Lauraceae
<i>Phaius tanker villeae</i>	Orchidaceae
<i>Hemionitis arifolia</i>	Pteridaceae
<i>Celtis tetrandra</i>	Ulmaceae
<i>Bryophyllum pinnatum</i>	Crassulaceae
<i>Calanthe sp.</i>	Orchidaceae
<i>Trichilia connaroides</i>	Meliaceae
<i>Persea macrantha</i>	Lauraceae

<i>Meliosma pinnata</i>	Sabiaceae
<i>Curcuma angustifolia</i>	Zingiberaceae
<i>Chionanthus malaelengi</i>	Oleaceae
<i>Elaeocarpus tuberculatus</i>	Elaeocarpaceae
<i>Elaeocarpus serratus</i>	Elaeocarpaceae
<i>Saussurea obavallata</i>	Asteraceae
<i>Bulbophyllum actibracteatum</i>	Orchidaceae
<i>Capsicum frutescens</i>	Solanaceae
<i>Microlepis hirta</i>	Dennstaedtiaceae
<i>Polypodium vulgare</i>	Polypodiaceae
<i>Hemionitis arifolia</i>	Pteridaceae
<i>Brayophyllum pinnatum</i>	Crassulaceae



selection of species among these native plants for afforestation and urban greening. There is also the impending danger of climate change, which is likely to affect some of our native plant species, and their phenology, and thereby effecting further regeneration and continuity of the species, which would result in loss of diversity. It might therefore become necessary to bring different wild indigenous species to other locations and also into city confines where they might have better opportunity to thrive under *ex situ* conditions.

For further interaction, please write to:
Dr H P Sumangala (Senior Scientist), ICAR-IIHR, Bengaluru, Karnataka. E-mail: sumangala.hp@icar.gov.in

Valley of Flowers – a paradise on earth for nature lovers

Valley of Flowers (VoF) sits amidst the picturesque mountains, valleys, and running streams of Western Gharwal Himalays, Uttarakhand, India. It is located in the Nanda Devi Biosphere Reserve with the coordinates (30°41'–30°48' N and 79°33'–79°46' E) and is spread across 87.5 km² including 63.56 km² of perpetual snow glaciers. The valley has a rich diversity of endemic flora and fauna and thus attracting botanists, naturalists, photographers and trekkers since long.

The emerald mountains, white clouds, green meadows and colourful plains easily paint dreamlike scenery in valley of flowers. Added to the charm are the cascading waterfalls that are abundant as we trek along any route. The valley primarily consists of sedimentary rocks comprising mica schists, rendering the soil acidic in nature. Nature has profusely designed flower carpets of different colours throughout the landscape in the backdrop of the mountain ranges of the Zaskar and Great Himalayas. It is a land of endless meadows, with overwhelming snowcapped peaks bearing icy glaciers that burst into bubbling streams with a background music of chirping birds. Locals have continued to believe that the valley had been created by fairies and not wonder, it's nothing short of a fairy land.

History and Discovery

Ancient Hindu texts suggest that this was the ancient valley wherein grew the famous Sanjeevani buti, a magical herb that could cure anything. It was even believed that Sanjeevani buti could help revive a dead person. The Valley of Flowers is also the place where Lord Hanuman came in search for the Sanjeevani Buti and decided to lift up the whole of Mount Sumeru

and flew it to the battlefield. Today, various scientific studies on the endemic herbs of the flower valley are under progress and interestingly, we have more than one candidate that could possibly be the legendary Sanjeevani plant. These include the *Cressa cretica*, *Dendrobium plicatile*, *Selaginella bryopteris* and many more.

However, the recent exploit of VoF in the modern times is credited to Frank S. Smythe, and his friends who met this unforeseen beautiful landscape while returning from a successful expedition to Mt. Kamet during 1931. He has camped in the valley to collect materials for his scientific book and took the seeds of few flowering plants from this valley to the Botanical Gardens in Scotland and Edinburg. The valley was declared as a National Park in 1982 and is also inducted into the UNESCO list of World Heritage Sites.

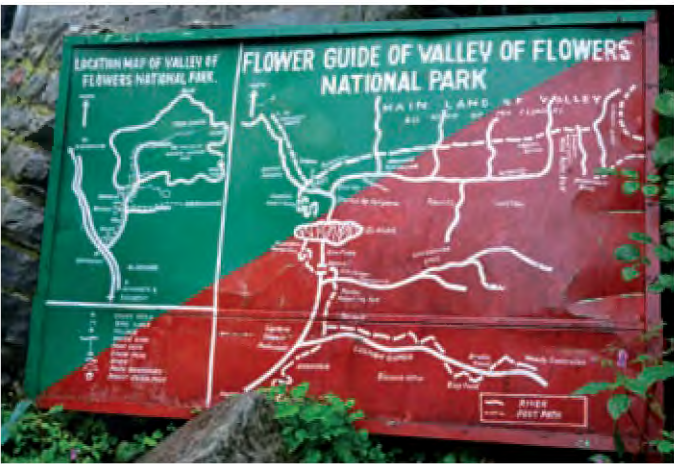
Brahma Kamal (*Saussurea obvallata*)

It's a flowering species of Asteraceae. It is native to Himalayas and is found in the altitudes around 4500 m i.e. in the trek route of Hemkund Sahib. Flower heads are purple, hidden from view in layers of yellowish-green papery bracts, which provide protection from the cold mountain environment. The flowers are hermaphrodite (have both male and female organs) and are pollinated by insects. It is considered a medicinal herb in Tibetan medicine, where it is used to treat urogenital disorders, liver infections, sexually transmitted diseases, bone pains, and cold and cough. It has a bitter taste and the entire plant is used. Due to greater exploitation by the human interventions, this plant has become endangered. It is the state flower of Uttarakhand.



Trekking routes

There are three common routes for trekking into the Valley of Flowers. The most popular trek route for nature enthusiasts is the route that follows the Pushpavati Stream. However, to reach the entry to the VoF, trekkers will have to get across the massive Ghoda Parvat and Rataban Peak.



Trekkers will be passing through the picturesque Bhuyandar Pass to emerge in the pastures of Gamsali Valley and Bank Kund and eventually the last Indian village called Niti before stepping into Tibet.

Another trek route to the VoF starts after crossing the suspension bridge at Alaknanda and then taking the right bank of the Lakshman Ganga along a mountainous path. The trek will take us through scary dense vegetation and the famed whispering forests along the Laxman Ganga. It would be after 10 kilometers of trek, we would emerge into open grasslands at the Bhuyandar Village and then

on to the beautiful valley towards the Kagbhushandi Taal. We would be walking along the Valley of Flowers for 3 more kilometers along the Laxman Ganga and finally cross over to Ghangaria. It would be a zigzag climb that has to be done very carefully. The Ghangaria landscape is marked by giant Deodar trees and acts as a conjunction/resting place for trekkers to both Lokpal Lake and Hemkund Sahib. Since overnight camping in the Valley of Flowers isn't permitted, trekkers and visitors spend the night at Ghangaria before moving on.

Blue Poppy (Meconopsis spp.)

This popular Himalayan Blue Poppy is native to the mighty Himalayas. It is one of the rare ornamental in the world of colourful flowers where BLUE doesn't occur frequently. It gorgeously decorates alpine meadows and the rock debris of moraine with flowers that come in lovely shades of blue and purple, often luminescent against snowy background, and always pleasing. They are slender-pedicelled, with 4 petals. The numerous golden-yellow stamens contrast well with the blue petals. A postal stamp is being issued by the Indian Postal Department commemorate this flower.

Table 1. Identification and description of some of the endemic flora from Valley of Flowers

Photograph	Common Name, Scientific Name, Family, Characteristics
	Himalayan Thimble, <i>Anemone obtusifolia</i> , Ranunculaceae, White or bluish on either side or golden yellow flowers; May to Early August
	Indian Barberry, <i>Berberis aristata</i> , Berberidaceae, Bright yellow flowers; March to June
	Blue poppy, Queen of Himalayan flowers, <i>Meconopsis aculeata</i> , Papaveraceae, Fluorescent blue flowers; June to September
	Tongzil, <i>Corydalis meifolia</i> , Fumeraaceae, Yellow with purple or violet tips or rarely orange flowers; June to September
	Bladder Campion, <i>Silene edgeworthii</i> , Caryophyllaceae, Bell shaped flowers marked with brownish black ribs bearing white petals; August to October



Indian Campion, *Silene indica*, Caryophyllaceae, Yellowish green flowers with brownish – purple calyx; August to September



Bladder Campion, *Silene vulgaris*, Caryophyllaceae, White or greenish white flowers, Pink or white tinged calyx; June to September



St. John's wort, *Hypericum perforatum*, Hypericaceae, Golden yellow flowers; June to October



Nepal Geranium, *Geranium nepalensis*, Geraniaceae, Pale pink flowers; June to August



Wallich's Geranium, *Geranium wallichianum*, Geraniaceae, Deep pink or purplish pink or blue with dark violet center; June to September



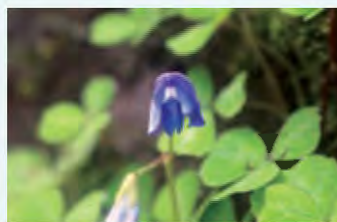
Devendra's Balsam, *Impatiens devandrae*, Balsaminaceae, White flowers; June to September



Rugged Yellow Balsam, *Impatiens scabrida*, Balsaminaceae, Yellow flowers; June to September



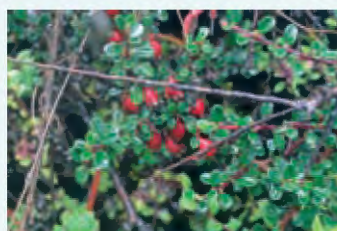
Dog flower, *Impatiens sulcata*, Balsaminaceae, Pink purple or dark crimson flowers; June to September



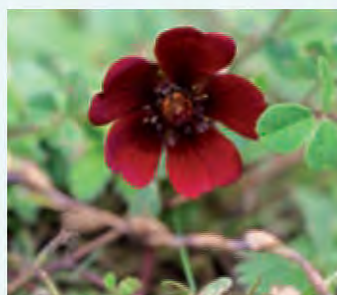
Blue Oxalis, Shamrock Pea, *Parachetus communis*, Fabaceae, Deep blue or purplish flowers; June to October



Goat's beard, *Aruncus dioicus*, Rosaceae, Pink flowers with dioecious sex form; July to August



Small leaved cotoneaster, *Cotoneaster microphyllus*, Rosaceae, White flowers with scarlet berries; May to October



Himalayan cinquefoil, *Potentilla atrisanguinea*, Rosaceae, Dark red flowers; June to August



Wild rose, *Rosa macrophylla*, Rosaceae, Pale pink or pinkish white flowers; June to August



Himalayan saxifrage, *Saxifraga parnassifolia*, Saxifragaceae, Bright yellow flowers; August to October



Himalayan Bog Star, *Parnassia nubicola*, Parnassiaceae, White flowers; June to September



Wallich Rhodiola, *Rhodiola wallichiana*, Crassulaceae, Bisexual yellow flowers; June to August



Himalayan flowers, *Morina longifolia*, Dipsaceae, White flowers turning pink on maturity; June to September



Stonecrop, *Sedum oreades*, Crassulaceae, Yellow, Spoon shaped flowers; June to August



Anaphalis, *Anaphalis royleana*, Asteraceae, White flower heads; June to August



River Beauty, *Epilobium latifolium*, Onagraceae, Flowers are rose purple or dark pink or pale pink; July to October



Pearly everlasting, *Anaphalis triplinervis*, Asteraceae, White ray florets with yellow disk; June to September



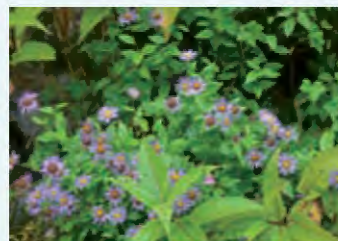
Wild celery, *Angelica archangelica*, Apiaceae, White flowered umbels; May to September



Fading Himalayan Aster, *Aster albescent*, Asteraceae, White ray florets with yellow disk; June to September



Chervil, *Chaerophyllum acuminatum*, Apiaceae, White flowered umbels; June to August



Creeping aster, *Aster diplostaphioides*, Asteraceae, Orange disk florets with purplish tips; June to August



Cow Parsnip, *Heracleum candicans*, Apiaceae, White flowered umbels; June to August



Himalayan daisy, *Cremanthodium arnicoides*, Asteraceae, Bright yellow flower heads with black disk; June to September



Milky Parsley, *Selinum wallichianum*, Apiaceae, White flowered umbels; June to September



Himalayan fleabane, *Erigeron multiradiatus*, Asteraceae, Dark to pale purple flower heads; August to September



Showy Inula, *Inula grandiflora*, Asteraceae, Golden yellow flower heads; Late June to September



Long leaved lettuce, *Lactuca dolichophylla*, Asteraceae, Pale purple or bluish flowers; July to October



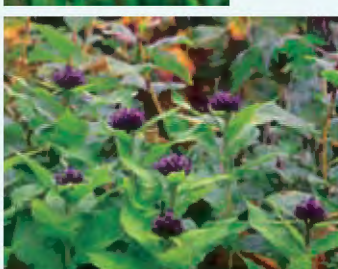
Stem clasp ligularia, *Ligularia amplexicaulis*, Asteraceae, Bright golden yellow flower heads; July to September



Himalayan blue-sow thistle, *Prenanthes brunoniana*, Asteraceae, Drooping blue, purplish white, pink flower heads; August to Late October



Viola leaved blue-sow thistle, *Prenanthes violaeifolia*, Asteraceae, Drooping blue or pale purple flower heads; Late August to October



Saussurea, *Saussurea auriculata*, Asteraceae, Purplish flower heads; August to Late October



Brahma Kamal, Sacred Lotus, *Saussurea obvallata*, Asteraceae, Purple flower heads with pale yellow boat shaped papery bracts; June to September



Saussurea piptathera, Asteraceae, Purple flower heads with corymb inflorescence; July to September



Ground Sel, *Senecio graciliflorus*, Asteraceae, Yellow flower heads; June to October



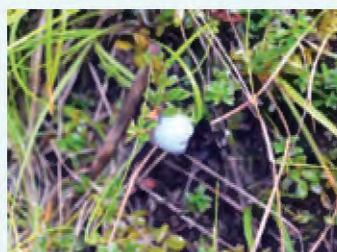
Rag wort, *Senecio laetus*, Asteraceae, Yellow flowers on corymb inflorescence; June to September



Golden rod, *Solidago virgaurea*, Asteraceae, Bright yellow flower heads; June to September



Large bell flower, *Campanula latifolia*, Campanulaceae, Blue purple, bell shaped flowers; June to August



Creeping Snow berry, *Gaultheria trichophylla*, Ericaceae, Orange coloured bell shaped flowers with fluorescent blue fruits; June to September



Spurred Gentian, *Helenia elliptica*, Gentianaceae, Pale blue flowers; July to October



Baby blues,
Eritrichium canum,
Boraginaceae, Bell
shaped pale flowers
with silky hairy calyx;
June to August



Hooked stickseed,
Heckelia uncinata,
Boraginaceae, Blue
or White flowers;
June to August



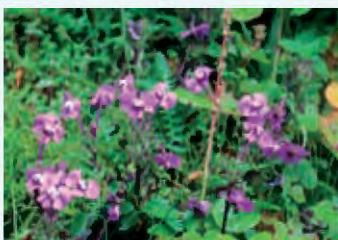
Dodder, Sky creeper,
Cuscuta reflexa,
Cuscutaceae, Cup
shaped, Ivory white
to pale pink flowers



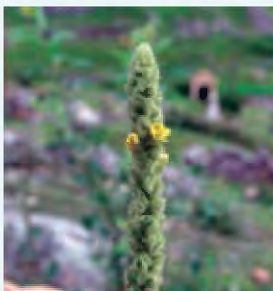
Apple of Peru,
Nicandra physalodes,
Solanaceae, Bell
shaped, blue or pale
violet with white
center; June to
September



Horned lousewort,
Pedicularis bicornuta,
Scrophulariaceae,
Pleasant yellow
flowers; July to
August



Kashmir lousewort,
Pedicularis punctata,
Scrophulariaceae,
Pink flowers with
white spot at the
throat; August to
October



Aarons rod,
Verbuscum thapsus,
Scrophulariaceae,
Yellow flowers on
woolly rod like
spikes; January to
July



Deep-blue curved
bells, *Strobilanthes*
atropurpureus,
Acanthaceae, Purple
or lilac flowers; June
to August



Shrubby mint,
Elsholtzia fruticosa,
Lamiaceae, Fragrant
dull white flowers;
July to October



Erect catmint,
Nepeta erecta,
Lamiaceae, Purple
or pale mauve
flowers; June to
August



Linear leaved thyme,
Thymus linearis,
Lamiaceae, Bright
purple crowded
flowers; May to
September



Himalayan
fleeceflower, *Bistorta*
affinis,
Polygonaceae, Pale
to deep pink densely
crowded flowers;
June to September



Bilberry plant,
Bistorta vacciniifolia,
Polygonaceae, Pink
clustered flowers;
July to September



Mountain Sorrel,
Oxyria dygina,
Polygonaceae,
Green tinged with
pink flowers; June to
August



Himalayan knotweed, *Polygonum polystachyum*, Polygonaceae, Fragrant white tinged with pink flowers in spreading panicle; July to September



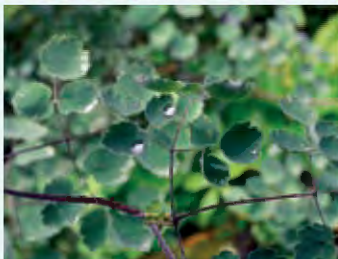
Euphorbia, *Euphorbia pilosa*, Euphorbiaceae, Bisexual flowers, Cup shaped involucre bracts; May to September



Purple Roscoe lily, *Roscoe purpurea*, Zingiberaceae, Lilac purple flowers; June to August



Jacquemont's cobra lily, *Arisaema jacquemontii*, Araceae, Long green with white banded spathe; June to July



Maiden hair fern, *Adiantum* spp., Pteridaceae, Dark green cut shaped, serrated leaves



Falconer's Thistle, *Cirsium falconeri*, Asteraceae, Spherical, cream coloured flower heads with triangular leaves with pale spines; August to September



Leafy Meadow-Rue, *Thalictrum foliolosum*, Ranunculaceae, Yellowish white, tinged with pink flowers borne on foam like sprays



Barbed Forget-Me-Not, *Cynoglossum wallichii*, Boraginaceae, Flowers are blue to bluish-white; May to August



Himalayan teasle, *Dipsacus inermis*, Caprifoliaceae, Funnel – shaped, creamy white flower heads; June to September



Thomson's Rush, *Juncus thomsonii*, Juncaceae, Brown or white flowers borne one globular head with protruded stamens; June to September



Lady fern, Pteridaceae,



Maple, *Acer* spp., Sapindaceae, Coppery coloured leaves



Ostrich fern, *Matteuccia* spp., Onocleaceae, Circular clump of fronds



Nepal knotweed, *Persicaria nepalensis*, Polygonaceae, Light pink-blue flowers borne on corymb



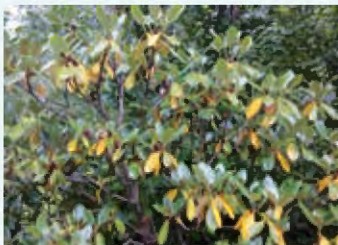
Common polypody,
Polypodium vulgare,
Polypodiaceae,
Fronds with
triangular leaflets
having sori on their
lower side



Woundwort, *Prunella vulgaris*,
Lamiaceae,
Two lipped flowers
having purple upper
lip and white lower
lip



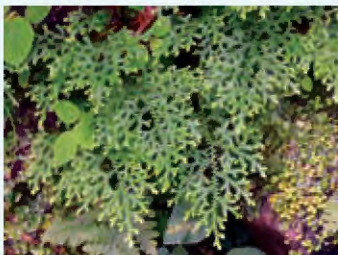
Himalayan rhubarb,
Rheum australe,
Polygonaceae, Dark
reddish-purple
flowers borne on
dense clusters



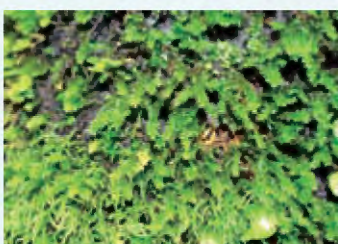
Rhododendron,
Rhododendron spp.,
Ericaceae, Scarlet
red or pink flowers
borne on clusters;
Early summer



Royal Fern,
Osmunda regalis,
Osmundaceae,
Flowering fern



Selaginella,
Selaginella spp.,
Selaginellaceae



Sphagnum moss,
Sphagnum papillosum,
Sphagnaceae



Melissa leaf
woundwort, *Stachys melissifolia*,
Lamiaceae, Reddish
pink flowers on
spike; June - August



Elegant desmodium,
Desmodium elegans,
Fabaceae, Pink or
pale lilac long
loosely arranged
flowers in terminal
inflorescence; June
to September



Himalayan mint
shrub, *Colquhounia coccinea*,
Lamiaceae, Red
tubular flowers borne
in terminal spikes;
August to September



Himalayan fir, *Abies pindrow*,
Pinaceae,
Evergreen leaves



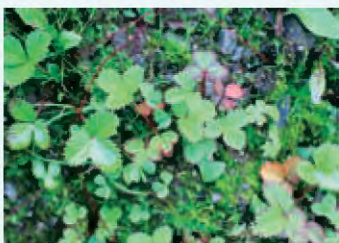
Vine leaved
anemone, *Anemone vitifolia*,
Ranunculaceae,
White flowers; July to
September



Himalayan clematis,
Clematis connata,
Ranunculaceae, Bell
shaped pale yellow
flowers; August to
October



Bellwort, *Codonopsis rotundifolia*,
Campanulaceae,
Sweet scented, Bell
shaped pale yellow
flowers; July to
August



Strawberry, *Fragaria nubicola*, Rosaceae, White flowers; June to August



Long-Stem Thorowax, *Bupleurum longicaule*, Apiaceae, Blackish brown flowers; June to September



Edgeworth's Figwort, *Scrophularia edgeworthii*, Scrophulariaceae, Stigma remain inside the flowers



Garhwal Reedgrass, *Calamagrostis emodensis*, Poaceae, Panicle is pale or faintly tinged with purple; July to September

While the above two trekking routes are most famous among the trekkers, a new route has been reopened after 45 years. The starting point of this trek is at Bankund for which one needs to cross the Ghangaria. This is a continuation of the Alaknanda - Ghangaria Trek but passes along a rich natural landscape that has been missed for many years. At Ghangaria, trekkers need to set up camp at Palsi Udiyar and cross the Kunth khal Pass the next day. Further journey takes us to Hanumanchatti along the Badrinath Road. This would be the stop that gives us the best ever view of the Valley of Flowers National Park and the Nilgiri Peaks. It certainly would be a sight and an experience of a lifetime.

Best time to visit

The whole region has the temperate and alpine kind of climate characterized by long severe winters and short cool summers. Depending on the season, the VoF takes different forms, each unique with their own visual and aesthetic offerings. During the winters, the valley remains completely covered under snow and is the best time to visit if we are looking for the magnificent view of the glacial peaks. However, if we want to experience the valley in its full bloom, the months between July and September are the most preferable. The swaying flowers, the rhythmic

TREKKING EXPERIENCES



The trekking experience to the valley of flowers (VoF), is unarguably the most beautiful trek available in India. This appears to be the true paradise of the planet, which offers beautiful panoramic vistas of various indigenous flora and it has to be in the bucket list of everyone who loves nature.

– Vijay Rakesh Reddy, S.



Flower Valley is a wonderland filled with beautiful of diverse endemic flora bounded by gorgeous landscapes. It's an incredible habitat where one can observe harmony between flora and fauna interlocked with mighty Himalayas.

– Varun Hiremath



It's a mesmerizing travel experience. Anyone with the zeal for acquaintance with nature could accomplish this challenging task. Valley of Flowers trek experience would enlighten the true feeling of traveling.

– Lakshmi Pathy, M.

gurgle of the Pushpavati, and the chirps and creeks of the wildlife around will easily get us into a trance.

How to reach

The Valley of Flowers is remotely located in the Chamoli District in Uttarakhand. The trip starts by reaching Rishikesh from Delhi. For logistic reasons most of the trekkers pass through Delhi. It is followed by an 11 hours bus/jeep journey from Rishikesh to Joshimath. Then, 1 hour bus/jeep ride from Joshimath to Govindghat. The last motorable stop to the Valley of Flowers is at Govind ghat and from then, it's a walk on foot. It's a 14 km trek from Govindghat to Ghangria, along the river Lakshman Ganga. This is the most difficult part of the trek, but also an enjoyable part of the trip. However, there are few porters (manual carriers/Mule carriers) are available for transportation of our luggage. Availing this facility would free us from heavy baggage and allows us to enjoy the nature endlessly. From the base camp Ghangria, the Valley of Flowers is a 3-4 km climb, where one has to go daily and come back the same day. The satellite picture enclosed here could give a rational idea about the location, altitude and the route for the fairy land.

Floral diversity

The alpine meadows of VoF are well known for their endemic flora and fauna. It harbours 520 vascular plant species; of these, 500 species are flowering plants. Some of the most colourful of flowering plants in this part of the valley include the Pedicularis, Pink Primulas, purple Campanulas, Golden Lily, Erigerons, creamy Anemones, the rare white Androsace, large purple Asters, the rosy-petalled Cypripedium, Green and chequered Fritillaries, *Morina longiflora*, Pink Geraniums, purple, blue and yellow Pansies, indigo-coloured Nomochairs, the Himalayan Blue Poppy, white and red Potentillas, dwarf Rhododendrons - Buransh, golden lily, Primulas in pink and blue and the deepest purple, pink Epilobium, Ranunculus, Bistorta and the heavily perfumed Brahma Kamal. Besides, the alpine meadows are the repository of valuable medicinal and aromatic plants (Table 1).

For further interaction, please write to:

Vijay Rakesh Reddy, ICAR-Central Institute for Arid Horticulture, Bikaner.

Indigenous potential ornamental flowering plants of Himachal Pradesh

Himachal Pradesh has 66% of the total geographical area as recorded forest area. Varying climatic and adaphic conditions have resulted in rich plant diversity in the state. One of the prospective uses of floristic diversity is the aesthetic value which can be utilized for the livelihood generation in the rural areas. Number of studies have been made to document the floristic wealth of the state. However, potential value wild plants species for ornamental purpose are not aptly highlighted. Therefore, in this article an endeavour has been made to list out potential wild plant species which can be exploited for ornamental purpose in near future. Different aspects of these wild plants should be thoroughly studied for their suitability as commercial ornamental crop.

THE state of Himachal Pradesh covers an area of 55,673 sq. km in the north-western corner of India between 75°-79° N longitude and 28°-33° E latitude. It is surrounded by Jammu and Kashmir in the north, Tibet in the east, Uttar Pradesh in the south-east, Haryana in the south and Punjab in the west. The state can be divided into southern and northern regions. Southern region is hot as plains of Punjab. Northern region has a temperate summer and winter with extreme cold and heavy snow fall. The state has 12 districts.

Himachal Pradesh has undulating topography, varying degrees of altitude ranging from 450 m to nearly 7000 m, subtropical to subarctic climate. It has resulted varied rich vegetation from delicious to alpine meadows and cold deserts. The vegetation of Himachal Pradesh is classified into five categories, viz. Tropical (below 1000 m), Subtropical (1800-2000 m), Temperate (1800-3500 m), Subalpine (3500-4000 m) and Alpine (above 4000 m).

Owing to varied climatic and physiographic condition, state has variety of floristic wealth. The state has immense potential for ornamental wild flowers which can be identified, screened and to develop suitable propagation technique for their mass propagation. Inaccessible terrain is major hurdle for exploration of these potential wild flowers. In this chapter, an attempt has been made to list out the potential wild flowers of the Himachal Pradesh which can be further studied for the potential utilization.



Forest scenario of Himachal Pradesh

The state has recorded forest area of 37,033 km², which is 66.52% of its geographical area. The reserve, protected and unclassified forests are 5.13%, 89.46% and 5.41% respectively of the recorded forest area. The forest cover in the state is 15,100 km² which is 27.12% of the total geographical area of the state. On the basis of density classes, 3,110 km² is under very dense forest, 6,705 km²

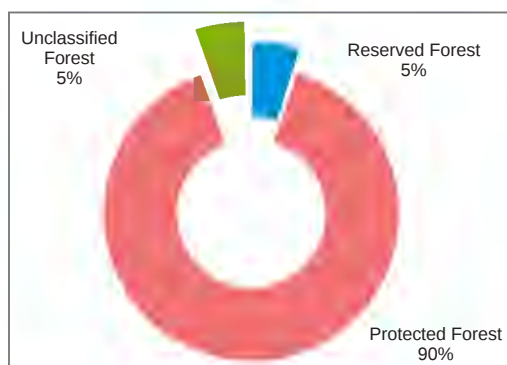
under moderately dense forests and 5,285 km² under open forest.

Flowering plants diversity of Himachal Pradesh

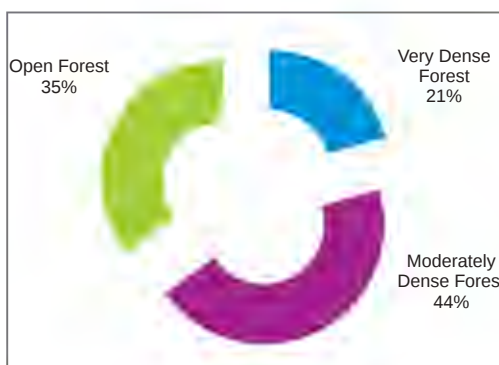
The different forest types of Himachal Pradesh exhibit vast plant diversity due to its diverse topography, soil, climate and geographical location. Studies on the floristic and vegetation of Himachal Pradesh have been made by various workers. The floristic analysis of Himachal Pradesh flora reveals that though dicotyledons dominate the flora, the monocotyledonous family Poaceae is the largest family in the area with 105 genera and 350 species.

Threatened species

A large number of species have been threatened and become rare or vulnerable to extinction due to various biotic and abiotic causes of which deforestation and overexploitation of plant species are the most important factors. Some of the rare and threatened species of the Himachal Pradesh are *Aconitum heterophyllum*, *Allium*



Per cent reserved, unclassified and protected forest area of Himachal Pradesh



Canopy density-wise forest cover of Himachal Pradesh

gums, resins, spices etc.

One of potential use of the diversity of flora is the ornamental flowering plants. The adoption of such wild ornamental plant species will not enrich our ornamental collection but also improve socio-economic condition of the people of Himachal Pradesh. Some of the important wild ornamental occurring are the species of *Anemone*, *Aster*, *Arisema*, *Berberis*, *Mahonia*, *Begonia*,

stracheyi, *Anemone tetrasepala*, *Angelica glauca*, *Arnebia euchroma*, *Astragalus nunori*, *Balanophora involucrata*, *Betula utilis*, *Ephedra gerardiana*, *Holboelia latifolia*, *Nardostachys jatamansi*, *Picrorhiza kurrao*, *Podophyllum hexandrum*, *Rheum australis*, *Valeriana jaeschkei* etc.

Potential ornamental flowering plants of Himachal Pradesh

Flowering plants provide variety of useful products for people of Himachal Pradesh to support their livelihood. Immense diversity of flowering plants gives not only ecological services but also contributes towards economic terms as source of timber, vegetable oil, food, medicine,

Capparis, *Erigeron*, *Hedera*, *Chrysanthemum*, *Hedychium*, *Hypericum*, *Inula*, *Impatiens*, *Iris*, *Primula*, *Trillidium*, *Rosa*, *Potentilla* etc. List of some of potential wild flowering plants species of Himachal Pradesh which can be domesticated for future ornamental value is given in the table 1.

Conclusion

Himachal Pradesh has varied climatic and physiographic conditions. As a result of this, it has rich plant diversity which has been immensely utilized since time immemorial. Apart from other economic benefits from biodiversity, state has immense potential of the

Table 1. Potential wild ornamental flowers of Himachal Pradesh

Name of the Plant/Common Name/Family	Habit
<i>Acer acuminatum</i> /Rath Kanchula/Aceraceae	Tree
<i>Acer caesium</i> /Kanjula/Aceraceae	Tree
<i>Acer oblongum</i> /Pharbanji/Aceraceae	Tree
<i>Acer sterculiaceum</i> /Mandra/Aceraceae	Tree
<i>Aconitum ferox</i> /Mitha Bis/Ranunculaceae	Herb
<i>Aconitum heterophyllum</i> /Atis/Ranunculaceae	Herb
<i>Aconitum violaceum</i> /Meetha, Mithi, Patis/Ranunculaceae	Herb
<i>Aesculus indica</i> /Pangar/Hippocastanceae	Tree
<i>Albizia julibrissin</i> /Pink Siris/Mimosaceae	Tree
<i>Albizia lebbeck</i> /Kala Siris/Mimosaceae	Tree
<i>Albizia procera</i> /Safed Siris/Mimosaceae	Tree
<i>Allium humile</i> /Small Alpine Onion, Ornamental	Herb
<i>Allium</i> /Amaryllidaceae	
<i>Allium stracheyi</i> /Jamboo, Feren/Alliaceae	Herb
<i>Anaphalis contorta</i> /Eared-Leaf Pearly Everlasting/Asteraceae	Herb
<i>Anaphalis royleana</i> /Linear-Leaf Pearly Everlasting/Asteraceae	Herb
<i>Anaphalis triplinervis</i> /Woolly Pearly Everlasting/Asteraceae	Herb
<i>Androsace sarmentosa</i> /Common Rock Jasmine/Primulaceae	Herb
<i>Anemone obtusiloba</i> /Kanchphool, kakrya/Ranunculaceae	Herb

<i>Anemone polyanthes</i> /Many Flowered Anemone/Ranunculaceae	Herb
<i>Anemone rivularis</i> /Kakru, Mirchilee/Ranunculaceae	Herb
<i>Anemone tetrasperma</i> /Four Petal Anemone/Ranunculaceae	Herb
<i>Anemone vitifolia</i> /Mudeela	Herb
<i>Angelica glauca</i> /Smooth Angelica, Choru/Apiaceae	Herb
<i>Aquilegia pubiflora</i> /Himalayan Columbine/Ranunculaceae	Herb
<i>Arenaria festucoides</i> /Fescue Sandwort/Caryophyllaceae	Herb
<i>Arisaema tortuosum</i> /Whipcord Cobra Lily, Bagh Jandhra/Araceae	Herb
<i>Arnebia benthamii</i> /Himalayan Arnebia, Balchadi/Boraginaceae	Herb
<i>Aster albescens</i> /Lilac Himalayan Aster/Asteraceae	Herb
<i>Aster diplostaphioides</i> /Creeping Aster/Asteraceae	Herb
<i>Aster flaccidus</i> /Weak Violet Aster, Alpine aster/Asteraceae	Herb
<i>Bauhinia purpurea</i> /Kanchan/Caesalpiniaceae	Tree
<i>Bauhinia vahlii</i> /Mahul, Malu/Caesalpiniaceae	Climber
<i>Bauhinia vaiegata</i> /Kwiral/Caesalpiniaceae	Tree
<i>Begonia picta</i> /Pattharchatta/Begoniaceae	Herb
<i>Berberis asiatica</i> /Daruhaldi/Berberidaceae	Shrub
<i>Bistorta affinis</i> /Himalayan Fleeceflower, Himalayan knotweed/Polygonaceae	Herb
<i>Bistorta vacciniifolia</i> /Rose Carpet Knotweed/Polygonaceae	Herb
<i>Buddleja crispa</i> /Himalayan Butterfly Bush/	Shrub

Scrophulariaceae		Gerbera gossypina/Hairy Gerbera Daisy, Kupheru,	Herb
Caesalpinia decapetala/Kingari/Caesalpinaceae	Climber	Jhulu/Asteraceae	
Calanthe tricarinata/Monkey Orchid/Orchidaceae	Herb	Habenaria intermedia/Vridhhi, Riddhi/Orchidaceae	Herb
Caltha palustris/Marsh Marigold/Ranunculaceae	Herb	Habenaria pectinata/Comb Habenaria/Orchidaceae	Herb
Campanula argyrotricha/Campanula/Campanulaceae	Herb	Hedychium spicatum/Sandharlika, Kapur Kachri/	Herb
Campanula latifolia/Great Bellflower/Campanulaceae	Herb	Zingiberaceae	
Catunaregam spinosa/Mainphal/Rubiaceae	Shrub	Heracleum lanatum/Cow Parsnip/Apiaceae	Herb
Cephalanthera longifolia/Narrow Leaved Helleborine,	Herb	Holboellia latifolia/Gophla/Lardizabalaceae	Climber
Sword-Leaved Helleborine/Orchidaceae		Hoya longifolia/Hoya Orchidaceae	Climber
Cicerbita violaefolia/Viola-Leaved Blue Sow-Thistle/	Herb	Hypericum elodeoides/Himalayan St Johns Wort./	Herb
Asteraceae		Hypercaceae	
Cinnamomum tamala/TejpatLauraceae	Tree	Hypericum oblongifolium/Chitroi, Chaya/Hypericaceae	Shrub
Clematis barbellata/Kanrya, Santai/Ranunculaceae	Climber	Impatiens amplexicaulis/Clasping-Leaf Balsam/	Herb
Clematis buchananiana/Ghantiyali/Ranunculaceae	Climber	Balsaminaceae	
Clematis montana Kujju/Kaunia/Ranunculaceae	Climber	Impatiens glandulifera/Himalayan Balsam/	Herb
Codonopsis rotundifolia/Roundleaf Bellflower/	Climber	Balsaminaceae	
Campanulaceae		Impatiens racemosa/Chunchuri/Balsaminaceae	Herb
Colquhounia coccinea/Phulpat/Lamiaceae	Shrub	Impatiens roylei/Himalayan Balsam/Balsaminaceae	Herb
Corydalis cashmeriana/Kashmir Corydalis/	Herb	Impatiens scabrida/Ban-til/Balsaminaceae	Herb
Fumariaceae		Impatiens sulcata/Chaul, Kwal/Balsaminaceae	Herb
Corydalis cornuta/Balsam Jad/Fumariaceae	Herb	Impatiens thomsonii/Gad-chaul/Balsaminaceae	Herb
Corydalis govaniana/Govan's Corydalis/Fumariaceae	Herb	Indigofera heterantha/Sakina/Papilionaceae	Shrub
Corylus jacquemontii/Bhotiya Badam, Kabasi/	Tree	Inula grandiflora/Showy Inula/Asteraceae	Herb
Betulaceae		Inula orientalis/Showy Inula/Asteraceae	Herb
Cremanthodium arnicoides/Himalayan Daisy/	Herb	Inula royleana/Himalayan Elecampane/Asteraceae	Herb
Asteraceae		Iris kemaonensis/Kumaon/Irislridaceae	Herb
Cremanthodium ellisii/Kitam. Himalayan Mini	Herb	Jasminum arborescens/Navamallika/Oleaceae	Shrub
Sunflower/Asteraceae		Jasminum grandiflorum/Chameli/Oleaceae	Shrub
Crotalaria alata/Winged-Stem Rattlepod/Papilionaceae	Herb	Juniperus communis/Common Juniper/Cupressaceae	Shrub
Cupressus torulosa/Surai/Cupressaceae	Tree	Kydia calycina/Bharanga, Pula/Malvaceae	Shrub
Cyananthus lobatus/Trailing/Bellflower	Herb	Lactuca dissecta/Split-Leaf Lettuce/Asteraceae	Herb
Campanulaceae		Leonurus cardiac/Motherwort/Lamiaceae	Herb
Cypripedium cordigerum/Heart-shaped Slipper Orchid/	Herb	Leycesteria formosa/Himalaya Nutmeg/	Climber
Orchidaceae		Caprifoliaceae	
Cypripedium himalaicum/Himalayan Slipper Orchid/	Herb	Ligularia amplexicaulis/Stem Clasping Ligularia/	Herb
Orchidaceae		Asteraceae	
Delphinium brunonianum/Musk Larkspur/	Herb	Lilium polyphyllum/White Himalayan Lily, Kalihari/	Herb
Ranunculaceae		Liliaceae	
Delphinium cashmerianum/Jem/Ranunculaceae	Herb	Lonicera hypoleuca/Yellow Himalayan Honeysuckle/	Shrub
Delphinium denudatum/Jadwar, Judwar/	Herb	Caprifoliaceae	
Ranunculaceae		Malva pusilla/Round Leaved Mallow/Malvaceae	Herb
Delphinium vestitum/Juha, Kalulu/Ranunculaceae	Herb	Meconopsis aculeata/Vanita/Papaveraceae	Herb
Desmodium multiflorum/Sunsuni/Papilionaceae	Shrub	Morina coulteriana/Caprifoliaceae	Herb
Desmodium suberosa/Manura/Papilionaceae	Tree	Morina longifolia/Whorl flower/Caprifoliaceae	Herb
Desmodium elegans/Chamle/Papilionaceae	Herb	Nepeta govaniana/Yellow Catmint/Lamiaceae	Herb
Deutzia compacta/Compact Deutzia/Hydrangeaceae	Shrub	Nepeta laevigata/Smooth Catmint/Lamiaceae	Herb
Dubyaea hispida/Bristly Dubyaea/Asteraceae	Herb	Origanum vulgare/Oregano, Wild Marjoram, Ban	Herb
Epilobium latifolium/River Beauty/Onagraceae	Herb	Tulsi/Lamiaceae	
Erigeron multiradiatus/Himalayan fleabane/Asteraceae	Herb	Ougeinia oojeinensis/Sandan/Papilionaceae	Tree
Erythrina suberosa/Dhaul dhak/Papilionaceae	Tree	Paeonia emodi/Chandrain/Paeoniaceae	Herb
Eurya acuminata/Chopdi, Chenu/Theaceae	Tree	Paraquilegia microphylla/Himalayan Spurless	Herb
Fritillaria imperialis/Kaiser's Crown/Liliaceae	Herb	Columbine/Ranunculaceae	
Fritillaria roylei/KakoliLiliaceae	Herb	Pavetta indica/Kathachampa/Rubiaceae	Shrub
Gaultheria nummularioides/Coinwort Snowberry/	Herb	Pedicularis bicornuta/Horned Lousewort/	Herb
Ericaceae		Orobanchaceae	
Geranium nepalense/Nepal Geranium/Geraniaceae	Herb	Pedicularis hoffmeisteri/Haldya Phool/	Herb
Geranium pretense/Meadow Geranium/Geraniaceae	Herb	Orobanchaceae	
Geranium wallichianum/Kaphla/Geraniaceae	Herb	Pedicularis porrecta/Paired Flower Lousewort/	Herb



1. *Cyananthus lobatus* 2. *Pedicularis porrecta* 3. *Campanula latifolia* 4. *Saxifraga brachypoda* 5. *Meconopsis aculeata* 6. *Anaphalis royleana* 7. *Aster diplostephioides* 8. *Primula edgeworthii* 9. *Primula denticulata*

Orobanchaceae

Pinus roxburghii/Chir Pine/Pinaceae

Tree

Pinus wallichiana/Blue Pine/Pinaceae

Tree

Pistacia integerrima/Kakru/Anacardiaceae

Tree

Podophyllum hexandrum/Himalayan May Apple,

Herb

Ban Kakri/Berberidaceae

Polygonatum verticillatum/Maida, Whorled Solomon's Seal/Asparagaceae

Herb

Potentilla atrosanguinea/Himalayan Cinquefoil/Rosaceae

Herb

Potentilla cuneata/Five Finger Cinquefoil/Rosaceae

Herb

Prenanthes brunoniana/Himalayan Blue Sow-Thistle,

Herb



1. *Bistorta vacciniifolia* 2. *Erigeron multiradiatus* 3. *Geranium wallichianum* 4. *Pedicularis bicornuta* 5. *Origanum vulgare* 6. *Morina longifolia* 7. *Potentilla cuneifolia* 8. *Silene vulgaris* 9. *Potentilla atrosanguinea*

Himalayan Rattlesnake Root/Asteraceae

Primula denticulata/Drumstick Primrose/Primulaceae Herb

Primula edgeworthii/Edgeworth's Primrose/
Primulaceae Herb

Primula floribunda/Buttercup Primrose/Primulaceae Herb

Primula macrophylla/Large Leaf Primrose/Primulaceae Herb

Primula rosea/Himalayan Meadow Primrose/
Primulaceae

Herb

Primula stuartii/Stuart's Primrose/Primulaceae

Herb

Prunus cerasoides/Padam/Rosaceae

Tree

Ranunculus diffusus/Spreading Buttercup/
Ranunculaceae

Herb

<i>Ranunculus hirtellus</i> /Simariya, Piryali/Ranunculaceae	Herb
<i>Ranunculus sceleratus</i> /Shim/Ranunculaceae	Herb
<i>Reinwardtia indica</i> /Phiyunli/Linaceae	Shrub
<i>Rhododendron anthopogon</i> /Dwarf Rhododendron, Talis/Ericaceae	Herb
<i>Rhododendron arboreum</i> /Buransh/Ericaceae	Tree
<i>Rhus parviflora</i> /Dhamila/Anacardiaceae	Tree
<i>Rosa macrophylla</i> /Himalayan Rose/Rosaceae	Shrub
<i>Rosa sericea</i> /Jangali Gulab, Dhurkunja/Rosaceae	Shrub
<i>Saxifraga brachypoda</i> /Spiny Leaf Saxifrage/Saxifragaceae	Herb
<i>Senecio chrysanthemoides</i> /Cheerful Senecio/Asteraceae	Herb

<i>Senecio grandiflorus</i> /Purple Ragwort/Asteraceae	Herb
<i>Senna floribunda</i> /Bari Kapasi/Caesalpinaceae	Shrub
<i>Silene indica</i> /Indian Champion/Caryophyllaceae.	Herb
<i>Silene vulgaris</i> /Bladder Champion/Caryophyllaceae	Herb
<i>Skimmia anquitilia</i> /Nair, Kedarpoti/Rutaceae	Climber
<i>Strobilanthes atropurpureus</i> /Deep-Blue Curved Bells/Acanthaceae	Shrub
<i>Thymus linearis</i> /Himalayan Thyme, Wild Thyme, Jangli Ajwain/Lamiaceae	Herb
<i>Toona ciliata</i> /Tun/Meliaceae	Tree
<i>Trachycarpus fortunei</i> /Windmill Palm/Arecaceae	Shrub
<i>Trollius acaulis</i> /Dwarf Globe Flower/Ranunculaceae	Herb
<i>Woodfordia fruticosa</i> /Dhawai/Lythraceae	Shrub

ornamental flowering plants. There are potential flowering tree, shrub, climbers, lianas and herbs which are to be collected and domesticated for their ornamental values. There are number of species due to their declining population require immediate attention for their conservation and mass multiplication. Micropropagation techniques may play vital role in the development of protocol of such threatened species for conservation and future utilization. There is so much variation in the flowering pattern of potential species which should be studied. Enhancement of flowering of the potential

flowering species is the one of the importance area to be undertaken immediately. In this endeavour, genetic improvement of these species will pay vital role. It will not improve the quality and quantity of the species but also enhance the socio-economic condition of the rural population of the Himachal Pradesh.

For further interaction, please write to:

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Textbook of *Field Crops Production* – Foodgrain Crops



(Volume I)

The first edition of Textbook of Field Crops Production was published in 2002 and there has been a heavy demand for the book. This book is now being brought out in two volumes. The chapters cover emerging trends in crop production such as System of Rice Intensification (SRI), export quality assurance in the production technology of commodities like Basmati rice, organic farming, resource conservation technologies, herbicide management etc. Good agronomic practices must judiciously inter-mix the applications of soil and plant sciences to produce food, feed, fuel, fibre, and of late nutraceuticals while ensuring sustainability of the system in as much possible environment and eco-friendly manner. The advent of hydroponics, precision farming, bio-sensors, fertigation, landscaping, application of ICT, GPS and GIS tools, micro-irrigation etc. is in the horizon. The textbook covers both the fundamentals of the subject and at the same time inspire and prepare both teachers and students for the emerging frontiers.

TECHNICAL SPECIFICATIONS

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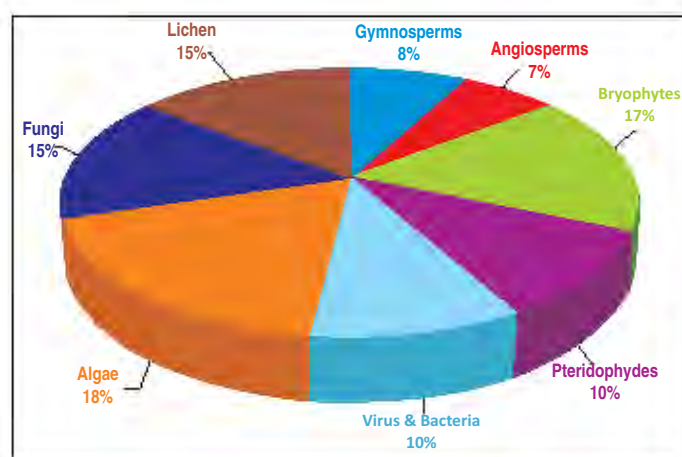
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Conserve to utilize the wild ornamental plants for ecosystem health and aesthetics

Global biodiversity maintains human and environmental health, and ensures food security. It is estimated that 5-50 million species of living forms exist on the earth, and only 1.7 million have been identified so far, that includes 427,205 species of green plants, fungi, bacteria and viruses; 61,917 species of vertebrates and protochordata and 1,232,490 species of invertebrates including protista.

WITH only 2.4% of the land area, India accounts for 7-8% of the recorded species of the world. Comparative account of recorded number of plant species in India and the world is given in Fig. 1. Two-thirds of the world's plant species are in danger of extinction due to pressure from the human population explosion, habitat loss by deforestation, over-exploitation of wild resources, introduction of exotic alien species, pollution and the adverse impact climate change. Global Status Report in 2017 (<https://www.worldgbc.org>) demonstrated that nature is declining globally at rates unprecedented, with up to 1 million species threatened with extinction, more than at any other time in human history. The natural resources, including biodiversity provide several intangible benefits, including aesthetics that allows behavioral changes in the living organism, particularly the humans. Be it orchids or conifers that transform and radiate the attractive richness of an ecosystem, do have ethical values in maintaining the ecosystem health. Thus, the wild ornamentals stand apart, both upon ecologically and socio-culturally.



Total number of plants in different categories (%) in India with respect to global Plant numbers
(Source: Floral Statistics of India, 2018)

Scope of Indian wild ornamental plants

Our indigenous floristic wealth proclaims significance and is deeply involved in our culture, literature, socio-economic life, romance and poetry. It would be very interesting, but a bit precarious task to incorporate such ornamental wild plants and flowers in which we may have natural lead, in the floriculture trade. The prime source of introduction of these plants are Botanical Gardens, which can very well coordinate exchange of seeds and plant materials within the country and abroad. Organized expeditions and more important individual botanists, gardeners and connoisseurs should collect such plants, which are not available commercially and found in nature only.

The ornamental plants, which are under usage in floriculture and landscaping presently hail from Europe and have endless list. The most prominent genera under cultivation as ornamentals are Rosa, Chrysanthemum, Gladiolus, Orchids, Dianthus, Gerbera *etc.* It will therefore necessitate a network of Botanical Gardens and good liaison within the subcontinent as well as abroad. Such plants can be collected from the wild, introduced, acclimatised at different altitudinal zones, multiplied and made available for distribution and sale to the nurserymen. Studies on their phenology and various floricultural parameters will be of utmost importance for these plants. Some of the explorations in Meghalaya and Punjab have listed a fair number of wild plants of horticultural importance. Recently, about 153 wild ornamental plant species were collected from various habitats of Palakonda hills in Eastern Ghats of Andhra Pradesh, India and categorized based on the attractiveness of flower (colour), habit and with various plant parts; it was found that white colour was dominant with 32 species, followed by yellow with 19 species, pink and purple each with 13 species, green and red each in 6 species, blue, 5 species and rose 4 species. Fifty five species however were of mixed colored flowers.

Essence of biodiversity conservation hot spots

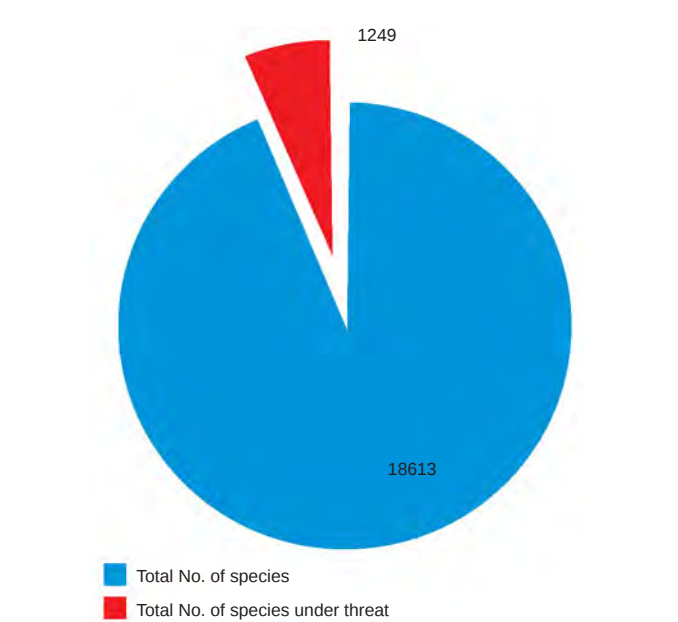
The Indian flora are mainly concentrated in three major centers of floristic diversity viz., the Himalayas, the Western Ghats and Andaman and Sundaland (Nicobar Islands) which are part of four of the 34 identified ‘global biodiversity hotspots’. IUCN (International Union for Conservation of Nature and Natural Resources) mainly emphasize on the plants that are endemic (to India) and/or in the rare, endangered and threatened (RET) category. In India, it is estimated that nearly 15-20% of total vascular flora i.e. 2,500 species of plants are under various degrees of endangerment. During the next 30-40 years, above 60,000 plants will face threats to their survival or even become extinct. Most of them could have been of great value to the humankind for various purposes such as economic, medicinal or ornamental. In addition, the country is one of the very important Vavilovian Centers of biodiversity and can boast of 45,944 species, which accounts for 10.75% of the known world plants. Of the 18,000 species of flowering plants (angiosperms), 36% are endemic and located in 26 endemic centers.

In India, a network of 668 protected areas has been established comprising 102 national parks, 515 wildlife sanctuaries, 47 conservation reserves and 4 community reserves. The total protected area is about 0.20 million km² (about 4.9% of the geographical area). In addition, sanctuaries in Tura range in Garo Hills of Meghalaya for the conservation of Rhododendrons and orchids in Sikkim have been established. About 96 different species of orchids are found in Simlipal National Park of Odisha and 150 different species of orchids are conserved in the Buxa Tiger Reserve of West Bengal. Also the country has 7 world heritage sites, one mixed world heritage sites and 26 Ramsar wetlands, that too add beautiful aesthetics.

Decline in aesthetic floral biodiversity

Among the flowering plants reported from India, one-third is considered endemic in the Western Ghats. Many of these endangered ornamental species, including some orchids, which possess medicinal properties urgently, require to be conserved on priority basis. About 1,220 species of orchids have been reported from India, among which 300 species are rare, 150 are endangered and ornamental and 37 are of medicinal importance. Paste of leaves of endangered Red vanda (*Renanthera imscootiana*) can treat skin diseases. Flower juice of endangered blue vanda (*Vanda coerulea*) generally used as eye drops for controlling glaucoma, cataract and blindness and leaves can be used as an expectorant.

The Neelgiri (Blue Mountains) hills of South India are named after *Strobilanthes kunthianus*, locally known as Neelakkurinji, those flowers in profusion once in 12 years. This genus is monocarpic in nature and bears extremely beautiful flowers. The dying out of these species subsequent to flowering produces enormous combustible material within and around



Threat status of flowering plants in India (Source: Floral Statistics of India, 2018)

shola forests, which are very susceptible to forest fires, occurrences of fire in these Shola forests burn the seeds and hence it may cause extinction of narrow endemics. The wild relatives of these plants contribute to the vast genetic resources for their varietal improvements and genetic manipulations. While hundreds of Indian wild plants from north-east India have found their way into many ‘European Botanic gardens, where they have been much appreciated. A few such remarkable examples from North-West Himalaya are *Impatiens glandulifera*, *Morina longifolia*, *Potentilla nepalensis*, *Meconopsis robusta*, *Primula denticulata*, *Paris polyphylla*,

Table 1. A few threatened and endemic orchids of Sikkim and their altitudinal distribution

Species	Altitudinal range	Habitat status
<i>Bulbophyllum trichocephalum</i> var. <i>capitatum</i> S.Z. Lucksom	800-1000 m	Lithophytes
<i>Calanthe anjanii</i> S.Z. Lucksom	2000-2500 m	Terrestrial
<i>Calanthe keshabii</i> S.Z. Lucksom	2000-2600 m	Terrestrial
<i>Coelogyne pantlingii</i> S.Z. Lucksom	2100-2500 m	Epiphytes
<i>Malaxis saprophyta</i> (K&P) Tang & F.T. Wang	1200 m	Terrestrial
<i>Cymbidium whiteae</i> King & Pantling	800-2000 m	Epiphyte
<i>Goodyera dongchenii</i> S.Z. Lucksom	2000-2300 m	Epiphyte
<i>Gastrochilus sonamii</i> S.Z. Lucksom	2300-2700 m	Epiphyte
<i>Liparis chungthangensis</i> S.Z. Lucksom	1800-2000 m	Lithophytes
<i>Liparis lydiaii</i> S.Z. Lucksom	1000-1300 m	Epiphyte
<i>Liparis pygmaea</i> King & Pantling	4350 m	Lithophytes
<i>Oberonia kingie</i> S.Z. Lucksom	1000 m	Epiphyte

Polygonatum verticillatum, *Eremurus himalaicus*, *Rosa brunonii*, *Lloydia serotina*, *Tulipa stellata* and some genera C; Y-orchids like *Bulbophyllum*, *Coelogyne*, *Cymbidium*, *Cypripedium*, *Dendrobium*, *Paphiopedilum* etc. With unabated degradation of natural resources, the wild ornamental plants are also under continuous threat, whereby their population status decline. As an example, a list of such species are given in Table 1.

Way Forward

The conservation and sustainable uses of wild resources is essential for ensuring environmental sustainability for the future generations. While some of the threatened factors like fast rate of biotic interference, destruction of natural habitat by human interference, invasion of some exotic weeds and unsustainable utilization of natural resources may adversely affect the existing diversity of plants and eventually degrade the richness and value of floral biodiversity of aesthetic value. In addition, a policy framework for the conservation of old cultivars or heritage varieties of ornamentals needs to be formulated. Further, a coordinated effort is needed to conserve the germplasm of ornamental and amenity plants for better utilization.

The conservation and sustainable use of wild

species that may have potential for introduction as new ornamental crops or as sources of genetic material that can be used in the development of existing crops, needs a much more coherent strategy than at present exists. This should be implemented at a national level and cover areas such as:

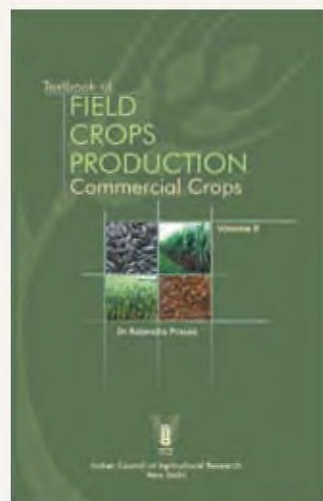
- Surveying at national level of the various holdings, both in cultivation and in seedbanks, of the different categories of species of ornamental or amenity value; An assessment of the conservation status and needs of these resources
- Identification of priority species or other taxa in need of urgent conservation action; Assessment of the role of protected areas for the *in situ* conservation of target ornamental species
- The capacity of germplasm banks, botanic gardens and other institutions for the exploration and maintenance of genetic resources of ornamentals. The role of the nursery for developing agro-technologies and trade in the conservation of ornamentals.

For further interaction, please write to:

Akanksha Rastogi, NMSHE-Task Force on Himalayan Agriculture, Indian Council of Agricultural Research, New Delhi.

Textbook of Field Crops Production – Commercial Crops

(Volume II)



Availability of high-yielding varieties/hybrids and increased irrigated facilities have resulted in the development of production-intensive cropping systems in several parts of India, and this has catalyzed further agronomic research based on the cropping-system approach. Many changes have also taken place in the crop-production technologies. And this necessitated the revision of the earlier publication brought out in 2002. The revised textbook is in two volumes: First is covering Foodgrains and second is on Commercial Crops.

The discipline of Agronomy has no longer remained mere field trials without application of discoveries emanating from the related disciplines of Genetics, Soil Science and Agricultural Chemistry, Plant Biochemistry, etc. The future Agronomy Landscape will face challenges of climate change, transboundary issues, TRIPS and other trade-related barriers, biotic and abiotic stresses, consequences of biotechnology and genetic engineering and increased market demands in terms of quality assurance, customized food crops, global competition, ecosystem services on land and social equities etc. The Agronomy must measure up to these futuristic challenges with well-defined metrics and methodologies for performance. The advent of hydroponics, precision farming, bio-sensors, fertigation, landscaping, application of ICT, GPS and GIS tools and micro-

irrigation is in the horizon. This revised edition in two volumes covers fundamentals of the subject and at the same time will inspire and prepare teachers and students for the emerging frontiers.

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Potential wild orchids in the genus *Vanda* from Western Ghats, India

Orchids are one of the most sought after ornamental plants. *Vanda* species of Orchidaceae and its hybrids are very well exploited in horticulture. The genus is distributed in India, South East Asia, southern China and Australia. Four ornamentally potential, wild species such as *Vanda testaceae*, *V. tessellata*, *V. thwaitesii* and *V. wightii* distributed in Western Ghats are discussed here. Two species *Vanda testaceae* and *Vanda tessellata* are widely utilised for making hybrids.

ORCHIDS, the members of family Orchidaceae are highly exploited in floriculture. The genus *Vanda* with about 80 species has a wide distribution in India, Himalaya, Southeast Asia, Indonesia, Philippines, southern China, and northern Australia. Several *Vanda* species and its hybrids are commonly cultivated for its showy, fragrant, long-lasting, and stunningly colourful flowers. More than five species are used in herbal medicine. *Vanda tessellata* is an ancient Indian remedy for rheumatic pain and Stilbenoids from *Vanda coerulea* are reported as anti-oxidant. *V. tessellata* is also reported to be aphrodisiac. The name 'Vanda' is derived from the Sanskrit name 'Vandaka' of *Vanda tessellata*.



Vanda tessellata

The genus has a monopodial growth habit with highly variable leaves in relation with its habitat. Some have flat, typically broad, ovoid leaves (strap-leaves), while others have cylindrical (terete), fleshy leaves and are adapted to dry period. Several attractive hybrids have been developed by crossing the species within the genus and also by crossing with other orchid genera. Many *Vanda* hybrids are very popular worldwide. Four ornamentally potential, little exploited, wild *Vanda* species from Western Ghats are described.

Vanda testaceae

This epiphytic plant grows in warm to cool climate. Stem is stout, woody, 10-20 cm long; leaves



Vanda testaceae



Vanda thwaitesii



Vanda tessellata

fleshy 9-15 × 1.5 cm, strap shaped and unequally lobed at the apex. Inflorescence is axillary, 20 cm long and having 6 to 10 laxly arranged flowers which are 1-1.5 cm across, petals narrowed towards the base and creamy yellow. Lip is yellowish with violet flush. Flowering is observed in March- April. This beautiful small *Vanda* is common in Western Ghats in a wide range of altitude. It is also distributed in NE India, Nepal, Myanmar, Sri Lanka and Thailand. Due to its horticultural value it is widely used for breeding and produced 13 hybrids, which were registered in Orchid Hybrid Registrar, Royal Horticulture Society, London.

Vanda tessellata

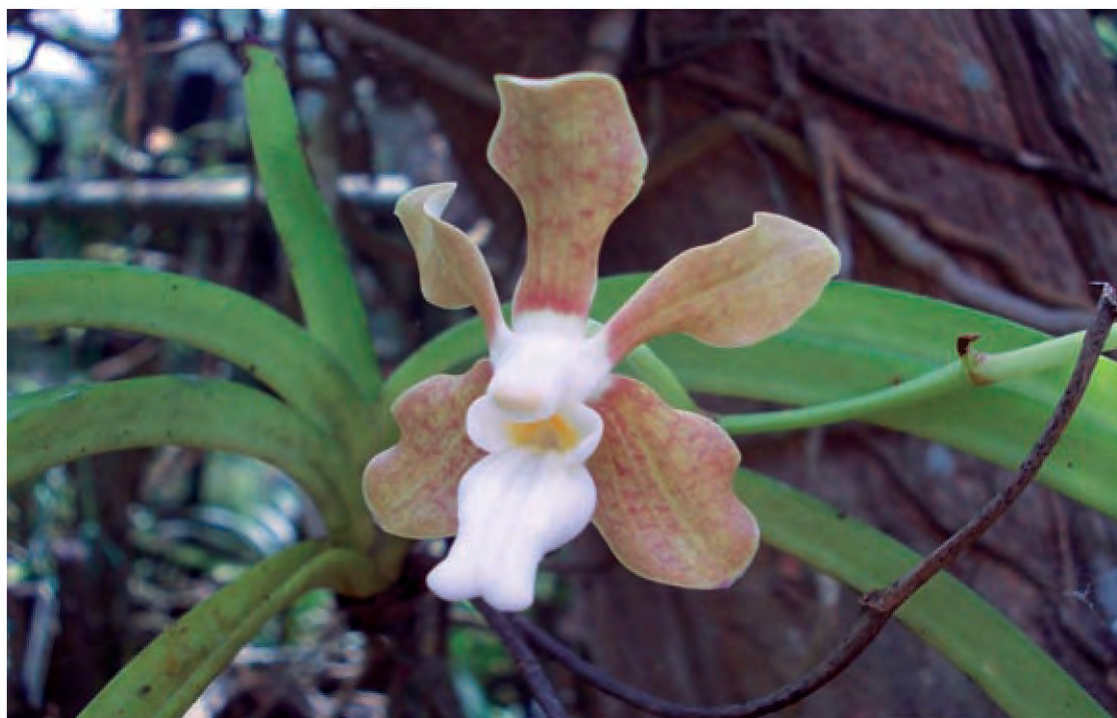
One of the most beautiful plants in the genus *Vanda*. *V. tessellata* is a sun loving woody stemmed epiphytic plant. Climbing stem with 30-60 cm long. The leaves are 15-20 cm long. The sub erect, 15-25 cm long inflorescence usually bear 4-5 flowers and some cases the number of flowers may increase up to 10. Flowers are large with 5 cm across having beautiful tessellation on sepals and petals. Rarely spotting is also seen. Usually the flowers are bluish or greyish green, with brown prominent tessellation. Several colour variants were reported from India and Sri Lanka. Flowering extended from April to May. Some plants show continuous flowering throughout the year.

Larger flowers with mild fragrance, tessellation on sepals and petals, bright colour of lip, free flowering nature and long lasting flowers are the major horticultural merits of this species. *Vanda tessellata* plays a leading component of *Vanda* breeding as male or female parent. About 200 hybrids have been so far registered using this species as one of the parents.

Vanda thwaitesii

Vanda thwaitesii was originally reported from Sri Lanka where it is now believed to be extinct. This *Vandas* species is distributed in the Western Ghats in the states of Kerala and Karnataka at an elevation of about 800 to 1,000 m. *V. thwaitesii* grows as an epiphyte in the moist deciduous to ever green forests. *Mangifera indica* and *Elaeocarpus tuberculatus* are the common host plants.

The plant is compact with short internodes. Stem 5-22 cm long, profusely rooting at base. Leaves are arched and apically bilobed, one of the lobes being sharply pointed. Flowers in an inflorescence are 1 to 3, pleasantly fragrant, 3-3.5 cm across. The flower colour is peculiar, ochre or dirty yellow with light to strong tessellations on sepals and petals, which are deeply orange brown towards their base and greenish yellow on backside, lip creamy white. This species produces flowers in April, both *in situ* and *ex situ*



Vanda wightii

conditions. It is a horticulturally unexploited species, from which no hybrids have been registered yet.

Vanda wightii

Vanda wightii was collected by Robert Wight in 1849 from Coimbatore, Paulghatcherry and Vaulya. After 150 years the species was recollected by from Karnataka and Kerala regions. Presently it is endemic to South India and a rare species, distributed in Tamil Nadu, Karnataka and Kerala naturally at an altitude range of 60-80 m. Generally the plant grows on *Ficus* trees in natural condition.

This epiphytic plant is with 15-22 cm long stem, leaves are closely arranged and 7-35 cm long and 1-2 cm wide, fleshy coriaceous and unequally bilobed at the apex. Inflorescence is 6-17 cm long bearing 2-3 flowers. Flowers are pleasantly fragrant, 4-4.5 cm across with dull brownish greenish yellow colour and light tessellation on sepals and petals, white at base and back side. Lip is white throughout, with a flash of yellow at the inner portion. The plant grows in semi shaded condition. Flowering is observed in September-November in its natural habitat.

Attractive colour, pleasant fragrance and long lasting flowers contribute its Horticultural importance. So far it has not been utilized for the production of registered hybrids.

Cultivation

Vanda is one among the five most horticulturally potential Orchid genera, since it possess the most magnificent flowers in the Orchid family. It has immensely contributed in orchid breeding and thus in cut flower market. Generally the vandaceous orchids are sun loving. All the four species described here, grow well under semi-shade condition. *Vanda thwaitesii* and *Vanda wightii* prefer cool climate for better flowering.

All these plants can be grown in orchid pots or baskets with good aeration. A combination of charcoal, tile pieces and coconut husk chips can be used as potting medium. All the three materials can be used individually also. These species can also be grown attached to the rough barked trees in large landscapes as well as gardens. These plants are slow growing and therefore, propagation is difficult. Mature plants produce

keikies from its basal portion, which can be detached carefully from the mother plant and can be used as a propagule.

In general these plants are not prone to the attack by insects or diseases. Occasionally flower buds and flowers are attacked by larvae of moths, which may damage the inflorescence. It can be prevented by spraying insecticides at young stage of inflorescence. In rainy season yellow spotting may appear which can be prevented by spraying fungicides containing Mancozeb and Carbendazim (2-3g/litre).

Fertilizer application: Normally all these species grow with the nutrients available from the atmosphere. Diluted organic manures like cow dung, diluted animal urine (1:15) and groundnut cake solution can be sprayed once in two weeks.

Summary

Vanda testaceae, *V. tessellata*, *V. thwaitesii* and *V. wightii* are ornamentally potential orchids from Western Ghats region of India. *Vanda tessellata* is already in use world wide for breeding to produce orchid hybrids. *V. testaceae* was used to create very few hybrids. The two rare species *V. thwaitesii* and *V. wightii* are not yet figured as a parent in the hybrid list. All these plants have a high potential for orchid breeding due to favourable floral features like colour, size, longevity, fragrance and flowering nature. As part of the sustainable utilisation of orchid genetic resources of the Western Ghats, JNTBGRI has already initiated the breeding programmes using these plants.

For further interaction, please write to:

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Indigenous ornamental flora for arid landscapes

The indigenous arid flora can tolerate harsh climatic condition and remains in presentable form during intense summer heat (50°C temperature) and during severe winter frost (-2°C), which makes them highly apposite for arid landscape with round the year acceptability. While most of the exotic ornamentals cannot tolerate extremities of climatic vagaries and showed high mortality and remains in presentable form only during short periods of milder climate or under indoor condition. The native flora of the desert are also crucial for maintaining the biodiversity of the arid eco-systems. Apart from the food and fodder utilization, these desert flora could also serve the purpose of ornamental gardening. Having peculiar characteristics obtained through leaf, stem or other modifications, they are highly suitable as specimen plants in the garden landscapes. The arid flora of the desert eco-system has the additional benefit of less water requirement rendering low maintenance and care compared to other ornamental species of other regions. However, some exotic flora such as bottle brush, bougainvillea, *Euphorbia milii*, *Lantana camera* and *Jatropha gossypifolia* etc. were introduced from other regions and showed high adaptability to arid climatic condition. In this way, the indigenous arid flora have special significance in landscaping of arid region as these are ecologically adaptable and economically viable.

THE harsh climate of arid regions supports a surprisingly large number of hardy, drought-resistant plant species. A major pie of the harsh landscape is located in the northwestern part of the country considered as the great Thar Desert of India. These arid regions are bestowed with a wide range of flora that has been adapted to the desert conditions of sandy soil, scarce water and high solar intensity. Some flora have subterranean root systems that tap deep into low ground water levels, others have smaller or no leaves, and spiky thorns to save on water loss through transpiration. Some species, particularly grasses,

and small herbaceous plants are ephemerals in that they live in short seasonal cycles; they germinate in the first rains in July and die out by the time the soil dries up by December, leaving behind seeds that will bloom again next year. The indigenous arid flora of the desert remains crucial for the survival of the nomadic pastoral and agricultural communities, providing them with food,



Khejri 'Thar Shoba' trees with lush green foliage



Date ornamental



Rohira (*Tecomella undulata*)

fodder, fuel, traditional medicines and a host of other derivatives. The desert flora could be broadly classified into trees, shrubs, climbers and grasses.

TREES

Desert trees are the native plants of the arid ecosystem adapted to the harsh weather and soil conditions over the centuries. They rarely grow as big as those of humid and semiarid ecosystems, but provide shelter to a range of desert fauna and even food and fodder for the desert inhabitants. Lack of nutrients, too much exposure to hostile nature, and low humidity, contribute to smaller stature more suitable for arid regions. Most of them grow in the outermost area of the deserts, where there is more water available. Some of the desert trees have ornamental appearance and have the potential to be used in the ornamental landscapes as avenue plants or as an element of 'focal point'. Some of the desert trees highly suitable for ornamental landscaping include Khejri, Rohira, Kumath, Pilu, Neem, Shisham, Lasoda and Bael etc.

Khejri (*Prosopis cineraria*)

Also known as Jammi, Shami, Khejri Tree, Jand, or Ghaf, is a species of flowering tree in the pea family, Fabaceae. It is native to arid

portions of Western Asia and the Indian Subcontinent. In India, it is declared as state tree of two states i.e. Rajasthan and Telangana. The tree is found in extremely arid conditions, with rainfall as low as 150 mm annually; but is indicative of the presence of a deep water table. As with some other *Prosopis* spp., *P. cineraria* has demonstrated a tolerance of highly alkaline and saline environments. During the harsh summers, the khejri plants show up lushy green appearance, thus making it highly suitable for arid landscaping with very low water requirement and maintenance. ICAR-Central Institute for Arid Horticulture, Bikaner has developed a dual purpose variety of khejri "Thar Shobha" which is thornless, dwarf and suitable for vegetable pod and fodder. It has extremely ornamental fine textured foliage particularly during severe summer (April to June). It is highly responsive to pruning and can be easily maintained as leafless condition during winter when sun light is required, which make it most apposite specimen tree, screening tree for kitchen garden or as avenue tree under water deficit condition of hot arid region. It is propagated by patch budding on seedling rootstock.

Pilu/ Jaal (*Salvodara persica*)

Popularly known as meswak tree, as the chewing sticks are used for oral hygiene, religious and social purposes. It is native to India, Africa and the Middle East; belonging to the family salvodoraceae. The pilu tree is a salt-tolerant shrub or small tree, living in arid zones. It is a large, well-branched evergreen shrub or small tree having soft whitish yellow wood. The bark is of old stems rugose, branches are numerous, drooping, glabrous, terete, finely striate, shining, and almost white. Fruits are small, globose, smooth and becomes red when ripe. It is suitable as a focal element in the arid landscape or as an avenue tree. It remains green during extreme summer and provides shelters for birds and animals. It is propagated by seed.



Neem



Datepalm



Lasoda



Khejri

Arid trees for avenue plantation



Bael tree with golden yellow foliage during leaf shading

Indian date (*Phoenix sylvestris*)

It is widely cultivated as a fruit crop in the arid regions of the world as well as India. In other regions, it is mostly grown as an ornamental plant and used in the urban landscaping. It has the special advantage of tolerance to extreme temperatures and saline water conditions. Date palm is also grown as an ornamental tree along road side and in front of buildings. The major advantage with the date palm trees is that they possess shallow root system and facilitate transplantation of huge, aged plants creating grand looking landscapes overnight. It is quite popular as an avenue plant in the urban landscapes of international airports, and hotels. It is propagated by suckers, seed and tissue culture.

Rohira (*Tecomella undulata*)

The tree species is popular as Desert teak/ Marwar teak and is found locally in the Thar Desert regions of India and Pakistan. It is a slow growing, deciduous or nearly evergreen tree of arid and semi-arid regions. It occurs on



Narium as a flowering shrub

flat and undulating areas including gentle hill slopes and sometimes also in ravines. It is well adapted to drained loamy to sandy loam soil having pH 6.5-8.0. The species thrives very well on stabilized sand dunes, which experience extreme low and high temperatures. It grows in areas of scanty rainfall (annual 150-500 mm) and high temperature (35°C to 48°C). It can withstand extreme low temperature (0°C to -2°C) during winter and high temperature (48°C to 50°C) in summers. The tree is a strong light demander. It is drought, frost, fire and wind hardy. At the time of flowering (December–February) it produces beautiful showy flowers in yellow, orange and red colours. This is best suited as an avenue tree in the arid landscapes. It is propagated by seed.

Neem (*Azadirachta indica*)

The neem is a tough evergreen tree, that offers leafy appeal, honey-scented blossoms, year round shade and perhaps the key to a future of soft pesticides. It is native to India and is ideal for revegetating barren landscapes. Its rapid growth, deep root system, and ideal CO₂ balance make it the “air conditioner” of choice. Because of its fast-growing biomass and ability to provide stable wind protection, it can quickly regenerate leached soils and turn them into fertile land. Being tall and leafy with dense



Hop bush



Henna

Arid flora amenable for garden hedging

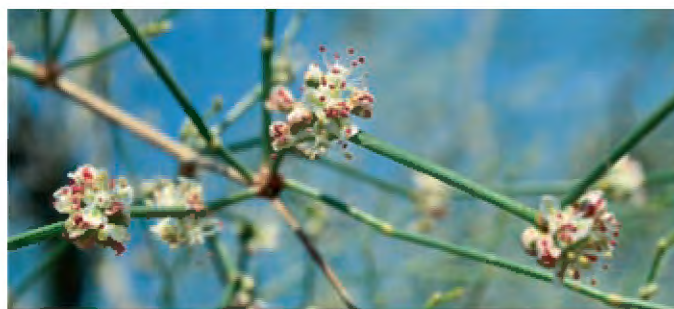


Ker (*Capparis decidua*)

crown, it could be well placed as a garden centerpiece or as an avenue plant. More than just a specimen plant, the neem tree provides a lot and demands only a little in a garden. It offers shade in a hot area with little rainfall and is extremely drought-resistant. It thrives in almost any well-draining soil, including deep sand, in sun or partial shade and in an outdoor garden or container indoors. Additionally, this tree improves soil fertility, neutralizes acidic soil and increases soil's water-holding capacity. It can be pruned and maintained as leafless during winter when sunlight is required. It is multiplied by seed and cutting. Now-a-days due to high demand of organic produce it is commercially used for making neem cake and neem oil.

Lasora (*Cordia spp.*)

It is a medium-sized broad-leaved deciduous tree and the fruits are popularly known as Assyrian plum/ Gonda. Though originated in China, it is found grown primarily in the Asia and other tropical regions all over the world. It flourishes well in the sandy soil of arid region. The fruits are edible and hence are used in the preparation of preserves, pickles and many other ayurvedic preparations. The wood being moderately hard, yields good quality



Hingota as protective fence

timber. It is generally used for making ornamental furniture, house posts, beams, scantlings, planks, dugout canoes, boats, tea boxes, cart shafts, axles, yokes, well-curbs, agricultural implements, combs, gun stocks, naves, spokes, *etc.* Have the potential to be used as an avenue plant.

Shisham (*Dalbergia sissoo*)

Most popular as north Indian Rosewood, shisham is a hardy, deciduous, fast-growing species with light crown. Leaves are leathery, alternate, and pinnately compound while flowers are whitish to pink, fragrant, and nearly sessile, blooming in dense clusters. Pods are oblong, flat, thin, strap-like. It is best known internationally as a premier timber species of the rosewood genus. However, Shisham is also an important fuel wood, shade, and shelter plant. With its multiple products, tolerance of light frosts and long dry seasons, this species deserves greater consideration for tree farming, reforestation and agro forestry applications. After teak, it is the most important cultivated timber tree in India, planted on roadsides, and as a shade tree for tea plantations. It is pruning responsive, can be maintained as leafless during winter and multiplied



Hingota

by seed and cutting.

Bael (*Aegle marmelos*)

It is considered as one of the sacred trees of Hindus and used for worship of lord Shiva and native to Indian sub-continent. It is known as Bengal quince, golden apple, and Japanese bitter orange or stone apple. It is highly drought tolerant and have very deep root system with slow growth in initial years. Bael is grown as shade tree and have ornamental fruits. Fruits have high medicinal value, rich in Vitamin B and marmelosin content and used for making preserve, juice and powder making. It is propagated by seed and patch budding. This could be used as an avenue tree or shade plant.



Rangoon creeper



Jamunicum grandiflorum

SHRUBS

Shrubs are an integral component of any ecosystem and are important from both ecological and economical point of view. In arid regions shrubs have distinct significance, as these are hardy, have high adaptability to arid environment. Shrubs are the source of food, fuel, fodder, fibre, gum, dye, and other products in these biomass deficient areas. The shrub as a vegetation form is hardier than the tree is proved beyond doubt by the presence of shrubs beyond the tree limit. Since ages, the shrubs of the arid eco-system have been the lifeline for the survival of human and livestock in the region. Some of these herbs could serve the purpose of ornamental gardening if placed in a right position. Indian arid zone is endowed with unique resources of such ornamental shrubs which have the wide scope for utilization in the ornamental gardening as hedge, topiary, border plants, biofence, etc.



Bui (*Aerva javanica*) as a potential dry flower



Kheemp (*Leptadenia pyrothecnica*) as a potential hedge/live fence

Nerium (*Nerium oleander*)

It is a shrub or small tree in the dogbane family Apocynaceae, toxic in all its parts. It is the only species currently classified in the genus *Nerium*. Oleander is a vigorous grower in warm subtropical regions, where it is extensively used as an ornamental plant in parks, along roadsides and in private gardens. It is most commonly grown in its natural shrub form, but can be trained into a small tree with a single trunk. Hardy versions like white, red and pink oleander will tolerate occasional light frost down to -10°C , though the leaves may be damaged. The toxicity of oleander renders it deer-resistant and its large size makes for a good windbreak – as such it is frequently planted as a hedge along buildings. The plant is tolerant of poor soils, intense heat, salt spray, and sustained drought – although it will flower and grow more vigorously with regular water. The flowers are showy, profuse, and often fragrant, which makes them very attractive in many contexts. It is propagated easily by seed and stem cutting.

Henna (*Lawsonia inermis*)

Henna is a heavily-scented, much-branched, slender, evergreen shrub or small tree. The plant is often cultivated in tropical and subtropical areas both for its use as a dye plant and also as an ornamental, being appreciated especially for the strong, pleasant fragrance of its flowers, which is reminiscent of tea rose (*Rosa chinensis*). Mass flowering was recorded twice a year, where 75% of the canopy was covered with flowers. Flowers are attractive, scented and bloomed in the morning and last for two days. It attracts butterflies, bees and birds. Tree architecture is attractive and the plant can fit into a small space. Because of its dense habit of growth, and amenability to pruning, the plant is particularly useful as a hedge. It is traditionally planted as a windbreak in vineyards. It is propagated

by seed and stem cutting.

Hop bush (*Dodonaea viscosa*)

This is a native desert shrub which has attractive, lush green foliage and growth habit similar to oleander. They can be used as an attractive green hedge and/or screening. They don't have colorful flowers; but their bright green foliage is their strong point. Hop bush can be allowed to grow into their natural shape or pruned into a formal hedge. This shrub does best in soil with good drainage. It has an upright growth habit that requires plenty of sunlight to reach its full height. The hop bush has an excellent, natural shape and seldom requires pruning. Pruning is required only to reduce its size or to remove dead or damaged foliage in the spring. Water deeply once a month in the summer, and rely on rainfall in the winter. It is propagated by seed.

Karonda (*Carissa carandas*)

It is a species of flowering shrub from the dogbane family Apocynaceae. It is a hardy, drought-tolerant plant that thrives well in a wide range of soils. It is an evergreen shrub or short statured plant with dichotomous branching. Mostly it is found grown wild in various parts of India. It is well suited to arid climate and grow well at higher temperatures. Being a thorny shrub, it is popular as a live fence for the orchards, and gardens. Few cultivars have attractive red colored fruits rendering them to be used as a focal element in the gardening or even trained as a bonsai plant. The berry-sized fruits that are commonly used as a condiment in Indian pickles and spices. When ripe the fruits are rich in anthocyanins making them a good source for extraction of natural food colorants. It is propagated by seed.



Thhor

Ker (*Capparis decidua*)

It is an important

indigenous shrub found growing in natural wild landscape, along farm boundaries, orans, gochars (local grasslands) and wastelands, widely distributed in arid and semi-arid tracts of India. Its natural habitat is pediment plains all over the dry regions. It is an important constituent of desert ecosystems and plays a significant role in the rural economy of peoples of the northwest arid regions of the Indian sub-continent. The natives of the Thar Desert recognized the importance of this shrub long ago. It is an extremely hardy species and provides vegetative cover in hot, sandy desert areas where little else grows. The shrub has a mass of slender, leafless branches, the small caducous leaves being found only on young shoots. Red conspicuous flowers appear in March-April, giving a grand appearance to the plant. Fruits are used for pickling in western India. It could be well used as a live fence/ hedge in the landscape due to thorny nature. It is propagated by seed.

Phog (*Calligonum polygonoides*)

It is a small shrub with scattered distribution all over the arid and semi-arid regions of India. It commonly grows on dry sandy soils and on sand dunes. It is very hardy and being capable of growing under adverse conditions of soil and moisture. It is frost hardy. It produces root suckers and is easily propagated by cutting and layering. The plant is much branched, rigid shrub. Branches trete pale and glabrous. It generally exhibit leaf fall during winters. Leaves when present alternate, stipulate, linear and subulate; stipules short and membranous, cup shaped, obliquely truncate and produced upward at one side. The plant gives the appearance of *Casuarina* from a distance. Hence, it could be well placed in ornamental garden as a hedge plant and foliage can be used as filler and base material for bouquet making.

Hingota (*Balanites aegyptiaca*)

Balanites aegyptiaca is an arid species, classified either as a member of the Zygophyllaceae or the Balanitaceae. It is a small shrub found growing naturally in Thar Desert particularly khejri tree. It can be used as protective fence owing to spine. It has whitish leathery leaves.

Young leaves and tender shoots are used as a vegetable, which is boiled, pounded, then fried or fat added to prepare it. It is propagated by seed.

CLIMBERS/ CREEPERS

Creepers are the ornamental plants which have the potential to be used over pergolas, or trained into a particular shape made of wired mesh/ network. The climbers/creepers used in this arid regions are generally evergreen and flowers round the year. The most commonly used climbers are Rangoon creeper, Climber bougainvillea, *Ipomoea* spp., etc.

Rangoon creeper (*Combretum indicum*)

Popular as Chinese honeysuckle, is a vine with red flower clusters and native to tropical Asia. It is the most common climber used in the home gardens of urban landscapes. It is not uncommon to see the creeper rooted only in a small hole in cemented ground, but the vine thriving and climbing high. Clusters of fragrant white pendulous trumpets open white then change to pink, red and finally a deep maroon. It is a vigorous twining climber blooming profusely throughout summer that can reach as much as 70 feet in tropical climates. This plant needs support for growing and is very useful in covering fences, supports, and walls. The fragrant white flowers grow in pendent racemes, quickly changing to pink then red, making a spectacular show. The growth rate is generally fast, and the plant does not make heavy fertilizer demands. Rangoon creeper does like medium to bright light. Under good conditions it will be necessary to prune the plant to keep it in bounds. Rangoon creeper is found in thickets or secondary forests of the Philippines, India and Malaysia. It has since been cultivated widely in the gardens as an easy to grow plant.

Chameli/ Royal Jasmine (*Jasminum grandiflorum*)

Jasminum grandiflorum subsp. *grandiflorum* is the subspecies of the jasmine native to south Asia having naturalized populations distributed all over. It is basically a climbing shrub bearing flowers with unique

Adaptations in the arid ornamentals

For survivability in the harsh arid climatic conditions, viz. low rainfall, intense sunlight and dry winds; the arid flora have developed numerous xerophytic adaptations. One of the simplest adjustment is to have a shorter lifecycle, which is found in the desert ephemerals that germinate during the first rains of July and die out by the time the soil dries up by December, leaving behind seeds that will bloom in the following year. The native plant species of the arid region have adaptations that enable them to reproduce, grow and survive in the most inhospitable edaphoclimatic conditions. Some plants have evolved special root systems, while others have unique leaf characteristics that allow them to withstand prolonged periods of drought. Many woody species simply lose their leaves when soil moisture conditions become too dry. In general, the flora of arid ecosystem exhibits xeromorphological leaf structures, physiological control of transpiration and metabolism, moisture and nutrient storage organs, and thorns. Generally plants lose water vapour through leaves in the form of transpiration. To reduce the surface area of leaves, arid ornamentals have adaptations such as fewer branches, smaller leaves and thorns/spines. Few arid species such as kair (*Capparis decidua*) has new leaves for less than a month around March and usually exists as an untidy thicket of leafless twigs. Some plants have fine hair on the surface of leaves to break the airflow or a wax coating on the leaf surface to reflect sunlight. Both these adaptations can be seen in *Cactus* species, *Calotropis procera*. Succulents like cactus are able to store water in its tissues. Thhor (*Euphorbia caducifolia*) is the most visible cactus of this region that grows in a widening circle, providing, within its stalks, a protected, shady microhabitat for other plants. Species such as the khejri tree (*Prosopis cineraria*) and the kair shrub (*Capparis decidua*) have a deep root system to tap into groundwater reserves.



CIAH Garden

sweet fragrance. The flowers grow from the tips of the stems in clusters of three to nine blooms. You should notice a strong, pleasant fragrance from the small white flowers typically blooming in Sept-Oct. especially in the arid regions. The scent of the Jasmine (spanish) is considered quite lovely. Commercially the plant is grown to produce perfume. In India, its leaves are widely used as an Ayurvedic herbal medicine and its flowers are used to adorn the coiffure of women.

EPHEMERALS AND HERBACEOUS ANNUALS

Arid ephemerals are the ornamental species which complete their lifecycle in a particular season, disperse their seeds and regrow with the onset of favourable conditions. They include flowering annuals and other ephemeral grass species with ornamental appearance. In addition to the mentioned species, all the winter annuals could be successfully grown in the arid regions during the winter seasons.

Bui (*Aerva javanica*)

It is also known as desert cotton or snow bush. It is a perennial semi-shrubby plant growing in tropical and subtropical dry areas. It is both erect and spreading, grows up to a height of 1.5 m high, and is covered with densely matted hairs on stems and leaves. It is muchbranched, with vigorous round stems that are woody at the base, and a dark stout taproot. It has numerous leaves, ovate to lance shaped, alternate and white to grey. The flowers are small and whitish and arranged in dense, woolly at branch-ends panicles. This herb is deep rooted, and is used as soil binder in desert reclamation. The dried woolly flower twigs have the potential to be used as such or after dyeing in the dry flower arrangements.

Broom brush/Kheemp (*Leptadenia pyrotechnica*)

This is a type of desert grass found in the desert parts of Rajasthan. This plant has wiry stems and leaves which grows upto two and half meters. This produce tiny star shaped flowers and thin elongated pods which are often used as vegetable by the desert dwellers. This plant is the best soil binder and the dried stems are often used for thatching purposes. It is very hardy in nature and the dried stems/leaves have the potential to be used in the dry flower industry.



Junagarh Fort Landscape

CACTI AND SUCCULENTS

These are the group of plants that store water in their stems, roots and leaves. They are highly adaptive for this arid climates due to their inbuilt xerophytic adaptations. There are about 60 different plant families within this group. These plants have evolved in some of the toughest growing conditions on earth, and are actually at their best when grown in hot sun and poor soil. Cacti and succulents lend themselves to all sorts of garden uses: in stone walls, between patio pavers, in rock gardens, and even for creating green roofs. But one of the easiest ways to grow them is in containers, specifically small dishes or troughs made from stone, terracotta, concrete or hypertufa. Very few species are ind igenous to our country viz. as Milk Hedge (*Euphorbia caducifolia*) while most of them currently in use are being introduced from other arid regions viz. *Adeniums*, *Agave*, *Furkriya*, *Yucca*, *Nolina* spp., *Sansevaria*, Jade plant, *Pedalanthus*, *Bryophyllum*, *Euphorbia milii* etc.

Leafless spurge/Milk Hedge (*Euphorbia caducifolia*)

It is a great looking, sparsely spiny columnar branching Euphorbia. It is very similar to *Euphorbia nivulia* (Leafy Milk Hedge). It differs chiefly in being a many stemmed, cactus-like, shrub forming dense, dendride thickets with numerous branches arising from the very base and at the top. It is the major species in rocky desert areas of western and central India and Pakistan. It grows in stony ground on barren coastal plains and in the hilly tracts of the Indian desert on well-drained limestone soils as well on sandy soil, and therefore the substrate varies from slightly alkaline to slightly acidic. The plant is used in parks and gardens for ornamentals and also for protective hedges, due to the fragility of its branches together with the well known skin irritancy of its latex. It can also be kept as an indoor ornamental plant. The leaves of this species are boiled and eaten as a vegetable by the local population, after throwing the cooking water. It is used for the treatment of cough or application on the blisters, warts and pustules and applied to cuts and wounds for speedy healing. Pakistan young branches are burned and smoke inhaled to treat asthma. It is propagated by cuttings.

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Ex situ conservation of wild ornamental plants at JNTBGRI

Wild ornamental plants are one of the untapped resources of the Western Ghats. In the present paper, nearly 300 species of underexploited or unexploited plants conserved at JNTBGRI are presented here along with their botanical identity, family, ornamental attraction, gardening or landscape application, propagation methods, etc. for their easy identification.

THE native plants having potential decorative principles are commonly known as 'Wild Ornamental Plants'. They are the wild progenitors of the present garden plants having wide array of horticultural aspects for native landscaping and gardening. They are equipped to live in the local climate, soil types. They can offer real alternatives to the existing trend of depending on exotic species which may later turn invasive. They may be more adaptable and less maintenance required. They have their own natural defenses against many pests and diseases; hence require less or no pesticides use. They help to connect people to nature and serve as prospective reservoirs of genetic stocks that can be utilized for hybridization and quality improvement programmes. Like many other tropical countries, India also depends upon exotic ornamentals in gardens/landscapes, overlooking the native potential ornamental resources. Interestingly, many of the native endemic and threatened species are potential horticultural plants, hence their conservation could also be ensured by using them as garden plants in captivities.

Rearing of multifarious ornamental plants for domestic and international trade is an urgent prerequisite. The ever growing demand for new cultivars/varieties cannot be satisfied unless we domesticate and breed our native flora. Many ornamental species in the wilderness are fast disappearing owing to natural as well as anthropogenic activities. This necessitates their proper exploitation and popularization before they are eliminated from their captivities. In this backdrop, JNTBGRI started a botanical enclave for the wild ornamental plants during 1992 through a programme funded by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India. The research team carried out a series of survey-collection-introduction activities mainly in the forest areas of the southern Western Ghats regions of Kerala and Tamil Nadu and established a gene pool at JNTBGRI. Majority of the introduced species thrived well and were highly adaptable to

the local weather conditions. In the present paper, we enlisted nearly 300 candidate species from our collection that have been properly identified and evaluated for their potential value (Table 1) for further research.

The candidate plants have been classified into Vines, Shrubs, Trees and Herbs depending on their habit. They exhibit a wide array of colours, texture and forms to create dynamic seasonal displays and can be used in residential and commercial landscaping, highway projects, habitat restoration or re-vegetation programme, storm-water management for parks and corporate office buildings, eco-friendly human habitat, etc. Many species are very easy to propagate through conventional methods and are less prone to pest and diseases. These are some of the greatest advantages of indigenous species domestication and popularization programme.

Landscape and street trees

Shade trees or street trees are trees whose growth habit is such that they spread wide enough to provide significant shade. Trees are deciding the structural frame of a landscape garden/ avenue. The canopy form, texture, colour due to flower/foilage/bark and pattern of branching/ phyllotaxy are the basic factors that decide beauty of a tree. Deciduous species like *Dillenia pentagyna* and *Cassia fistula* that undergo sharp canopy changes during the course of the year may provide structural mobility to the tropical landscape. Thick and lush green foliages of *Agasthyamalaia pauciflorum*, *Calophyllum* spp., *Cocculus laurifolius*, *Cinnamomum* spp., *Cyathocalyx zeylanicus*, *Fagraea racemosa*, *Garcinia* spp., *Humboldtia* spp., *Mesua ferrea*, *Poeciloneuron indicum*, etc. are producing less amount of litter, so these species can be planted near pools and patios. *Euphorbia vajravelui*, *Dichrostachys cinerea*, *Cochlospermum religiosum*, *Fagraea racemosa*, *Bombax ceiba*, etc. are excellent display plants in rocky areas. *Antidesma acidum*, *Elaeocarpus tuberculatus*, *Flacourtia montana*, *Sterculia guttata*, *S. urens*, etc are having showy and edible fruits which attracted many wildlife including birds to the

Table 1. Living wild ornamental plants at JNTBGR

Species name/ Propagation	Ornamental attraction	Application
Climbers		
<i>Anamirta cocculus</i> / Seeds	Shining green pendent leaves, white fruits in bunches from old wood	Vinery
<i>Ancistrocladus heyneanus</i> */Seeds	Leaf pattern	Vinery
<i>Argyreia fulgens</i> */ Seeds	Graceful habit and pink flowers	Vinery
<i>Argyreia nervosa</i> / Seeds	Graceful habit and rose-purple flowers	Vinery/Pergola/ Arches
<i>Asparagus racemosus</i> /Seeds	Habit of the plant, white flowers	Vinery
<i>Bauhinia phenicea</i> */Seeds	Saffron coloured young foliage and brick red flowers in terminal corymbose racemes	Vinery
<i>Bauhinia scandens</i> / Seeds/stem cuttings	Curious stem alternately twisted one way and other between the straight margins similar to the serpent movement. Small white flowers in long racemes.	Vinery
<i>Calamus travancoricus</i> */ Seeds	Lush green climbers with leaflets arranged in single plane	Vinery
<i>Capparis rheedei</i> */ Seeds	Straggling habit with large pale blue flowers with yellow throat.	Vinery/Container display
<i>Chonemorpha fragrans</i> /Seeds/ stem cuttings	Huge Climbing shrubs with large shiny leaves and creamy white flowers with yellow centre.	Vinery/trellises/ Pergolas
<i>Combretum malabaricum</i> */ Seeds/root sprouts	A gregarious climber with rose and white flowers in terminal racemes	Vinery
<i>Coscinium fenestratum</i> /Seeds	A large climber with drooping branches and stiff dark green leaves with ash- grey beneath.	Vinery
<i>Desmos chinensis</i> var. <i>lawii</i> */Seeds	Profusely branched climbers with ovate lanceolate leaves and green drooping flowers	Vinery
<i>Diploclisia glaucescens</i> /Seeds	Habit of the plant	Vinery/pergolas/ Arches/Trellises
<i>Entada rheedei</i> ./ Seeds	Profusely branched climber with dark green compound leaves and long pods.	Vinery/pergolas.
<i>Erythralium scandens</i> /Seeds	A beautiful climber with ovate leaves, red fruits and blue/Seeds.	Vinery/trellises
<i>Getonia floribunda</i> / Seeds	Profusely branched climbing habit	Vinery
<i>Gloriosa superba</i> / Seeds/tubers	Red flowers	Vinery/trellises
<i>Gynochthodes ridsdalei</i> */Seeds	Habit of the plant	Vinery/pergolas
<i>Ipomoea mauritiana</i> /Seeds/ tubers	A medium sized climber with palmately lobed leaves and funnel shaped rose flowers	Vinery/fences
<i>Jasminum coarctatum</i> /Seeds/ stem cuttings	White flowers	Vinery

Species name/ Propagation	Ornamental attraction	Application
<i>Jasminum cordifolium</i> */Seeds/ stem cuttings	White flowers	Vinery
<i>Jasminum flexile</i> var <i>ovatum</i> /Seeds and stem cuttings	White flowers	Vinery
<i>Jasminum flexile</i> var. <i>travancorensis</i> */ Seeds/stem cuttings	White flowers	Vinery
<i>Jasminum ritchii</i> / Stem cuttings	White flowers	Vinery
<i>Kunstleria keralensis</i> */Seeds	Graceful habit	Vinery
<i>Pothos scandens</i> / Seeds/stem cuttings	Dark green leaves and red fruits	Woodland gardens
<i>Rhaphidophora pertusa</i> /Stem cuttings	Climbing shrub with dark coriaceous leaves	Woodland garden
<i>Salacia beddomei</i> */ Seeds	Globose pink fruits	Vinery/pergolas
<i>Salacia fruticosa</i> */ Seeds	Habit of the plant	Vinery/pergolas
<i>Sarcostigma kleinii</i> / Seeds	An beautiful climber with orange fruits from old wood	Vinery/pergolas
<i>Tetracera akara</i> / Seeds	White flowers	Vinery
<i>Thunbergia fragrans</i> /Seeds	An evergreen climber with white flowers	Vinery/pergolas
<i>Thunbergia mysorensis</i> */Seeds	An evergreen climber with yellow flowers in pendulous racemes	Vinery/pergolas
Herbs		
<i>Acranthera grandiflora</i> */Seeds	Blue flowers	Indoor container display
<i>Acrotrema agasthyamalayanum</i> */Seeds and suckers	Scapigerous nature, pale green leaves, yellow flowers	Indoor/shade house plant
<i>Acrotrema arnotianum</i> */Seeds and suckers	Scapigerous nature, green leaves blotched with grey, yellow flowers	Indoor/shade house plant, Ground cover
<i>Acrotrema uniflorum</i> /Seeds and suckers	Scapigerous nature, green leaves blotched with grey, yellow flowers	Indoor/shade house plant, Ground cover
<i>Adiantum raddianum</i> /Spores	Habit	Indoor container display
<i>Aglaonema simplex</i> /Stem cuttings and/Seeds	Graceful habit	Indoor container display
<i>Anaphyllum wightii</i> */Seeds	Pedatifid leaves, greenish brown spirally twisted spath, red fruits	Indoor container display
<i>Anoectochilus regalis</i> /Suckers	Leaves and flowers	Indoor container display
<i>Artanema longifolium</i> /Seeds	Purple flowers in terminal racemes	Container display
<i>Asplenium nidus</i> Spores	Habit	Indoor Container display
<i>Begonia albo-coccinea</i> */Seeds/ leaf cuttings	Scapigerous herbaceous habit with rose coloured flowers and dark green peltate leaves.	Indoor Container display
<i>Begonia arnotiana</i> */Seeds/ leaf cuttings	Scapigerous habit with suborbicular variegated leaves, pink flowers.	Indoor Container display

Species name/ Propagation	Ornamental attraction	Application
<i>Begonia burkilli</i> / Seeds, leaf cuttings	Habit of the plant	Indoor Container display
<i>Begonia dipetala</i> var. <i>hydrophila</i> */ Seeds/stem cuttings	Erect or pendent habit with white flowers and dark green leaves often with scattered white blotches.	Indoor Container display
<i>Begonia floccifera</i> */ Seeds/leaf cuttings	Scapigerous herbaceous habit with white flowers and dark green wooly leaves.	Indoor Container display
<i>Begonia malabarica</i> */Seeds/ stem cuttings	Erect herbaceous habit with small white flowers	Indoor Container display
<i>Begonia palmata</i> / Seeds, leaf cuttings	Habit of the plant	Indoor Container display
<i>Biophytum intermedium</i> / Seeds/stem cuttings	Profusely branched herb with terminal clustered leaves and yellow flowers	Container/ hanging pot display
<i>Biophytum poterioides</i> */Seeds	Erect herb with terminal clustered leaves and brick red or flame coloured flowers	Container/ hanging pot display
<i>Biophytum veldkampii</i> */Seeds	Erect herb with terminal clustered leaves and yellow flowers	Bedding plants
<i>Calanthe sylvatica</i> / Suckers	Pink flowers	Indoor Container display
<i>Cheilocostus speciosus</i> /Seeds	Habit of the plant	Ground cover
<i>Curcuma aeruginosa</i> Rhizomes	Dark pink colored bracts and yellow flowers	Bedding/Outdoor container display
<i>Curcuma caesia</i> * Rhizomes	The leaves have a deep violet-red patches which runs through the length of the lamina.	Bedding/Outdoor container display
<i>Curcuma ecalcarata</i> */ Rhizome	Flowers	Ground cover
<i>Dianella ensifolia</i> / Seeds	Clustered herbs with pale blue or off-white flowers and blue fruits	Container display
<i>Dracaena terniflora</i> /Seeds	Perennial herbaceous plant with dark green leaves and pale yellow flowers in terminal racemes	Indoor container display
<i>Ecbolium ligustrinum</i> /Seeds/ stem cuttings	A dark green herbaceous plant with terminal 4-sided bracts and greenish-blue flowers.	Ground cover
<i>Elatostemma lineolatum</i> var. <i>setosum</i> */Seeds/ stem cuttings	Erect herb with dark green leaves.	Indoor container display
<i>Elephantopus scaber</i> /Seeds	Scapigerous plants with small erect purple flowers in narrow heads.	A very good turf plant.
<i>Exacum courtallense</i> */Seeds	Blue flowers	Indoor container display
<i>Gymnostachyum febrifugum</i> */Seeds	Scapigerous habit and erect Inflorescence with pale yellow flowers	Ground cover/ Container display
<i>Hedychium coronarium</i> / Rhizomes	White fragrant flowers	Ground cover

Species name/ Propagation	Ornamental attraction	Application
<i>Hedychium flavescens</i> /Rhizome	Clustered erect shoots with sulphur yellow flowers	Ground cover
<i>Henckelia gambleana</i> */Seeds	Scapigerous habit with blue flowers in dichasial cymes	Indoor container display
<i>Henckelia incana</i> / Seeds	Scapigerous habit with blue flowers in dichasial cymes	Indoor container display
<i>Henckelia innominata</i> */Seeds	Scapigerous habit and blue flowers	Indoor container display
<i>Henckelia repens</i> */ Seeds	Trailing habit with blue flowers in cymes	Indoor container display
<i>Hoya wightii</i> / Seeds/stem cuttings	Graceful habit and bunches of pale yellow flowers	As an epiphyte on other plants/In hanging pots
<i>Huperzia squarrosa</i> /Suckers	Habit	Indoor container display
<i>Impatiens diversifolia</i> */Stem cuttings/Seeds	Pink or rose coloured flowers	Container display/Bog gardens
<i>Impatiens verticillata</i> */Stem cuttings	Brick red flowers	Container display in shade house
<i>Jerdonia indica</i> */ Seeds/leaf cuttings	Scapigerous habit and pink flowers	An ideal container plants for the shade house
<i>Lobelia nicotianifolia</i> /Seeds	White flowers in terminal racemes	Container display
<i>Neurocalyx calycinus</i> /Seeds	Habit of the plant, pale pink flowers	Indoor container display
<i>Ophiopogon intermedius</i> /Tillers	Tufted herbaceous habit interspersed with white flowers	Container display/Ground cover
<i>Pancratium triflorum</i> /Bulbs	Large white flowers	Ground cover
<i>Peliosanthes teta</i> Subsp. <i>humilis</i> / Seeds/suckers	Tufted herb with shining stiff leaves and dark purple flowers.	Container display/Ground cover
<i>Pennisetum polystachyon</i> /Seeds	Long yellow dense spiciform panicles	Ground cover
<i>Phrynium pubinerve</i> /Tillers	Herbs with dark green coriaceous leaves	Bog gardens
<i>Pteris argyrea</i> / Spores	Habit	Indoor container display
<i>Rhynchoetechum permolle</i> /Seeds	Habit of the plant	Indoor container display
<i>Torenia travancorica</i> */Seeds	Trailing herb with blue flowers	Container display
<i>Zingiber nimmonii</i> / Seeds/rhizome	Reddish brown stem and white flowers in slender scapes	Container display
<i>Zingiber zerumbet</i> / Rhizomes	Habit of the plant, pale yellow flowers in ovoid spikes	Ground cover
Shrubs		
<i>Abutilon indicum</i> / Seeds	Yellow flowers	Shrubbery
<i>Astonia venenata</i> */ Seeds and Stem cuttings	Green shining leaves and white flowers	Shrubberies/ Container display outdoor
<i>Angiopteris helferiana</i> /Spores	Habit	Ground cover in wood land gardens
<i>Antidesma acidum</i> / Seeds	Graceful habit	Shrubbery

Species name/ Propagation	Ornamental attraction	Application
<i>Antistrophe glabra</i> */Seeds	Graceful habit	Container display outdoor
<i>Ardisia blatterii</i> */Seeds	Graceful habit	Container display
<i>Ardisia elliptica</i> /Seeds	Habit of the plant, pink flowers	Shrubbery
<i>Ardisia solanacea</i> /Seeds	Graceful habit and large pink flowers in axillary racemes	Container display/shrubberies
<i>Areca triandra</i> /Seeds	Habit of the plant, bunches of red fruits	Avenue plant for garden footpaths
<i>Barleria courtallica</i> */Seeds/stem cuttings	Large blue flowers in terminal racemes	Container display/Shrubberies
<i>Barleria involucrata</i> var <i>elata</i> /Seeds/stem cuttings	Blue flowers in terminal racemes	Shrubberies
<i>Barleria strigosa</i> /Stem cuttings	Blue flowers in dense terminal clusters	Container display outdoor/Ground cover
<i>Breynia retusa</i> /Seeds/stem cuttings	An elegant shrub with small dark green leaves and pendent branches with beautiful depressed globose orange fruits	Shrubberies
<i>Breynia vitis-idaea</i> /Seeds/stem cuttings	An elegant shrub with pendent branches with several small globose red fruits	Shrubberies
<i>Campylospermum serratum</i> /Seeds	Yellow flowers and red fruits	Shrubbery
<i>Carissa spinarum</i> /Seeds	Flowers	Shrubbery
<i>Chassalia curviflora</i> /Seeds	Flowers	Shrubbery
<i>Coffea neobridsoniae</i> */Seeds	White fragrant flowers appeared as one time throughout the plant before the emergence of leaves	Container display outdoor
<i>Coffea travancorensis</i> /Seeds	A profusely sprouted subshrub with shining leaves and white flowers	Container display outdoor
<i>Ensete superbum</i> */Seeds	An erect 12 feet long plant with large leaves. Pseudostem is about half as long as the plant with large drooping inflorescence resembling the plantains mixed with large spathes.	Specimen plant in garden
<i>Eranthemum capense</i> /Seeds, stem cuttings	Pale blue flowers	Container display indoor/shade house
<i>Erythroxylum lanceolatum</i> /Seeds	An evergreen shrub with lanceolate leaves .	Container display outdoor
<i>Eugenia mooniana</i> /Seeds	Small ovate or elliptic leaves with white flowers and red fruits	Shrubbery
<i>Euonymus indicus</i> /Seeds	Habit of the plant	Shrubbery
<i>Flemingia strobilifera</i> /Seeds	An erect branching shrub with white flowers	Container display
<i>Flueggea leucopyrus</i> /Seeds	White fruits	Shrubbery
<i>Gmelina asiatica</i> /Seeds/stem cuttings	Pendulous branches and yellow flowers	Shrubbery

Species name/ Propagation	Ornamental attraction	Application
<i>Gomphostemma eriocarpum</i> */Seeds	Pale yellow flowers from the axils of the leaves	Container display indoor/shade house
<i>Goniothalamus cardiopetalus</i> */Seeds	Graceful habit	Shrubbery
<i>Goniothalamus keralensis</i> */Seeds	Graceful habit	Shrubbery
<i>Grewia nervosa</i> [= <i>Grewia microcos</i>]/Seeds	Habit of the plants, yellow flowers	Shrubbery
<i>Helicteres isora</i> /Seeds	Red flowers with yellow calyx and spirally twisted fruits	Shrubbery
<i>Hibiscus vitifolius</i> /Seeds	Large yellow flowers	Shrubbery
<i>Impatiens grandis</i> /Stem cuttings	Perennial evergreen shrub with large white flowers streaked with red lines	Potted plants (outdoor)
<i>Ixora agasthyamalayana</i> */Seeds	Bunches of white flowers	Shrubbery
<i>Ixora johnsonii</i> */Seeds/root cuttings	Attractive leaves and bunches of white flowers	Container display outdoor
<i>Ixora lanceolaria</i> */Seeds	Ovate-lanceolate leaves with greenish yellow flowers	Container display outdoor
<i>Ixora nigricans</i> /Seeds	Bunches of white flowers	Shrubbery
<i>Ixora polyantha</i> */Seeds	Bunches of white flowers	Shrubbery/Container display
<i>Ixora undulata</i> /Seeds	White fragrant flowers	Shrubbery
<i>Justicia santapau</i> */Stem cuttings/Seeds	White flowers in terminal racemes.	Shrubbery
<i>Luvunga eleutherandra</i> */Seeds	Graceful habit	Container display
<i>Meiogyne pannosa</i> */Seeds	Graceful habit and pale yellow flowers and red fruits	Shrubbery/Container display
<i>Melastoma malabathricum</i> /Seeds	Purple flowers	Shrubbery
<i>Memecylon angustifolium</i> /Seeds	Graceful habit and blue flowers	Shrubbery
<i>Memecylon deccanense</i> */Seeds	Graceful habit and blue flowers	Shrubbery
<i>Memecylon edule</i> /Seeds	Graceful habit and blue flowers	Shrubbery
<i>Memecylon royenii</i> /Seeds	Graceful habit	Shrubbery
<i>Memecylon sivasadanii</i> */Seeds	Graceful habit and blue flowers	Shrubbery
<i>Memecylon talbotianum</i> */Seeds	Graceful habit and blue flowers	Shrubbery
<i>Memecylon umbellatum</i> /Seeds	Graceful habit and blue flowers	Shrubbery
<i>Memecylon gracile</i> */Seeds	Habit of the plant	Potted plant in shade house
<i>Meogyne ramarowii</i> */Seeds	Graceful habit and pale yellow flowers	Shrubbery/Container display
<i>Muraya paniculata</i> /Seeds	Fragrant white flowers and graceful habit	Shrubbery

Species name/ Propagation	Ornamental attraction	Application
<i>Naringi crenulata</i> / Seeds	Graceful habit	Shrubby
<i>Nothopegia aureo- fulva</i> */Seeds	Graceful habit	Shrubby/ Container display
<i>Nothopegia travancorica</i> /Seeds	Graceful habit	Shrubby/ Container display
<i>Ophiorrhiza eriantha</i> */Seeds	Elegant habit with pink flowers	Container display indoor
<i>Ophiorrhiza nairii</i> */ Seeds	Elegant habit with pink flowers	Container display indoor
<i>Ophiorrhiza schendurunii</i> */ Seeds	Elegant habit with pink flowers	Container display indoor
<i>Osbeckia aspera</i> / Seeds/stem cuttings	Spreading shrub with purple flowers	Shrubby/ Container display
<i>Osbeckia virgata</i> / Seeds/stem cuttings	Slender subshrub with many purple flowers	Shrubby/ Container display
<i>Pandanus thwaitesii</i> /Suckers	Elegant habit	Container display
<i>Pavetta indica</i> / Seeds	Profusely branched shrub with shining leaves and corymbose white flowers	Shrubby
<i>Pavetta tomentosa</i> / Seeds	Profusely branched shrub with corymbose white flowers	Shrubby
<i>Phlogacanthus grandis</i> */Seeds, stem cuttings	Flowers	.
<i>Phyllanthus gageanus</i> */Seeds	Elegant shrub with leaves clustered near the stem tip; flowers red	Potted plant in shade house
<i>Polyalthia longipedicellata</i> */ Seeds	Graceful habit	Shrubby/ Container display
<i>Polyalthia suberosa</i> */Seeds	Graceful habit	Shrubby/ Container display
<i>Psychotria flavida</i> */ Seeds	Habit of the plant	Shrubby
<i>Rauvolfia serpentina</i> /Seeds/ root cuttings	Erect subshrub with white flowers and red calyx	Container display
<i>Rhinacanthus nasutus</i> /Seeds and stem cuttings	White flowers	Shrubby
<i>Schefflera venulosa</i> /Seeds/ stem cuttings	An epiphytic shrub with radiating leaflets	Shrubby/ Container display
<i>Schefflera wallichiana</i> */Seeds/ stem cuttings	An epiphytic shrub with radiating leaflets	Shrubby/ Container display
<i>Senna alata</i> /Seeds	Large leaves with yellow flowers	Container display
<i>Senna saphera</i> / Seeds	Yellow flowers	Container display
<i>Stenosiphonium setosum</i> */Stem cuttings	Pale blue flowers	Shrubby/ Container display
<i>Strobilanthes anomallica</i> */Stem cuttings/Seeds	Evergreen shrub with white flowers	Shrubby
<i>Strobilanthes andamanensis</i> */ Stem cuttings/ Seeds	Slender shrub with yellow flowers	Container display
<i>Strobilanthes barbatus</i> var. <i>bonaccordensis</i> */ Stem cuttings/ Seeds	Evergreen shrub with white flowers	Shrubby

Species name/ Propagation	Ornamental attraction	Application
<i>Strobilanthes ciliata</i> */Stem cuttings/Seeds	Evergreen shrub with pale blue flowers	Shrubby
<i>Strobilanthes consanguineus</i> */ Stem cuttings/ Seeds	Evergreen shrub with white flowers	Shrubby
<i>Strobilanthes decurrens</i> */Stem cuttings/Seeds	Evergreen shrub with white flowers	Shrubby
<i>Strobilanthes gamblei</i> */Stem cuttings/Seeds	Evergreen shrub with golden leaves and pale pink flowers	Shrubby
<i>Strobilanthes hamiltoniana</i> /Stem cuttings/Seeds	Evergreen shrub with pink flowers	Shrubby
<i>Strobilanthes heyneana</i> /Stem cuttings/Seeds	Evergreen shrub with white or pale blue flowers	Shrubby
<i>Strobilanthes lupulina</i> /Stem cuttings/Seeds	Evergreen shrub with purple bracts and blue flowers	Shrubby
<i>Strobilanthes pushpangadanii</i> */ Stem cuttings/ Seeds	Evergreen shrub with golden leaves and pink flowers	Shrubby
<i>Syzygium occidentale</i> */Seeds	Elegant habit, white flowers	Shade places, particularly along the water course
<i>Syzygium zeylanicum</i> /Seeds	Elegant habit and white fruit bunches	Hedge plant
<i>Tabernaemontana gamblei</i> */Seeds/ stem cuttings	White flowers	Container display
<i>Tarenna monosperma</i> */ Seeds/stem cuttings	White flowers	Container display
<i>Thespesia lampas</i> / Seeds	Yellow flowers	Shrubby
<i>Thottea idukkiana</i> */ Seeds	Elegant habit	Shrubby/ Container display
<i>Thottea ponmudiana</i> */ Seeds	Elegant habit	Shrubby/ Container display
<i>Thottea siliquosa</i> / Seeds	Elegant habit	Shrubby/ Container display
<i>Thottea sivarajanii</i> / Seeds	Elegant habit	Shrubby/ Container display
Trees		
<i>Actinodaphne campanulata</i> /Seeds	Canopy form	Shade tree
<i>Actinodaphne wightiana</i> /Seeds	Silvery white young leaves	Avenue tree
<i>Agasthiyamalaia pauciflorum</i> */Seeds	Graceful habit	Shade tree
<i>Alstonia scholaris</i> / Seeds	Canopy form	Avenue tree
<i>Anacolosa densiflora</i> /Seeds	Habit of the plant	Avenue tree
<i>Antidesma acidum</i> / Seeds	Graceful habit	Avenue for footpaths in small landscapes
<i>Arenga wightii</i> / Seeds, suckers	Habit of the plant	Avenue/Specimen plant
<i>Baccaurea caurtallensis</i> */Seeds	Dense cauliflorous red flow- ers in racemes, Bunches of red or yellow fruits	Avenue, Arboretum trees

Species name/ Propagation	Ornamental attraction	Application
<i>Bauhinia malabarica</i> /Seeds`	Pink flowers	Avenue tree
<i>Bentinckia condapanna</i> */ Seeds	Slender annulate grey stem and the bunch of many chocolate coloured fruits	Avenue/Specimen plant in small landscapes,
<i>Bischofia javanica</i> / Seeds	Habit of the plant	Avenue tree
<i>Bombax ceiba</i> / Seeds	Habit of the plant	Avenue tree
<i>Buchanania lanceolata</i> /Seeds	A lush green evergreen tree	Avenue tree
<i>Butea monosperma</i> / Seeds	A deciduous tree with large flowers of orange-scarlet colour before the onset of leaves	Avenue/Specimen tree
<i>Calophyllum apetalum</i> /Seeds	Evergreen tree with white flowers	Avenue/Specimen tree
<i>Calophyllum inophyllum</i> /Seeds	Evergreen tree with terminal racemes of white flowers	Avenue trees
<i>Careya arborea</i> / Seeds	A small sized deciduous tree with large creamy white flowers and globose fruits.	A fire resistant species can be used as a best candidate species for arid gardens.
<i>Caryota urens</i> / Seeds	Habit of the plant	Avenue/Specimen plant
<i>Cassia fistula</i> /Seeds	Long pendent racemes of yellow flowers from leafy or leafless branches.	Avenue tree
<i>Chrysophyllum roxburghii</i> /Seeds	A large evergreen tree with drooping shining leaves.	Avenue tree for shade landscapes
<i>Cinnamomum heyneanum</i> */Seeds, stem cuttings	A profusely branched evergreen tree with erecto-patent branches and small ovate-lanceolate leaves.	Avenue tree for shade landscapes, especially along stream banks
<i>Cinnamomum malabatum</i> /Seeds, stem cuttings	A profusely branched evergreen tree with more or less drooping branches and large shining leaves.	An avenue tree
<i>Cinnamomum mathewianum</i> var. <i>ponmudianum</i> */ Seeds	A conical shaped evergreen tree	Avenue tree
<i>Cinnamomum riparium</i> */Seeds, stem cuttings	A profusely branched evergreen tree with erecto-patent branches and small ovate-lanceolate leaves.	Shade landscapes especially along stream banks
<i>Clausena indica</i> / Seeds	A profusely branched evergreen tree with shining compound leaves clustered towards the branch tips.	Avenue tree,
<i>Cocculus laurifolius</i> / Seeds	An evergreen plant with shining green leaves.	Can be used as an elegant shrub or can be trained as hedges in gardens
<i>Cochlospermum religiosum</i> /Seeds	A deciduous tree with large yellow flowers in terminal racemes from the branchlets.	Avenue for garden path ways, candidate species for the rock gardens

Species name/ Propagation	Ornamental attraction	Application
<i>Croton malabaricus</i> */Seeds	Dark green leaves with shining silvery colour beneath.	Shade tree for small home gardens
<i>Cullenia exarillata</i> / Seeds	A large evergreen tree with coppery leaves and large spiny fruits	Avenue tree especially along shady areas
<i>Cyathocalyx zeylanicus</i> /Seeds	An evergreen tree with straight branches and greenish flowers	Avenue tree
<i>Cycas circinalis</i> / Seeds	Elegant habit	Specimen/avenue for garden pathways
<i>Cynometra bourdillonii</i> */Seeds	An evergreen plant with brightly coloured young shoots	Container display/shrubberies
<i>Cynometra irippa</i> / Seeds	An evergreen plant	Container display/shrubberies
<i>Dichrostachys cinerea</i> /Seeds	A thorny shrub with pretty tasseled flowers and twisted fruits and very small leaflets	Rock gardens or arid gardens
<i>Dillenia bracteata</i> */ Seeds	An elegant tree with large leaves and white flowers	Shade tree
<i>Dillenia pentagyna</i> / Seeds	A deciduous tree with yellow flowers and globose fruits	Avenue tree
<i>Dimocarpus longan</i> /Seeds	An evergreen tree with mauve coloured young flush	Shade tree
<i>Diospyros buxifolia</i> / Seeds	An evergreen tree with conical shape. Leaves are small ovate shaped and are densely packed on the branchlets. Flowers white, small	Shade tree
<i>Diospyros candolleana</i> /Seeds	A beautiful evergreen tree with spreading or drooping branches	Shade tree
<i>Diospyros ebenum</i> / Seeds	A beautiful evergreen tree with conical canopy	Shade tree
<i>Diospyros foliosa</i> / Seeds	Habit of the plant	Avenue plant
<i>Diospyros malabarica</i> /Seeds	A beautiful evergreen tree with straight branches and drooping dark green leaves and creamy white flowers	Shade tree
<i>Dipterocarpus indicus</i> /Seeds	An evergreen tree	Avenue tree
<i>Elaeocarpus serratus</i> /Seeds	Large evergreen tree with terminal clusters of leaves and white flowers in axillary long racemes	Shade tree
<i>Elaeocarpus tuberculatus</i> /Seeds	A large buttressed evergreen tree with large obovate leaves clustered on the branch tips. The moderately sized white fragrant flowers are born in axillary long racemes	Shade tree
<i>Erythroxylum moonii</i> /Seeds	An evergreen tree	Shade tree
<i>Erythroxylum obtusifolium</i> /Seeds	Habit of the plant	Avenue plant
<i>Euphorbia vajravelui</i> */Stem cuttings	Dark green cladode	Rock garden

Species name/ Propagation	Ornamental attraction	Application
<i>Fagraea ceylanica</i> / Seeds	Large dark fleshy green leaves and pale yellow campanulate flowers.	Gardens along water bodies/ bonsai making
<i>Fagraea racemasa</i> / Seeds	Graceful habit and creamy white flowers in terminal racemes	Shade tree
<i>Ficus callosa</i> / Seeds/stem cuttings	Habit of the plant	Shade tree/ bonsai garden
<i>Filicium decipiens</i> / Seeds	Graceful habit with dark green fern like leaves	Shade tree
<i>Flacourtia mantana</i> /Seeds	Habit of the plant; red fruits	Shade tree/fruit orchards
<i>Garcinia gummi-gutta</i> /Seeds	Conical shape of the tree with dark green leaves on pendulous branches.	Shade tree
<i>Garcinia morella</i> / Seeds	Habit of the tree	Shade tree
<i>Garcinia talbotii</i> */ Seeds	Habit of the tree	Shade tree/ Container display
<i>Garcinia wightii</i> / Seeds	Habit of the tree	Shade tree
<i>Gluta travancorica</i> / Seeds	Habit of the tree	Shade tree
<i>Glycosmis mauritiana</i> /Seeds	Graceful habit	Shade tree
<i>Gmelina arborea</i> / Seeds	Yellow flowers	Shade tree
<i>Goniothalamus malayanus</i> /Seeds	Graceful habit	Shade tree
<i>Gordonia obtusa</i> / Seeds	Large white flowers	Shade tree
<i>Gymnacranthera canarica</i> /Seeds	Graceful habit	Shade tree along water bodies
<i>Holarrhena pubescens</i> /Seeds	Pale yellow fragrant flowers in terminal dichasial cymes from the branches	Flowering tree
<i>Hopea parviflora</i> / Seeds	Graceful habit	Avenue tree
<i>Hopea ponga</i> / Seeds	Graceful habit	Avenue tree
<i>Humboldtia bourdillonii</i> */Seeds	Graceful habit	Shade tree
<i>Humboldtia brunonis</i> */Seeds	Graceful habit, pink flowers	Shade tree
<i>Humboldtia decurrens</i> /Seeds	Graceful habit, young shoots	Shade tree
<i>Humboldtia vahlana</i> /Seeds	Graceful habit, white flowers	Shade tree
<i>Ixora brachiata</i> / Seeds	Graceful habit and bunches of pink flowers	Shade tree
<i>Kingiodendron pinnatum</i> /Seeds	An evergreen tree with graceful habit	Shade tree
<i>Knema attenuata</i> / Seeds	Graceful habit with peculiar branching of the tree	Specimen tree
<i>Lagerstroemia microcarpa</i> /Seeds	White bark	Shade tree
<i>Lagerstroemia speciosa</i> /Seeds	Spreading branches with rose-pink flowers in long racemes.	Flowering trees
<i>Litsea venulosa</i> / Seeds	Graceful habit	Bonsai, indoor
<i>Lohopetalum wightianum</i> /Seeds	Graceful habit	Shade tree

Species name/ Propagation	Ornamental attraction	Application
<i>Madhuca neriifolia</i> / Seeds	Graceful habit	Shade tree, preferably along water bodies
<i>Mallatus philippinensis</i> / Seeds	Graceful habit, saffron coloured fruits	Shade tree
<i>Mastixia arborea</i> / Seeds	Graceful habit	Shade tree/ Container display
<i>Memecylon agasthyamalaia-num</i> */Seeds	Graceful habit	Small/Home gardens/ Container display indoor
<i>Mesua ferrea</i> /Seeds	Graceful habit and pale yellow flowers	Shade tree
<i>Myristica malabarica</i> /Seeds	Graceful habit	Shade tree
<i>Nageia wallichiana</i> /Seeds	Elegant habit	Shrubbery/ Container display
<i>Neolitsea scrobiculata</i> /Seeds	Habit of the plant	Avenue plant
<i>Ormosia travancorica</i> /Seeds	An evergreen tree with spreading canopy	Avenue/Shade tree
<i>Pinanga dicksonii</i> */ Seeds/suckers	Slender stemmed palms with clustered appearance	Shrubbery
<i>Pleurostylia opposita</i> /Seeds	Profusely branched evergreen shrub	Small/Home gardens/ Container display indoor
<i>Poecilaneuron indicum</i> /Seeds	An evergreen tree with spreading straight branches	Shade tree
<i>Pterospermum diversifolium</i> /Seeds	Trees with tomentose leaves and white flowers	Shade tree
<i>Pterospermum reticulatum</i> /Seeds	Trees with tomentose leaves and white flowers	Shade tree
<i>Pterospermum rubiginosum</i> /Seeds	Medium sized tree with spreading branches and white flowers	Shade tree
<i>Pygeum wightianum</i> /Seeds	A large handsome tree with white flowers	Shade tree
<i>Quassia indica</i> / Seeds	Evergreen tree	Shade tree
<i>Saraca asoca</i> /Seeds	An elegant tree with orange-red flowers	Shade tree
<i>Schleichero oleosa</i> / Seeds	Graceful habit	Shade tree
<i>Scalopia crenata</i> / Seeds	Habit of the plant	Avenue tree
<i>Semecarpus auriculata</i> /Seeds	Graceful habit	Shade tree
<i>Spondias acuminata</i> /Seeds	Elegant habit	Shade tree
<i>Spondias indica</i> / Seeds/stem cuttings	Brown foliage and branchlets	Container display
<i>Spondias pinnata</i> / Seeds	Elegant habit	Shade tree
<i>Sterculia guttata</i> / Seeds	Orange fruits	Shade tree
<i>Sterculia urens</i> / Seeds	Palmately lobed leaves and red fruits	Shade tree
<i>Strombosia ceylanica</i> /Seeds	Evergreen tree with conical canopy	Avenue tree
<i>Symplocos cochinchinensis</i> /Seeds	White fragrant flowers	Avenue tree

Species name/ Propagation	Ornamental attraction	Application
<i>Syzygium caryophyllatum</i> / Seeds	Elegant habit	Shade tree
<i>Syzygium cuminii</i> / Seeds	Elegant habit	Avenue tree
<i>Syzygium densiflorum</i> / Seeds	Elegant habit	Shade tree
<i>Syzygium laetum</i> / Seeds	Elegant habit and red or yellow flowers	Shade tree
<i>Syzygium megacarpum</i> / Seeds	Elegant habit and white or creamy white flowers in terminal cymes	Shade tree
<i>Syzygium mundagam</i> / Seeds	Elegant habit, white flowers	Shade tree
<i>Syzygium myhendrae</i> / Seeds	Habit of the plant	Avenue tree
<i>Syzygium palodense</i> / Seeds	Elegant habit	Shade tree
<i>Syzygium travancoricum</i> / Seeds	Elegant habit	Avenue tree
<i>Syzygium makul</i> / Seeds	Habit of the plant	Avenue tree
<i>Tabernaemontana alternifolia</i> / Seeds	White fragrant flowers	Avenue plant
<i>Terminalia paniculata</i> / Seeds	Elegant habit and brown bunches of fruits	Shade tree
<i>Tetrameles nudiflora</i> / Seeds	Elegant habit	Shade tree
<i>Vateria indica</i> / Seeds	Elegant habit	Shade tree
<i>Wrightia arborea</i> / Seeds	Elegant habit and pale yellow flowers with red corona.	Shade tree
<i>Wrightia tinctoria</i> / Seeds	Elegant habit and white flowers	Shade tree
*Endemic plants of the Western Ghats		

Species name/ Propagation	Herb	Ornamental attraction	Application
Ground cover			
<i>Acrotrema arnotianum</i> / Seeds and suckers	Herb	Scapigerous nature, green leaves blotched with grey, yellow flowers	Indoor/shade house plant, Ground cover
<i>Acrotrema uniflorum</i> / Seeds and suckers	Herb	Scapigerous nature, green leaves blotched with grey, yellow flowers	Indoor/shade house plant, Ground cover
<i>Biophytum poterioides</i> / Seeds	Herb	Erect herb with terminal clustered leaves and brick red or flame coloured flowers	Container display/ bedding plants

Species name/ Propagation	Herb	Ornamental attraction	Application
<i>Biophytum veldkampii</i> / Seeds	Herb	Erect herb with terminal clustered leaves and yellow flowers	container display/ bedding plants
<i>Cheilocostus speciosus</i> / Seeds	Herb	Habit of the plant	Ground cover
<i>Curcuma aeruginosa</i> / Rhizomes	Herb	Dark pink colored bracts and yellow flowers	Outdoor container display, bedding
<i>Curcuma caesia</i> / Rhizomes	Herb	The leaves have a deep violet-red patches which run through the length of the lamina.	Container display or can be used as bedding plants
<i>Curcuma ecalcarata</i> / Rhizome	Herb	Flowers	Ground cover
<i>Desmodium heterocarpon</i> / Seeds	Spreading or trailing herbs	Dark green leaves with terminal clusters of purple-blue flowers	Ground cover
<i>Gymnostachyum febrifugum</i> / Seeds	Herb	Scapigerous habit and erect Inflorescence with pale yellow flowers	Ground cover/ container display
<i>Peliosanthes tetra Subsp. humilis</i> / Seeds/suckers	Herb	Tufted herb with shining stiff leaves and dark purple flowers.	Container display/ Ground cover
<i>Ecboium ligustrinum</i> / Seeds/stem cuttings	Herbs	A dark green herbaceous plant with terminal 4-sided bracts and greenish-blue flowers.	Ground cover
<i>Hedychium coronarium</i> / Rhizomes	Herbs	White fragrant flowers	Ground cover
<i>Ophiopogon intermedius</i> / Suckers	Herbs	Habit of the plant	Ground cover
<i>Pancratium triflorum</i> / Bulbs	Herbs	Large white flowers	Ground cover
<i>Pennisetum polystachyon</i> / Seeds	Herbs	Long yellow dense spiciform panicles	Ground cover
<i>Hedychium flavescens</i> / Rhizome	Perennial rhizomatous herbs	Clustered erect shoots with sulphur yellow flowers	Ground cover
<i>Gymnostachyum febrifugum</i> / Seeds	Herb	Scapigerous habit and erect Inflorescence with pale yellow flowers	Ground cover/ container display

gardens. Palms such as *Arenga wightii*, *Bentinckia condappana*, *Pinanga dicksonii* are suitable for planting along walkways, roads or even filling up of shady corners of the garden. *Cynometra bourdillonii*, *C. irippa*, *Clausena indica*, *Dimocarpus longan*, *Spondias acuminata*, *Glycosmis mauritiana*, *Erythroxylon spp.*, *Chrysophyllum roxburghii*, *Ficus callosa*, *Filicium decipiens*, *Knema attenuata*, *Mastixia arborea*, *Nageia wallichiana*, etc. have excellent forms and shapes

suitable for the landscape applications. *Memecylon agasthyamalayanum* is a very beautiful species owing to its dense foliage but difficult to thrive in ordinary weather conditions. It is better to train as a potted plant in shade houses. *Alstonia venenata*, *Baccaurea courtallensis*, *Dillenia bracteata*, *Fagraea racemosa*, *Humboldtia bourdillonii*, *H. decurrens*, *Prunus ceylanica*, *Syzygium laetum*, *S. mundagam*, *Careya arborea*, *Cassia fistula*, *Gordonia obtusa*, *Holarrhena pubescens*,



Acranthera grandiflora



Acrotrema agasthyamalayanum



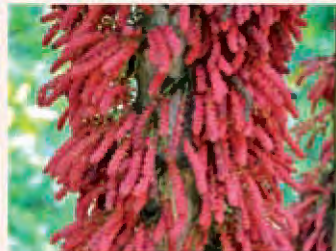
Acrotrema amottianum



Aglaonema simplex



Alstonia venenata



Baccaurea courtallensis



Ardisia solanacea



Barleria courtallica



Bauhinia phoenicea



Begonia albo-coccinea



Begonia amottiana



Begonia dipatala



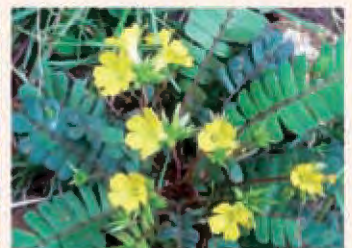
Begonia floccifera



Begonia floccifera



Biophytum poterioides



Biophytum veldkampii



Careya arborea



Desmos chinensis



Henckelia gambleana



Henckelia incana



Hoya wightii



Ipomoea mauritiana



Jerdonia indica



Ixora nigricans



Ixora lanceolaria



Ophiorrhiza eriantha



Tabernaemontana gamblei



Tabernaemontana divaricata



Terminalia paniculata



Syzygium laetum



Syzygium laetum



Strobilanthes pushpangadanii



Pancratium triflorum



Strobilanthes hamiltoniana



Rauvolfia serpentina



Ophiorrhiza schendurunii



Gomphostemma eriocarpum



Syzygium zeylanicum



Melastoma



Melastoma malabathricum



Ophiorrhiza nairii



Justicia santapauli



Ixora polyantha



Jasminum flexile



Quisqualis malabarica



Humboldtia brunonis



Strobilanthes lupulina



Pygeum wightianum



Curcuma aeruginosa



Desmodium heterocarpum



Ensete superbum



Fagraea racemosa



Helicteres isora



Gymnostachyum febrifugum



Humboldtia vahliana



Ixora brachiata



Ixora agasthyamalayana



Lobelia nicotianifolia



Thunbergia mysorensis



Strobilanthes consanguineus

Lagerstroemia speciosa, *Pterospermum* spp., *Symplocos cochinchinensis*, *Wrightia* spp., etc are having beautiful flowers hence they can be planted along the boardwalk and streets or as a break for the gardens. *Anacolosia densiflora*, *Actinodaphne wightiana*, *Buchanania lanceolata*, *Calophyllum inophyllum*, *Diospyros buxifolia*, *D. ebum*, *Dipterocarpus indicus*, *Hopea parviflora*, *Elaeocarpus serratus*, *Kingiodendron pinnatum*, *Lophopetalum wightianum*, *Ormosia*

travancorica, *Schleichera oleosa*, *Syzygium* spp., etc are having very attractive shape and beautiful foliage with occasional flowers or fruits are suitable shade trees for the public parks or gardens. *Tetrameles nodiflora* is a very fast growing tree with attractive buttress and pale bark. *Syzygium travancoricum* and *S. palodense* are two endangered species with edible fruits. They are mainly seen along the water course, hence they can be planted near the waterlogged areas.



A. *Agasthiyamalaia pauciflorum* (Bedd.) S. Rakj. & Janarth.; **B.** *Mesua ferrea* L.; **C.** *Calophyllum inophyllum* L.; **D.** *Fagraea racemosa* Jack.; **E.** *Humboldtia bourdillonii* Prain.

Species of *Humboldtia*, *Vateria indica*, *Calophyllum apetalum*, *Garcinia gummi-gutta*, *Gymnacranthera canarica*, *Myristica malabarica*, *Lagerstroemia speciosa*, *Madhuca neriifolia*, *Semecarpus auriculata*, etc also suitable for waterlogged areas. Apart from their multiple uses, many of the tree species can be grown as potted plants during their early stage of the growth phase. Trees like *Alstonia scholaris*, *Butea monosperma*, *Calophyllum apetalum*, *Cassia fistula*, *Cochlospermum religiosum*, *Lagerstroemia speciosa*, *Mesua ferrea* etc. have extraordinary accent aesthetic features which make worthy of their application as 'Specimen trees' in landscapes.

Shrubs for various purposes

Flowering shrubs provide colours and structure as a backbone to the landscape or the gardens. They

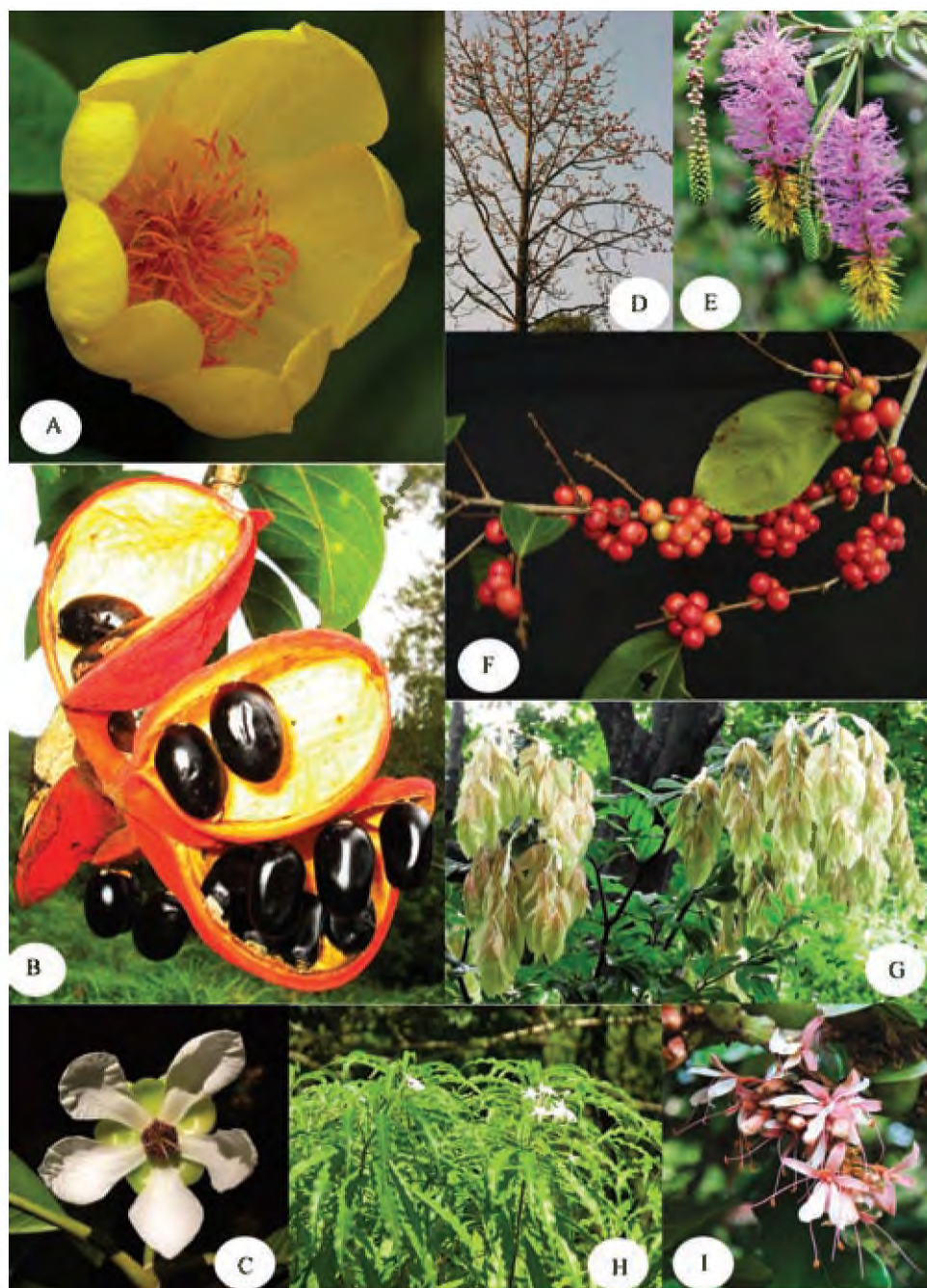
can be used as ground covers, hedge plants or even eye catching focal points. Southern Western Ghats flourished with several shrubby ornamentals with a wide range of shape, size, leaf texture, flower colours and growth habits. *Ardisia solanacea*, *Barleria courtallica*, *B. involucrata*, *B. strigosa*, *Eranthemum capense*, *Helicteres isora*, *Ixora polyantha*, *I. nigricans*, *I. lanceolaria*, *Impatiens grandis*, *Melastoma malabathricum*, *Osbeckia* spp., *Memecylon* spp., *Ophiorrhiza* spp., *Strobilanthes* spp., *Stenosiphonium* spp., *Thespesia lampas* etc. are producing very beautiful flowers, but their period of longevity is limited to a few days to weeks. However, species such as *Ixora johnsonii*, *Ophiorrhiza schendurunii*, *Phyllanthus gageanus*, *Strobilanthes gamblei*, *S. pushpangadan* etc. can be used as a focal point of the garden owing to their beautiful foliage as well as shapes. *Strobilanthes lupulina* is having beautiful pink bracts which remain there for several months. *Ardisia littoralis* is a shade loving plants often seen near the backwaters. *Ardisia blatterii*, *Eugenia mooniana*, *Gomphostemma eriocarpon*, *Memecylon gracile*, *Ophiorrhiza eriantha*, *O. nairii*, *Osbeckia virgata*, *Shefflera venulosa*, *S. wallichiana*, *Strobilanthes* spp., *Tabernaemontana gamblei* etc can be used as potted shrubby

species for decorating in various places of the gardens. Species such as *Angiopteris helferiana*, *Antistrophe glabra*, *Thottea* spp., etc are excellent shade loving plants. *Antidesma acidum*, *Tarenna monosperma*, *Nothopegia aureo-fulva*, *Pandanus thwaitesii*, *Polyalthia suberosa*, *P. longipedicellata*, *Syzygium occidentale*, etc. have beautiful shapes and can be planted along the streams or water bodies. *Syzygium zeylanicum* is a beautiful plant for hedges as well as for focal points owing to its eye catching bunches of white fruits. The plietesial species of *Strobilanthes* and *Stenosiphonium* are taking several years for producing flowers, but their beautiful globose shaped growth habit find them a place in the garden. Most of these species are sun lovers hence can also be recommended as ground covers. *Meiogyne ramarowii*, *M. pannosa* etc. have beautiful conical shape and

yellow flowers. *Ensete superbum* is another key attraction with its peculiar habit. *Breynia patens*, *B. vitis-idaea*, *Fluggea leucopyrus*, *Campylospermum serratum*, etc. have beautiful fruits of various colours. The bell shaped flowers of *Thespesia lampas* and screw shaped fruits of *Helicteres isora* is very characteristic features for those species. The shady and moist areas of the garden may be filled with species of *Thottea*, of which, majority are endemic to the southern Western Ghats. Species of *Thottea* having cup shaped yellow and dark purple flowers can be used as potted plants. Certain species like *Rauvolfia serpentina*, *Rhinacanthus nasutus*, *Senna alata*, *Pavetta indica*, *P. tomentosa*, etc are well known medicinal plants with beautiful flowers. Introduction of such important medicinal plants in ornamental horticulture will ensure its effective conservation.

Vines and other climbers

Vines and other climbing plants are available in a variety of forms, texture and colours. Many of them are having beautiful foliages, flowers or fruits. They are able to grow in both shade as well as in good sun, owing to its phenotypic plasticity. There are several advantages of using them in landscapes. The very important one is, it taking only the vertical space of the garden so that people having little ground space can use them wisely for adding privacy, hiding unsightly scenes, create shades etc. It will also enhance the aesthetic appeal of the garden by the vines being trained on arches, pergolas and trellises to soften the harsh views of rocks, walls etc. Climbers trained on meshes and fences could enact as screens to hide unpleasant/private areas of the garden. *Entada rheedii*, one of the worlds longest liana can be used for covering the vertical walls of multistoried housing and corporate complex. *Anamirta cocculus*, *Coscinium fenestratum*, *Diploclisia glaucescens*, *Bauhinia scandens* etc are evergreen climbers can be used in pergolas. *Kunstleria keralensis* is an endemic species of the southern Western Ghats which can be a great ground



A. *Cochlospermum religiosum* (L.) Alston; **B.** *Sterculia guttata* Roxb. ex DC; **C.** *Dillenia bracteata* Wight; **D.** *Bombax ceiba* L.; **E.** *Dichrostachys cinerea* (L.) Wight & Arn.; **F.** *Flacourtia montana* J. Graham; **G.** *Cynometra bourdillonii* Gamble; **H.** *Alstonia venenata* R. Br.; **I.** *Humboldtia decurrens* Bedd. ex Olive.

covers. Its beautiful leaves and black coloured flowers are very attractive. *Gloriosa superba* is an annual climber with beautiful red flowers and is a good choice for trellises and pots alike. *Bauhinia phenicea* is a massive climber and can be utilized for both ground cover and on pergolas. The beautiful brick red flower during summer is a key attraction to the visitors. *Capparis rheedii* is another promising species with large pale blue flowers with yellow throat and can be planted in rocky areas. *Calamus travancoricus* is a slender cane which can be trained on trellises. *Ancistrocladus heyneanus* is another luxuriant evergreen straggling species with lush green foliages. Species such as *Asparagus racemosus*,

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Combretum malabaricum, *Jasminum flexile* var. *travancorense*, *J. ritchii*, etc. are good climbing species for trellises as well as for ground covers. *Rhaphidophora pertusa*, *Pothos* spp., etc are root climbers ideal for woodland gardens. *Salacia fruticosa*, *S. chinense*, *S. malabarica*, *Sarcostigma kleinii*, etc are interesting for their pretty coloured fruits and lush green climbing nature. *Tetracera akara*, *Jasminum cordifolium*, *J. coarctatum*, *Thunbergia fragrans*, etc are beautiful climbers with flowers. *Getonia floribunda*, often has several clusters of flowers which remain on the plant till the next flowering seasons. *Thunbergia mysorensis* is another remarkable species with long pendent racemes of yellow or yellowish – maroon flowers, is a great choice for pergolas. Species of *Argyreia* such as *A. fulgens* is an endemic species with graceful habit and pink flowers, is a good option for fences. In short, the forests of the southern Western Ghats are having many sort of climbers carved for gardening but very little efforts have been taken so far for their domestication and popularization.

Herbs and other ground covers

This is a large group of ornamental plants occurring in the wilderness. They offer a variety of colour, form, foliage and texture, and are easy to grow and care for. They may be annual, biennials or perennials and most of them are propagated through seeds, bulbs, rhizomes or tubers. In this paper, we have avoided the wild orchids that are already being using elsewhere. The herbaceous wild ornamentals can be classified into tender, semi-hard and hardy species depending on their tolerance with the local weather conditions. They cover the areas quickly by suppressing weeds hence the maintenance cost can be reduced considerably. *Acrotrema arnottianum* and *A. uniflorum* are two commonly available species found in the low level evergreen forests of the southern-most region of Kerala, can be a good choice of potted plants. They are also used as ground covers because of their beautiful foliage and yellow flowers. *Acrotrema agasthyamalayanum* is a high altitude species only

thriving well in shade house as a potted plant. Several species of ferns and fern allied such as *Adiantum raddianum*, *Pteris* spp., *Huperzia* spp., etc can be grown as indoor plants. *Curcuma aeruginosa*, *C. caesia*, *C. ecalcarata*, *Cheilocostus speciosus*, *Dracaena terniflora*, *Hedychium flavescens*, *H. coronarium*, *Dianella ensifolia*, *Pancratium triflorum*, *Zingiber* spp., etc are a few species used as ground covers. *Artanema longifolium*, *Phrynium pubenerve*, *Torenia travancorica*, *Impatiens verticillata*, *I. diversifolia*, *Lobelia nicotianifolia*, etc can be planted in the waterlogged or marshy areas. *Ophiopogon intermedius*, *Peliosanthes teta* ssp. *humilis*, etc are very hardy plants suitable for borders in the gardens. *Anaphyllum wightii*, *Begonia* spp., *Calanthe sylvatica*, *Ecbolium ligustrinum*, *Henckelia* spp., *Elatostemma* spp., *Jerdonia indica*, *Rhynchoetechum permolle*, etc are excellent potted plants in shade houses or shady areas of the gardens. *Biophytum veldkampii*, *B. poterioides*, *Gymnostachyum febrifugum*, *Pennisetum polystachyon*, etc may be used as ground covers. *Aglonema simplex*, *Anoectochilus regalis*, *Asplenium nidus* etc can be used as potted plants of one's choice. *Elephantopus scaber*, *Centella asiatica*, etc. can be used as good ground covers as an alternative to high maintenance turf.

Conclusion

Multiplication, popularization and development of suitable agro-techniques to these vanishing resources is highly inevitable for their effective conservation. A sophisticated plant conservatory-cum-nursery with climatic control will be established for an early establishment of the introduced species. A hybridization unit for developing novel breeds as well as the quality improvement programme is underway. The unit also caters the need of public for quality planting materials for their home gardens. Since it is a new concept, it will take some years to achieve the goal with real effect.

For further interaction, please write to:

E S Santosh Kumar, Jawaharlal Nehru Tropical Botanic Garden and Research Institute, Palode, Thiruvananthapuram District, Kerala-695562, India.

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Crossandra at a Glance



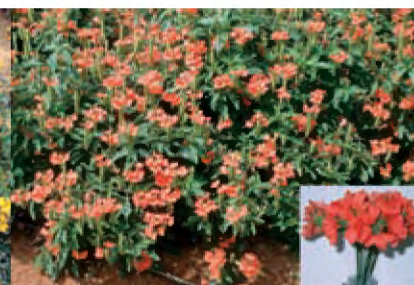
Crossandra



Arka ambara



Arka Kanaka



Arka shravya



Crossandra malavalli



Crossandra multiplication

Crossandra chenna
July–August 2019

Crossandra

: Crossandra is a evergreen semi shrubgrowing to a height of 4ft. It is native to Madagascar, grown in India and Sri Lanka. The flowers are used for hair adornment and garlands are used for Pooja purpose.

Botanical name : Crossandra (*Crossandra undulaefolia* salisb.) syn. *C.infundibuliformis* (L) Nees

Family : Acanthaceae

Commercial varieties : Arka ambara, Arka kanaka, Arka Shreeya, Arka Shravya, Arka Chenna, Local Orange, Soundarya

Economic part : Flower

Propagation technique : rooted Terminal cuttings

Nursery period : Throughout the year except December and January

Multiplication time : 30-45 days

Spacing : 2 ft X 2 ft

Climate and soil requirements : It grows very well from 25 to 40 degree C. Temperature below 15 degree is not suitable. Well drained sandy loamy soil is best suited. It is highly prone to water stagnation

Leaf : Evergreen, simple

Growth form : Perennial herb

Flowering period : Through out the year, less during rainy days, peak during summer

Pollination : Highly self pollinated

Pollinating agent : NA

Economic yield : 300-350 g/plant/year.

First harvest : 6 months after planting

Harvesting method : Hand picking

Harvesting period : Through out the year

Physiological disorder : prone to Iron deficiency

Pests : Midge and Thrips

Diseases : Highly susceptible to Phytophthora wilt

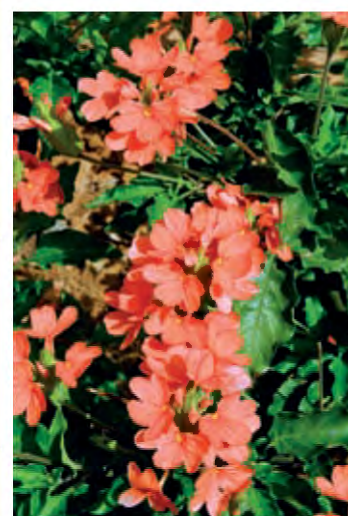
Line	Yield/plant/yr (g)
Arka Ambara	320.
Arka Kanaka	311
Arka Shreeya	315
Arka Shravya	302
Arka Chenna	310
Local Orange	120



Crossandra chenna



Crossandra malavalli



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