

IMPORTANT TREE SPECIES

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Summary

Trees have evolved over many millions of years and this process is still continuing. Modern day trees exhibit great diversity and are represented by broad-leaved hardwoods (generally the dicotyledonous angiosperms), softwoods (gymnosperms, mostly the conifers), and a few non-seed bearing fern trees. Trees are part and parcel of human life. They are providers as well as protectors, in addition to being aesthetically important. Because of this they are worshipped in every religion. Unfortunately, this important resource is a target of civilization as due to the burgeoning human population, they are heavily over-exploited. Taking trees to meet human needs leads to deforestation, land degradation, pollution, floods, biodiversity loss, etc. Plantation forestry has provided some relief but very careful management is required if it is to be sustainable. This chapter aims at providing basic information about useful trees, their distribution and economic importance in different geographical regions of the world.

1. Introduction

A tree is any plant that has a woody stem of at least 8 to 10 feet in height, with crown of branches and leaves at the top. In contrast, a shrub, though woody, has many stems of

smaller size and produces branches close to the ground. The trees are the largest and longest-lived organisms, with a long and often enigmatic evolutionary history. The first ever trees (now extinct) were probably giant Pteridophytes (non-seed bearing plants) of the order Lepidodendrales of Lycopsida (comprising *Lycopodium*, *Selaginella*, etc.) and Calamitales of Sphenopsida (the *Equisetum* group). These formed the well-known *Swamp Forests* of the Carboniferous era (360 to 290 million years ago) that still provide the major source of coal and oil in the present times. Cycads are the most primitive of all the extant trees. Sequoias, in California, are the giants (300 ft tall and 30 ft diameter) and the oldest (about 4000 yrs). Redwoods and Douglas firs of the Pacific coast of North America are the tallest, and the Eucalypts, native of Australia, are the next tallest trees. *Taxodium mucronatum* (Tree of Tule) has the largest circumference (175 ft). Most of the trees belong to the Gymnosperms and Angiosperms, the higher groups of seed bearing plants. However, some ferns e.g. *Cyathea*, though rare, are trees. Some like Bristlecone Pine (*Pinus aristata*) growing in the arid highlands of California are very old (4000 years). A few younger branches of such woody otherwise dead plants are still producing cones. The Maidenhair Tree (*Ginkgo biloba*), is a member of perhaps the oldest known surviving order of trees, having withstood the pressures of a long evolutionary history since the Carboniferous, and is recognized as a *Living Fossil*.

Trees can be classified variously. According to common observations, trees can be evergreen (bearing a full canopy of foliage year-round), semi-evergreen, and deciduous (shedding their leaves in winter). However, scientifically these vascular plants can be grouped as Pteridophytic (seedless vascular plants), Gymnospermic (naked seed-bearing) and Angiospermic (enclosed seed-bearing) trees. Conventionally, Gymnospermic (that lack vessels in the wood) and Angiospermic (that possess vessels in the wood) are referred to as softwood and hardwood trees, respectively.

Pteridophytes are represented by beautiful and graceful tree ferns that constitute a small and relatively rare group confined to humid mountain forests in the tropics, subtropics and warm temperate regions of the southern hemisphere.

Gymnosperms comprise the cycads, ginkgoes and conifers. Cycads, the remnants of much more prevalent group in the geological past, are distributed in the warm regions of the eastern and western hemispheres. Through cultivation the Buddhists have preserved *Ginkgo biloba*, the only living member of the Ginkgoes. Conifers, the largest group of gymnosperms, e.g. pines, cedars, araucarias, hemlocks, firs or Douglas firs etc., are mostly evergreen and possess needle-like leaves.

Conversely, Angiosperms, bearing true flowers and seeds enclosed inside well-developed fruits, have flattened/expanded leaves. Among them, the dominant trees are dicots, while monocots (except for the family Arecaceae or some agaves, *Dracaena* and *Yucca* found in tropical and sub-tropical regions) contain no tree species. Despite their larger size, ‘monocot trees’ and tree ferns are not considered true trees. The broadleaved trees are mostly deciduous (old leaves are shed in winters and new leaves appear in spring). Most of the conifers, except larches, and many of the broadleaved trees found in tropical areas are evergreen.

Trees, though stationary, are organisms possessing enormous range of growth strategies; they are able to withstand harsh environmental conditions of high and low temperature, floods, snow, rains and storms, etc. They live in a diversity of natural habitats and geographical regions including mountaintops, plains, deserts and marshy areas. The average age of trees varies greatly between species. However, they enjoy a long lifespan and rarely die of old age. They may succumb to diseases, insect/pest attacks or some other environmental calamity. Trees have a centralized system with each branch/shoot or root capable of growing independently due to dominance of the apex. The main growing stem often controls their radial growth/expansion. They multiply vegetatively (through suckers and/or stem cuttings) as well as sexually (producing large quantities of seeds). The quality of trees (particularly, orchard/horticultural) can be improved by grafting. Tissue culture, or protoplast culture, has further revolutionized the multiplication of trees particularly for rapid clonal production in large numbers.

Careful microscopic examination of woods can provide information about past climates—a science known as *dendroclimatology*, while the analysis of growth rings (*dendrochronology*) in the trees helps with dating. The formation of growth rings in trees is season-specific and enables them to expand radially. In winters, the cambium remains inactive and results in no radial growth, in contrast to the following active spring growing season. This differential growth results in the formation of growth rings. Heartwood in the center, where large quantities of secondary metabolites are dumped in the absence of an effective mechanism for excretion in trees, is composed of dark coloured dead tissue that provides passive support to the tree. This extremely durable portion is surrounded by another wood called sapwood, that is lighter in colour and younger than the heartwood.

2. Importance of Trees

Trees are the silent protectors of the overall health of our planet. Apart from economic benefits, they provide us with unmatched environmental protection—they reduce soil erosion, act as sink for atmospheric carbon dioxide, release large amount of oxygen, provide shade and protection against harmful UV radiations, absorb pollutants and slow down global climate changes such as global warming. They provide shelter to countless species of wildlife and lower organisms like fungi, lichens, mosses, liverworts and microbes. They mitigate glare and reduce noise levels and are, therefore, considered essential components of urban areas. Their foliage and glossy colourful flowers, bark, branches and fruits add beauty to their habitat. Exhibiting a broad range of colour, diversity in structure, form, canopy and architecture, they are used in city landscaping. They meet the demands of firewood, charcoal, timber, fodder, medicines, oils and food, apart from a number of industrial products including gums, resins, rubber, cork, etc.

Trees live much longer than human beings. They have featured in many religions and folklores. Evergreen conifers are used in Christmas celebrations. Tree worship was common amongst Teutonic and Scandinavians. In Hindu mythology, there are mentions of a number of sages like Valmiki and Kalidasa who meditated under the canopy of trees. They are even worshiped and found in religious ceremonies. Lord Buddha achieved enlightenment under a Bo tree. The leaves of *Aegle marmelos* are offered to

Lord Shiva. The Royal Oak (*Quercus robur*) sheltered Charles II, King of England, after defeat in 1651.

Owing to its geographical situation and seasonal variations, India has a vast diversity of trees. Noteworthy among them are *Cassia fistula* (Indian laburnum), *Erythrina indica* (Indian coral tree), *Butea monosperma* (Flame of the forests), *Bombax ceiba* (Red silk-cotton), *Anthocephalus kadamba* (Kadam), *Mimusops elengi* (Maulsari) etc. A number of other multipurpose trees like *Mangifera indica* (Mango), *Syzygium cumini* (Jamun), *Emblica officinalis* (Amla), *Moringa oleifera* (Drumstick), *Cocos nucifera* (Coconut) *Tamrindus indica* (Tamrind), *Aegle marmelos* (Bil), are known for their fruits, rich vitamin or medicinal value. *Azadirachta indica* (Neem) is a rich source of bio-pesticides. Avocado (*Persea americana*) is famous for its nutritious fruit and oil in Central America and Mexico. *Ficus spp.* (Figs) provide shade and possess religious importance. *Terminalia arjuna* (Arjun) has medicinal value. *Santalum album* (sandal wood) is known for its scented wood and oil, apart from food, cool drink and shelter. *Morus spp.* (Mulberries), *Thuya sp.* (Red Cedar), and Bayberry Birches are popular for birds and wildlife shelter.

In spite of all this, trees remain short of meeting the basic needs of the people, particularly fuel-wood energy in rural areas of the developing world. Here, most of the timber yielders like teak, deodar, rosewood, and sandalwood are over-exploited and prone to illicit felling and smuggling. This has led to depletion in natural forests. In order to cope with the demand and saving the natural forests, plantation forestry has been adopted as the solution. In this context, various afforestation and reforestation programmes like social-forestry, farm-forestry and agro-forestry have been introduced almost throughout the forest-deficient world. As a consequence, many exotic tree species have found their way to different countries. Some exotics have revolutionized the landscape and set-ups in their new place. *Hevea brasiliensis* for rubber, *Cinchona* for anti-malarial drug, *Jacaranda mimosifolia*, *Tecoma argentea*, *Delonix regia* (Gulmohar) for avenues while *Anacardium occidentale* for casewhnut, *Theobroma cacao* for beverage trees and *Eleaeis guineensis* (African Oil-palm) for cooking oil, etc. have been planted on a large scale. In India, large-scale introduction of fast growing trees like *Eucalyptus* and *Populus* for industrial use has greatly changed the land scenario, but their large-scale introduction, at the cost of natives like *Dalbergia sissoo* (Rosewood), *Acacia nilotica* (Babul), *Azadirachta indica* (Neem) and *Moringa oleifera* (Drumstick) has led to controversial ecological changes and has resulted in renewed interest in indigenous trees. Many efforts are being made to strengthen the science and awareness of plantation forestry through improving breeding systems, and understanding genetic variability, phenology, pollination biology, seed production, ecology, soil biology, and entomology. In addition new information on germplasm collection, provenance trials, progeny testing, and growth curves, etc., is being sought the world over.

Although every tree is important economically and ecologically, in the present overview, an attempt has been made to briefly discuss some of the most important ones, adopting the arrangement of the articles covered under this topic.

3. Softwoods

Gymnosperms are mostly woody plants that originated in the late Devonian and flourished in the Triassic until they were largely replaced by angiosperms. Several members of the gymnosperms are extinct, but among the living, conifers are the most widespread and largest group. They represent large evergreen trees with separate male and female strobili (cones) borne on the same (e.g. *Pinus*) or different individuals (e.g. *Ginkgo*). They are found primarily in the temperate and boreal zones of the world. Junipers, pines, larches and spruces, the most dispersed gymnosperms, are found throughout the northern hemisphere, whereas Araucarias are the most widespread in the southern hemisphere. Redwoods are restricted to California. Gymnosperms yield commercial lumber (e.g. pines, Douglas firs, spruce, firs, cedars, hemlocks, etc.), food (Himalayan edible pine, pinyon pine, some junipers, larches and cycads), volatile terpenes, resins and gums besides providing ornamental value. *Cycas*, *Macrozamia* and *Zamia* yield starch that is used in foodstuffs. Conifers are widely planted in all kinds of afforestation programmes, particularly as shelterbelts/windbreaks.

Conifers—the largest group of Gymnosperms—are represented by 50 genera and 550 species; they include world's tallest and oldest trees. The modern genera like *Sequoia*, *Abies*, *Cupressus*, *Juniperus*, *Larix*, *Pinus* and *Pseudotsuga* represent the largest trees. Most conifers are evergreen, woody, upright trees but some have a shrubby nature. *Dacrydium laxifolium* found in New Zealand is the smallest gymnosperm, whereas *Sequoia giganteum* in California is the tallest tree of the world. The oldest conifers like *Pinus longaeva* are about 5000 years old. The leaves of the conifers, to conserve water, are generally needle-like or scale-like or intermediate between the two. In most, male and female cones are found on the same tree, though there are dioecious species also.

Conifers are represented by 9 families. The family Araucariaceae include two genera, *Araucaria* and *Agathis*, with 18 and 13 species, respectively. They are distributed in the southern hemisphere, extending up to Southeast Asia. Many of the Araucarias and *Agathis* distributed in tropical and sub-tropical forests of New Caledonia are endemic to the region. The family Cephalotaxaceae represented by *Cephalotaxus* and *Amentotaxus* with 12 species is found in the Himalayas, Japan, Taiwan, and Thailand. Fossil evidence indicates that this family was once widely distributed in the Old World. The family Cupressaceae has 20 genera and 125 species that are widely distributed throughout the world. They have a greater degree of adaptability and can tolerate boggy and swampy sites. *Phyllocladus* is the only representative of the family Phyllocladaceae which is restricted to New Zealand and Australia in the region of montane forests. Though it is quite similar to the family Podocarpaceae, there are some unique features like the presence of phylloclades, that make it different from the latter. The family Pinaceae has 12 genera and about 200 species distributed exclusively in the northern hemisphere. These are *Pseudolarix*, *Larix*, *Pinus*, *Cedrus*, *Cathaya*, *Hesperopeuce*, *Picea*, *Tsuga*, *Nothotsuga*, *Pseudotsuga*, *Abies* and *Keteleeria*. All genera have living as well as fossil species and have evolved in the northern hemisphere. Another large family, the Podocarpaceae is represented by 17 genera and nearly 125 species which are distributed in the tropical and sub-tropical regions of the southern hemisphere. The genera of this family include *Parsitaxus*, *Microcachrys*, *Microstrobos*, *Lagarostrobus*, *Lepidothamnus*, *Dacydium*, *Dacrycarpus*, *Halocarpus*, *Acropyle*, *Falcatifolium*, *Retrophyllum*, *Nageia*, *Podocarpus*, *Afrocarpus*, *Saxegothaea*, *Prumnopitys*, and *Sundacarpus*. Sciadopityaceae is a distinct family represented by single monotypic

genus, endemic to mountains of central and southern Japan. The trees have a sparse and restricted distribution and, as per the fossil records, the small range of these trees is highly relictual. The family Taxaceae has four genera: *Pseudotaxus*, *Austrotaxus*, *Torreya* and *Taxus*, with nearly 20 species. The members of family Taxodiaceae are distributed in north temperate to sub-tropical regions of both old and new worlds, except for *Athrotaxis* that is present in the southern hemisphere also. This family includes *Glyptostrobus*, *Metasequoia*, *Taxodium*, *Cryptomeria*, *Athrotaxis*, *Sequoiadendron*, *Taiwania*, *Cunninghamia*, and *Sequoia*.

Thus, the conifer group is an assemblage of diverse species distributed across various parts of the world. They are economically very important and in fact have been over-exploited. Their wood, generally a high quality timber, is categorized as soft and is used for furniture, house building, posts, poles, pulpwood for paper, and fuel. Conifers are also a source of volatile oils, turpentine oils, oleoresins, and pharmaceuticals, etc. The wood of Douglas Fir is considered to be one of the most valuable. Because of the high quality timber, their rate of exploitation exceeds their natural regeneration and growth. Consequently, the relatively fast growing introduced pines have replaced some of the rare but slow-growing conifers. It is, therefore, very important to preserve this immensely useful genetic resource. Some of the conifers that enjoy wide use are described hereunder.

***Abies* (Fir)**

This is a large genus of over 40 species distributed throughout the North Temperate Zone. Firs are tall, evergreen monoecious trees with small twigs having circular leaf scars. *Abies* are known as true firs, to differentiate them from the Douglas Fir or Chinese Fir, etc. They are well adapted to snowy environments due to their short stout branches and pointed tips. Young stems of the tree have fragrant blisters. The buds are round and covered with resinous waxy material. The cones that appear on the topmost branches are sticky with fragrant drops of resins and do not fall intact; they shed their scales one by one. Firs are a source of timber, but quality-wise the wood is not considered very good compared to other trees. Some species are a source of turpentine oil and have medicinal value. *Abies* are also used as Christmas trees.

Abies alba (Silver Fir), ecologically and historically important in Europe, occurs naturally in sub-alpine forests and in mixture with Pines or Larch or Beech or other broadleaved trees in montane forests. Since its natural stands are rich in biodiversity and give good landscape, their conservation has been emphasized. It thrives best in fertile soils rich in limestone and silicates.

Abies concolor (White Fir) is another important productive and valuable forest tree that dominates over large areas of montane forests in California and southern Oregon and eastward into the central and southern Rocky Mountains. It grows best on moderately deep and well drained sandy-loam to clay-loam soils, from flat to gentle slopes at an altitude from 1500 to 3500m. The wood is used as timber for heavy construction, boxes, plywood, pulp, etc.

Abies pindrow (Silver Fir) is a fast growing, evergreen commercially important tree with a dense conical crown of dark green foliage, extensively found in dry and moist temperate forests of the western Himalayas in Afghanistan, Pakistan, India, Bhutan and Nepal at altitudes of 2000 to 3500 m in pure stands or in association with numerous coniferous and broadleaved species. The wood has straight-grains, and medium-fine and uneven texture. The wood, that yields good pulp, is non-durable, difficult to treat with preservatives, but easy to saw and work.

Abies balsamea (Balsam Fir), one of the ten fir species native to North America, is a popular Christmas tree in Canada and eastern USA. It serves as a good windbreak and an important source of food and cover for wildlife. Its wood is light, soft, weak and dull with straight- and even-grains; boards produced from it are, therefore, distinct. Because of poor mechanical properties, its nail-holding capacity is low. However, it is good for quality paper, pulp, and tissue paper, etc. The resin, buds and sap have been traditionally used to treat a number of ailments, while medicinal compounds and spirit varnishes are prepared from its extract.

Abies religiosa, (Mexican Fir) grows in pure stands and in association with other tree species in humid climates. The wood is of medium to good grade, coarse-grained, and easy to work. It is also used for medicinal and ornamental purposes, and as a source of paper pulp. Young plants are used as Christmas trees, although the needles tend to fall before the Christmas season is over.

***Cedrus* (True Cedars)**

They are tall, monoecious trees with needles borne in dense clusters arising from stout woody pegs. The barrel shaped cones are found on the top of the branches. True cedars, generally native to the Mediterranean, Middle East and Himalays, are different from the false cedars found in the pacific northwest. The genus is represented by four distinct species reported from the rocky mountains of North Africa. *Cedrus deodara* is one of the most important and easily recognisable with yellow green to blue green needles borne in dense clusters. Native to the Himalayan mountains, it is an important source of wood.

***Cupressus* (Cypress)**

Cupressus is native to warm temperate climates in the northern hemisphere, and is also found in the Mediterranean, North America and Asia. Many of the *Cupressus* species show similarities with other genera especially *Chamaecyparis*, *Taxodium* and *Cupressocyparis* and even confuse taxonomists. The trees are large, evergreen, and exhibit a great variety in shape, size and colour. There are species that are extremely drought resistant.

One of the important *Cupressus* species is: *C. sempervirens* (common or evergreen cypress) that is native to Turkey, Greek islands, the Middle East and North Africa. It produces high quality durable wood that is resistant to pests. It is ornamental, medicinally important and used for soil conservation. *C. lawsoniana* (Lawson's Cypress) is widely planted in Europe, and *C. arizonica* (Arizona Cypress) and *C.*

macrocarpa (Monterey Cypress) are grown in the United States, mainly for ornamental value, wood and landscaping, etc.

Several *Cupressus* species are found in Asia. These are *C. cashmeriana* (Kashmir cypress) native to the Himalayas and grown mainly for ornamental value in gardens, avenues and temples. It is also a source of timber. *C. lusitanica* (Mexican cypress), prone to fire, is grown through the Mediterranean regions of the world. *C. disticha* (swamp or deciduous cypress) is an agroforestry tree that grows in swampy regions of the world including India, Mexico and USA. *C. torulosa* (Himalayan or Bhutan Cypress) also provides good quality timber. *C. formosensis* (Formosan Cypress), found on mountains of Taiwan and an introduced species in China, is another species providing light red high-quality timber used for construction purposes. *C. japonica* (Japanese Cedar) is grown extensively in Japan.

***Juniperus* (Juniper)**

Junipers, with about 60 relatively ill-defined known species are slow growing, dioecious, short, durable trees with aromatic wood that tolerate extreme conditions in temperate semi-arid and arid climates of the northern hemisphere. The leaves of these trees are either scale-like or needle-like. The fruits are rounded. *J. scopulorum* (Rocky Mountain Juniper) and *J. virginiana* (Red Juniper) are important ornamental species of North America. *J. scopulorum*, known for its longevity, tolerates high water deficits and can be grown in dry montane, boreal, temperate, semi-arid or mesothermal climates. It is also grown for the purpose of soil conservation.

The wood of *J. virginiana* is highly valuable because of its durability, workability and beauty. The tree provides oil for fragrance, and shelter, resting, nesting and roosting sites for birds and other wildlife. *J. excelsa* (Grecian juniper) and *J. foetidissima* are grown in Mediterranean regions of both Europe and southeast Asia. The wood of both these trees is valuable and durable, resistant to fungi and insects and possesses anti-microbial and medicinal value.

Among the other species *J. chinensis* is a large evergreen tree that occurs in China, Japan, and Korea, where it is planted for valuable wood, seed oil, afforestation and ornamental value. Another species, *J. alata*, found in the moist rain forests of South-East Asia, is over-exploited due to its good quality timber.

***Picea* (Spruce)**

Picea are evergreen conifers represented by about 40 species, almost all of which are distributed in the northern hemisphere. Of these, about 30 are native of temperate areas and 7 being of USA. *Picea* needles are stiff and prickly and arise from small woody pegs. The bark is scaly and the cones papery and thin. Some species, for example, *Picea abies* exhibit a number of varieties and forms. Since it is so widely distributed in Eurasia, and shows large phenological variations, its taxonomic status remains difficult to ascertain. Economically, the most important conifer of Europe, it is fast growing, hardy and productive in both natural and artificial stands.

The area of its distribution includes central, south-eastern and north-eastern Europe, Russia, Siberia and the East Ural mountains, at altitudes up to 2300 m. It is also planted in its native Eurasia as well as outside in Japan, Korea, USA, Canada, South Africa, Australia, and New Zealand. The wood is light with little distinction between heartwood and sapwood and yields high quality pulp with balanced strength properties. The nailing and screwing quality is good.

Its important species include *P. glauca* (White or Canadian Spruce), *P. rubens* (Red Spruce/Eastern Spruce/Yellow Spruce), *P. sitchensis* (Sitka Spruce)—an ecologically important coastal species of the north temperate coastal rain forest of western North America and valuable for pulp, lumber, and musical instruments, etc., *P. obovata* (Siberian Spruce)—a source of quality timber species widely distributed in Eurasia, *P. smithiana* (Himalayan Spruce)—an ornamental tree in Western Himalayas possessing the longest needles of all *Picea* species, *P. koraiensis* (Korean Spruce)—a source of timber, habitats for a wide variety of game and non-game wildlife, forage for livestock, and used for recreation, re-vegetation, and land reclamation, etc., *P. mariana* (Black Spruce)—a widely distributed, major component of boreal, especially post-fire, forests and a source of quality pulp, gum and resins, *P. orientalis* (Oriental Spruce), *P. pungens* (Blue Spruce)—with ornamental value in USA and Europe is slow-growing, long-lived conifer serving as a Christmas tree and as food and shelter for birds and other wildlife. It is also used as indicator of deer populations.

***Pinus* (Pine)**

Pinus, the largest genus of the family Pinaceae comprising tall, evergreen, monoecious trees, is represented by nearly 90 species distributed in the northern hemisphere, extending across the equator near Indonesia. The long life of some of the pines can be attributed to the presence of functional needles that survive for 20 to 30 years, providing photosynthates to the tree. The needles, restricted to the lateral spur shoots are ultimately shed as a unit from the tree, exhibiting an example of vegetative specialization. Pines are the source of valuable timber used extensively for making furniture, doors, railway sleepers, window frames and paper-pulp, etc.

Based on the number of needles, Pine timber is divided into the *soft pines* (5 needled species with pale-coloured wood), and the *hard pines* (2-3 needled species with heart wood always darker than the sap wood). Several species provide oleoresin, which upon distillation yields turpentine oil and the non-volatile product *Rosin* or *Colophony*. These find extensive use such as in paints, varnishes, soap and synthetic pine oil industries. Some species, e.g. Himalayan Edible Pine or Pinyon Pine, yield edible seeds with removable testa. The bark of *Pinus* is also known to yield a dye.

Pines native to North America have been widely planted throughout the world in a variety of climates like sub-alpine, semi-arid, tropical and sub tropical. Apart from their ornamental value, they are also planted to serve as a source of mulch, straw or as shelterbelts and windbreaks in agroforestry, etc. Most of the North American pines also provide shelter and food for wildlife and game birds and thus do a great environmental service. The important North American species include *P. albicaulis* (White Bark Tree), *P. banksiana* (Jack Pine), *P. contorta* (Shore Pine), *P. ponderosa* (Ponderosa Pine), *P.*

echinata (Short Leaf Pine), *P. edulis* (Pinyon Pine), *P. elliottii* (Slash Pine), *P. flexilis* (Limber Pine), *P. radiata* (Radiata Pine), *P. lambertiana* (Sugar or Big Pine), *P. montezumae* (Montezuma Pine), *P. monticola* (Western White Pine), *P. muricata* (Bishop Pine), *P. patula* (Mexican Weeping Pine), *P. strobus* (Eastern White Pine), *P. taeda* (Loblolly Pine), *P. tecunumanii* (Tecunuman Pine), *P. rigida* (Pitch Pine), *P. macrocarpa* (Big Cone Pine), *P. jellreyi* (Jeffery Pine), *P. leiophylla* (Smooth Leaved Pine), *P. pseudostrobus*, (Pseudostrobus or Smooth Barked Pine).

The pines native of the Mediterranean region are also found as plantations in several regions of Europe and Asia. Apart from their recreational value, they are used for timber, wood and various non-wood products. The common ones include: *P. halepensis* (Aleppo Pine), *P. brutia* (Brutian Pine), *P. pinea* (Stone Pine), and *P. pinaster* (Maritime Pine). Other pines native of Europe include: *P. cembra* (Arolla or Swiss Stone Pine), *P. nigra* (Black Pine), *P. canariensis* (Canary Pine), while those of Asia are: *P. densiflora* (Japanese Umbrella Pine or Japanese Red Pine), *P. kesiya* (Khasya Pine), *P. gerardiana* (Himalayan Edible Pine), *P. koraiensis* (Korean or Fruit Pine), *P. roxburghii* (Chir Pine), *P. thunbergii* (Japanese Black Pine), and *P. wallichiana* (Blue Pine).

***Thuja* (Arborvitae)**

Thuja, represented by five species, is an evergreen, monoecious tree native of North America and far-eastern Asia (Japan, Korea and China). The leaves are scale like and of two types with decussate arrangement. Their cones are like rose buds or the bowl of a smoker's cup. *T. occidentalis* (Eastern or Northern White Cedar) with very high canopy density and limited commercial value, is native to North America but is planted extensively in Europe, Eurasia and China as an ornamental or for soil conservation, windbreaks and shelterbelts. *T. plicata*, (Western Red Cedar) is highly tolerant of different environmental conditions and a source of wood and several non-wood products. It is native to North America but has been widely introduced in Europe.

***Tsuga* (Hemlock)**

Tsuga, represented by 14 species and spread throughout Eastern and Western North America, China, Japan and Taiwan, are tall, monoecious, commercially important, evergreen trees with short linear leaves with a notched apex. The trees are distinct with their drooping tops and branches. Unlike pines, the pollen grains are not winged (except one subgenus which has winged pollen) but they have an annular frill. Male and female cones are generally solitary.

Tsuga canadensis (Eastern Hemlock), introduced in Europe, is native of North America. This is a typical species of wet temperate regions with lot of frost tolerance. Recognized for its ornamental and wood value, it is used in medicine while its bark is used for dyes and tanning. *T. heterophylla* (Western Hemlock), is an efficient producer of fibre. It is native to North America, growing on acidic and nutrient poor soils in cool temperate environments, but it is planted in India, U.K. and other parts of Europe.

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SAMPLE CHAPTERS