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A HANDBOOK OF CONIFERÆ

INCLUDING GINKGOACEÆ

A
HANDBOOK OF CONIFERÆ
INCLUDING GINKGOACEÆ

BY

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AND

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WITH DRAWINGS BY MISS G. LISTER, F.L.S.

SECOND EDITION

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PREFACE TO FIRST EDITION

In the present handbook conifers are dealt with from the point of view of the gardener, forester, and student rather than the botanist, and we have therefore tried to describe the plants in as simple language as possible. In order to add to the usefulness of the work we have endeavoured to include all known species, although many of them are not suitable for outdoor cultivation in the British Isles.

The keys for the identification of the genera and species in cultivation, if used with care and in conjunction with the illustrations, should enable the student to identify most of the conifers he meets with in gardens. Species not known to grow in this country are as a rule omitted from the keys.

Recent expeditions to China have resulted in a large addition to the conifers cultivated in Britain. Many of these are still in a young state, and the identity of some of them is obscure. It is evident, however, from a careful study of the available material, that the number of species is fewer than was at first supposed.

The names adopted are chiefly those of the Kew *Hand-list of Coniferæ*, except where recent research has dictated to the contrary. A fairly complete list of synonyms and common names has been included.

Our descriptions have in most cases been drawn up from living plants or herbarium specimens.

We wish to record our thanks for facilities granted by the present Director, Dr. A. W. Hill, and to Sir David Prain, the late Director of Kew; to Dr. O. Stapf, for help with the genus *Podocarpus* and for advice upon difficult points. We are also under obligation to colleagues and friends at the Royal Botanic Gardens, Kew, and the British Museum (Natural History), for help in various ways. Professor A. Henry has allowed us to make free use of information from *The Trees of Great Britain and Ireland*, and given us other assistance.

The following owners of estates, among others, have kindly furnished us with specimens of living conifers for study and comparison :—His Grace the Duke of Bedford ; the Marquis of Headfort; Lieut.-Colonel Sir George Holford ; the late Sir Edmund Loder, Bart. ; Sir John Ross of Bladensburg ; Mr. G. W. E. Loder ; Professor W. W. Smith (the Regius Keeper, Royal Botanic Gardens, Edinburgh) ; Mr. C. Coltman-Rogers ; Mr. W. Banks ; Mr. H. Clinton-Baker. To Sir John Stirling Maxwell and Mr. F. R. S. Balfour we are indebted for the loan of photographs for reproduction ; and we have also to thank the Council of the Royal Horticultural Society for permission to reproduce illustrations from their *Journal*. Messieurs L. Pardé and R. Hickel, the well-known French authorities on conifers, in addition to identifying critical species, have also sent us many interesting specimens from the famous arboretum at Des Barres and other French gardens and nurseries.

Miss G. Lister, whose careful and accurate drawings are a feature of the book, has made many useful suggestions, and her assistance with the proof sheets has been invaluable.

W. D.
A. B. J.

PREFACE TO SECOND EDITION

The first edition of this work being exhausted and a new edition rendered necessary, the opportunity has been taken to correct obvious errors and misprints, and to include descriptions of several species and varieties which were inadvertently omitted. During the seven years which have elapsed since the book was first published a considerable number of new species have been described, chiefly as the result of recent exploration by collectors in China and elsewhere, and though in every case we have not seen specimens which would enable us to judge of their status, short descriptions of the most important have been included in this revision.

As it was not possible, except at very considerable expense, to place these additional species in their correct alphabetical positions in the genera, they have been included as a supplement at the end of the work with a separate index.

We have also endeavoured to bring the book into line with the latest views on nomenclature, by giving a list of names, at the beginning of the book, which are more strictly in accordance with the Vienna rules for the species concerned than those used in the text, which are the well known names current in gardens in this country.

In order to facilitate the use of the book we have substituted generic headings for family headings on the right hand pages.

W. D.
A. B. J.

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LIST OF SYNONYMS

In order to avoid difficulties amongst cultivators old well-known specific names were retained in the original edition of this work, instead of using names many of which, though botanically correct, were practically unknown amongst arboriculturists. We, however, now consider that it would have been wiser to have given both names, and in order to direct attention to the most important instances the following special list of synonyms is given :—

Name appearing in this Work.	Correct Name according to the Rules of Botanical Nomenclature.
Abies brachyphylla Maximowicz.	*Abies homolepis* Siebold & Zuccarini.
Abies bracteata Nuttall.	*Abies venusta* K. Koch.
Abies pectinata De Candolle.	*Abies alba* Miller.
Abies Webbiana Lindley.	*Abies spectabilis* Spach.
Agathis loranthifolia Salisbury.	*Agathis alba* Foxworthy.
Araucaria imbricata Pav.	*Araucaria araucana* K. Koch.
Cunninghamia sinensis R. Brown.	*Cunninghamia lanceolata* Hooker.
Cupresses cashmeriana Royle.	*Cupressus pendula* Griffiths.
Glyptostrobus heterophyllus Endlicher.	*Glyptostrobus pensilis* K. Koch.
Larix americana Michaux.	*Larix laricina* K. Koch.
Larix europaea De Candolle.	*Larix decidua* Miller.
Larix leptolepis Murray.	*Larix Kaempferi* Sargent (not Carriere).
Libocedrus Doniana Endlicher.	*Libocedrus plumosa* Sargent.
Picea alba Link.	*Picea glauca* Voss.
Picea morindoides Rehder.	*Picea spinulosa* Henry.
Picea nigra Link.	*Picea mariana* Britton, Sterns and Pogg.
Pinus Laricio Poiret.	*Pinus nigra* Arnold.
Pinus montana Miller.	*Pinus Mugo* Turra.
Pinus tuberculata Don.	*Pinus attenuata* Lemmon.
Pseudolarix Fortunei Mayr.	*Pseudolarix amabilis* Rehder.
Pseudotsuga Douglasii Carriere.	*Pseudotsuga taxifolia* Britton.
Thuja japonica Maximowicz.	*Thuya* (*Thuja*) *Standishii* Carriere.
Tsuga Albertiana Sénéclauze.	*Tsuga heterophylla* Sargent.
Tsuga Brunoniana Carriere.	*Tsuga dumosa* Sargent.
Tsuga Pattoniana Sénéclauze.	*Tsuga Mertensiana* Sargent (not Carriere).

A HANDBOOK OF CONIFERÆ

INTRODUCTION

THE CONIFERÆ.

The trees and shrubs included under the Coniferæ form a group which was much better represented at earlier periods of the world's history than at present, although it is still the most important class of Gymnosperms.

They comprise two families, forty-four genera, and about 380 species. With them is usually included the family *Ginkgoaceæ*, although recent research places it between the Coniferæ and *Cycadaceæ*, with affinities to ferns.

The geographical distribution of existing species of conifers is of great interest, some being widely spread, while the majority are confined for the most part to distinct areas, a few being decidedly local. All are temperate or sub-tropical plants, those found in tropical latitudes being confined to sub-tropical or temperate elevations.

Morphology.

A detailed account of the anatomy and life-history of the Coniferæ is beyond the scope of the present work. There is a large literature on this branch of the subject scattered through various botanical publications. A good account of the group is given by Coulter and Chamberlain,[1] and we do not propose to give more than a general outline here or such information as is necessary for purposes of identification.

The Seedling Plant.

Seedling conifers present special points of interest. In the first place, the number, form, and size of the cotyledons or seed-leaves vary greatly in different genera and species, and often furnish sufficiently distinctive characters for identification. The cotyledons usually appear above ground, but in the genus *Araucaria* two forms of germination occur ; one in which the two seed-leaves do not appear above the surface of the soil, as in

[1] *Morphology of Gymnosperms* (1917). See also Masters, "Anatomy and Life History of the Coniferæ," *Journ. Linn. Soc.* XXVII, 226 (1890).

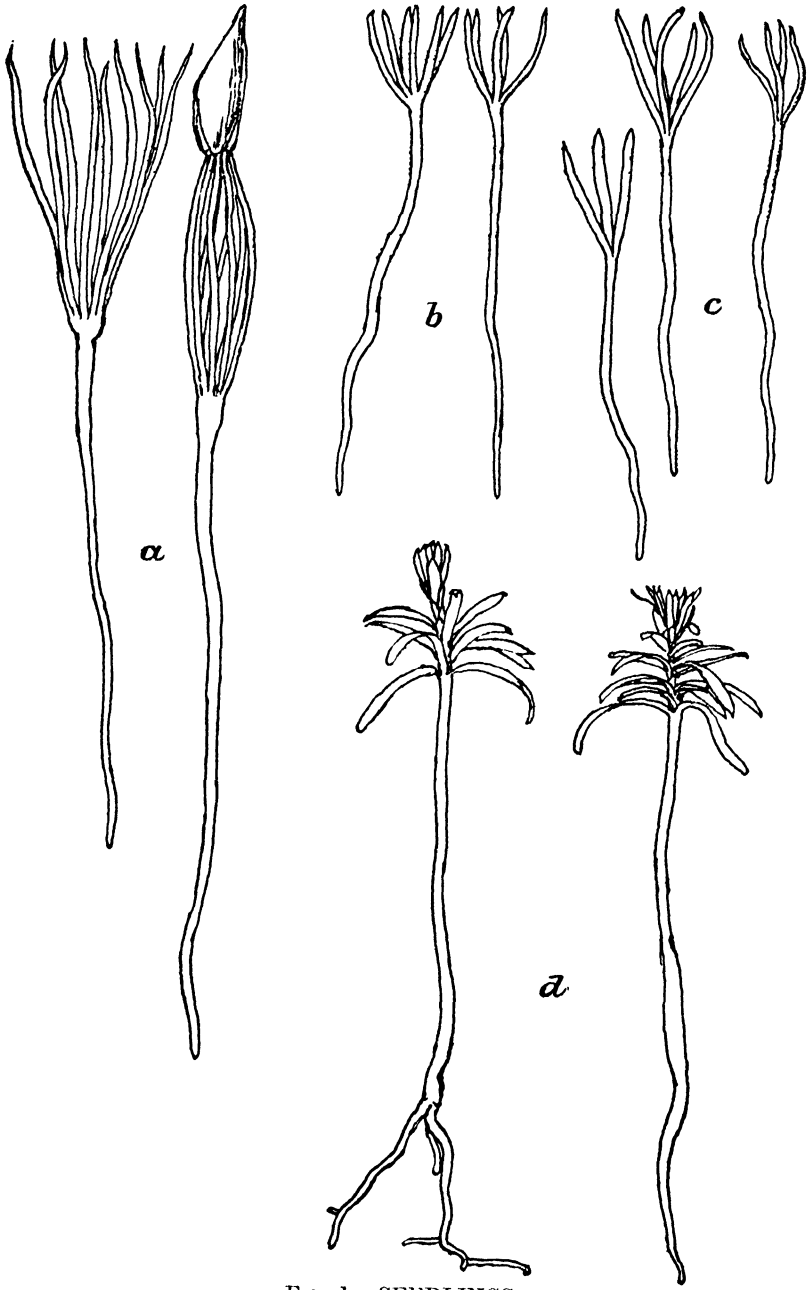

FIG. 1.—SEEDLINGS.

a, *PINUS CANARIENSIS*, two seedlings with nine cotyledons, which in one specimen are still enclosed at the tips in the seed-coat; *b*, *ABIES SUBALPINA*, two seedlings with five and six cotyledons respectively; *c*, three seedlings of *TAXODIUM DISTICHUM*, with three, four, and five cotyledons; *d*, two seedlings of *TAXUS BACCATA*, with two and three cotyledons respectively and succeeding leaves.

A. imbricata (the common monkey puzzle), but are enclosed within the seed, the other in which the four seed-leaves are raised upon a well-marked stalk. In the genera *Torreya* and *Keteleeria* the cotyledons also remain enclosed within the seed. The number of the cotyledons is very variable. In the *Cupressineæ* and *Taxaceæ* they rarely exceed two; when more than two, as in *Pinus* and *Abies*, the number is often variable, ranging from 3 or 4, as in *Pinus contorta*, to 15 or 18, as in *P. Sabiniana*.

The size of the cotyledons also varies greatly in different species of the same genus. In *Pinus Pinea*, *P. canariensis*, and *P. Armandi* they are 1½–2 in. long and proportionately stout, while in *P. contorta* they rarely exceed ½ in. in length and are very slender. The cotyledons are usually linear in form and in some cases the midrib is prominent. In many species of *Pinus* they are three-sided and in *P. Strobus* they are distinctly toothed on the margins. The apex may be pointed, as in *Pinus*, or blunt and notched as in *Abies*. In some species of *Abies*, *Pinus*, and *Larix* the cotyledons are longer than the primordial leaves which follow. In certain species of *Thuya* and *Cupressus*, they are about the same length as the succeeding leaves. The cotyledons usually fall away during the first year, but in *Taxus* they persist until the third and in *Abies* until the fourth year.

Trunk and Branches.

The relatively large development of the trunk as compared with that of the branches is a characteristic of many conifers. The verticillate arrangement of the branches, their spreading direction and gradual diminution in size from below upward, give rise to a tree of markedly pyramidal form, which depends mainly on the alternate development and non-development of the buds. In later life the tree generally loses its lower branches and the branching at the apex becomes less regular. In cases where the development of stem and branches is more equal, as in the yew, a bushy habit is the result. This form becomes modified into a fastigiate or columnar habit as the branches assume an upward tendency, as in *Libocedrus decurrens*, while pendulous forms are produced by the downward tendency of the branches.

Buds.

The buds of conifers are much like those of other plants in their position and arrangement. A usual feature in the development of the leading shoot is a terminal bud surrounded by smaller buds, while in lateral shoots the terminal bud is often accompanied by two smaller buds, which sometimes remain dormant. The shape of the buds and budscales and their resinous or non-resinous character often afford good specific characters. The young

shoots which develop from the buds vary greatly in colour and degree of hairiness; they also furnish in some instances a reliable means of identification. In *Larix*, *Pseudolarix* and *Cedrus* two kinds of shoots are produced, the one long and slender, with scattered leaves, the other short and thick, with the leaves in tufts at the extremities. The former are extension or leader shoots, the latter resemble the spurs of fruit trees.

Foliage.

The leaves of conifers, which, except in a few genera, are evergreen, vary considerably in appearance. The adult leaves are ovate, needle-like, flat, and linear, or assume the form of closely pressed scales. In many cases the leaves which succeed the cotyledons differ in form, attachment, or arrangement, and to some extent in structure from those which characterize the adult state of the tree. The arrangement of the leaves often varies on different parts of the tree. Thus on the erect leading shoots of various species of *Abies*, *Picea*, *Pseudotsuga*, *Tsuga*, *Taxus*, and *Cephalotaxus*, the leaves spread on all sides. On coning shoots the leaves are vertically placed, while on the lateral branches they are arranged nearly in one horizontal plane. The surface of the leaf is perforated with stomata which are breathing pores or apertures in the epidermis surrounded by guard cells leading into an intercellular space below. In *Pinus*, *Picea*, and *Abies* the stomata are disposed in longitudinal bands on one or both surfaces, their position being indicated by white dots of glaucous bloom.

Beneath the epidermis are usually found one or more layers of long, thick-walled strengthening cells known as the hypoderm, often forming an unbroken sheet or perforated by the stomata, and sometimes thickened by additional layers. In the genus *Pinus* the hypoderm varies considerably in the different species and occasionally affords distinctive characters [1] which are mentioned in the description of the species.

Traversing the mesophyll or spongy tissue of the leaf are the resin ducts, which although variable in position usually occur in definite numbers and in well-defined situations according to genera and species (see *Tsuga*, *Abies*, and *Pinus*). These resin canals are not very constant in their occurrence and are sometimes absent. When present the canals terminate at the base of the leaf and do not join on to those of the stem. In the centre of the mesophyll is the bundle sheath or endoderm, consisting of a single row of oval cells. These encircle the pericycle (thin-walled) cells, in the centre of which is the fibro-vascular bundle which constitutes the midrib of the leaf. In some cases (as in *Araucaria*) there are several such bundles running through the leaf.

[1] Shaw, *Genus Pinus*, 6 (1914).

Flowers.

The male and female flowers of conifers are produced separately either on the same tree or on different trees. The male flowers consist of a number of stamens arranged in catkin-like clusters, each stamen usually including an anther and filament. In colour they are usually some shade of yellow, violet, or deep crimson. The anthers are produced either on the sides or on the under-surface of the staminal leaf or sporophyll, which consists of a filament expanding above into a scale-like connective. The pollen grains are globular and sometimes winged.

The female flowers are borne in cones, each flower usually consisting of a bract and a scale, one above the other, the lower one (the bract) being sterile, the upper one (the scale) fertile and bearing a seed or seeds on its upper surface. The relative proportions of the bract and seed scale vary in different cases so that while in some genera, such as *Abies*, the bract and scale are always distinguishable, in others the two are so intimately blended as to be indistinguishable to the naked eye when the cones are ripe (see *Pinus*). The seeds are not, as in other flowering plants, enclosed in an ovary, but lie exposed on the upper surface of the scale; hence the name "*Gymnosperms*" or "naked-seeded plants." The flowers are usually wind-pollinated.

There are two theories about the morphology of the flower. Some regard the male as one flower of many stamens; others, however, consider each stamen as a separate flower, hence the difference in the terms flower, catkin, and cone, applied to the male inflorescence. Similarly the female cone may be regarded as a single flower composed of many bracts and scales, or each bract with its seed scale may be treated as a distinct flower.

The number of ovules to each fertile scale varies considerably in different genera. Sometimes it is solitary, as in *Taxus*; in *Pinus* there are two seeds to each scale, while in some species of *Cupressus* they are numerous.

Further details of external morphology will be found under the descriptions of the various genera.

Wood.

The wood is distinguished from that of other flowering plants in the absence of vessels, and is composed of tracheids or elongated spindle-shaped cells with closed ends which are dovetailed between one another. They have woody walls marked with bordered pits, which are a characteristic feature of coniferous woods. The medullary rays traversing the wood are usually only one cell thick and rarely visible without a lens. In some genera (notably *Pinus*) resin ducts are conspicuous as small dots on the transverse surface of the wood, whilst in certain other genera (*Abies*)

such ducts are absent. The distinction between spring and autumn wood is usually well marked in trees from temperate regions, but less distinct in species from warmer countries. Heart-wood and sap-wood are not always well defined.

Economic Uses.

Many conifers yield timber of very great economic importance, In most cases the wood is strong in comparison to its light weight, straight-grained, easily worked, durable, or easily made so by treatment with preservatives. It takes paint, polish, or glue well, and is suitable for a wide range of work, particularly general carpentry and joinery, pit props, telegraph poles, railway sleepers, paving blocks, and paper pulp. By destructive distillation various tar products, pyroligneous acid, etc., are obtained. Several species yield resin in commercial quantities, which is used in the preparation of paints and varnishes or distilled for the production of turpentine and rosin. From bark-blisters and wood a semi-resinous substance is procured which is used in medicine and for other purposes. Oil obtained by the distillation of leaves, fruits, and wood is used in medicine and perfumery. Fibre from bark and foliage is sometimes used in upholstery ; the seeds of certain species are valuable for food, whilst the bark of others is employed by tanners. Further particulars of the economic uses are given under the respective species.

Propagation.

Whenever possible, conifers should be increased by seeds, for seedlings usually form the best trees. Cuttings of various species, particularly of *Cupressus*, may be rooted, and this method of propagation is necessary in the case of varieties that do not breed true from seeds. Grafting is also resorted to in such cases, but grafting should not be tried until other means of propagation have been tried and failed. When grafting is practised stocks closely related to the scions should be chosen. Layered branches sometimes take root, but plants raised by this means are often misshapen. A few species (notably *Cryptomeria japonica* and *Sequoia sempervirens*) produce coppice shoots from cut-over trees. Seeds may be sown during autumn or early spring (the latter time for preference), the ground chosen being on the light side, well drained, and well worked. For large quantities of seed, beds 4 feet wide, separated by paths 12–15 in. wide, are most convenient. The soil should be on the dry side when the seed is sown. The seed should be sown rather thinly, lightly covered with soil and pressed down by means of a light wooden roller. Steps must be taken to protect the seeds from vermin and, when necessary, to shelter seedlings from frost and hot sun. Small quan-

tities of seed may be sown in pots or boxes in frames or greenhouses.

Cuttings are usually inserted in sandy soil in a cold frame or in a warm greenhouse, July and August being the most suitable time. Grafting is carried on indoors in spring, the stocks having been established in pots during the previous autumn.

Young Plants (Nursery Treatment).

Seedlings raised in pots or boxes should be lined out about one inch apart in nursery rows before the roots are able to become twisted or interlaced. Those raised in outdoor beds may be allowed to remain one or two years in the beds, according to density. They should eventually be lined out in borders, the plants being placed about 3 in. apart in rows 9–12 in. apart. In this position they may remain for one or two years. Plants 9–12 in. high are usually large enough for planting under sylvicultural conditions, but larger plants may be planted in parks and gardens where they can receive individual attention. Young trees left in nursery borders should be transplanted every alternate year until they are placed in permanent positions. Many conifers are, however, difficult to establish after they have attained a height of several feet, and it is usually wise to find them permanent positions whilst they are quite small.

Permanent Planting.

Trees that are planted in gardens or parks are usually placed in well-worked ground. In such cases the principal danger to guard against is deep planting. When large holes have been made for the plants they should be filled up and allowed to settle for several weeks before the trees are planted. At planting time the upper roots should not be covered by more than an inch or two of soil. Trees placed under woodland conditions are often badly treated. The worst kind of planting, probably, is notching. By this method a small opening is made in the ground and the roots of the young plant are pushed in. The hole is often too small to admit the roots, which are therefore doubled up. Such plants are often difficult to establish, and there are frequently considerable losses. By breaking up a small area of ground with a mattock or pickaxe and planting with a spade better results are secured. Where the land is moderately even it pays in forest planting to plough the ground, or at any rate strips of ground, for the plants, and where a hard pan occurs a few inches below the surface it is wise to use a subsoiler on the plough. Subsoiling will often do away with the necessity for draining. After ploughing, planting can be carried out at a much faster rate than in hard ground, and the young plants make more rapid progress. In all cases deep planting must be avoided.

Pruning.

Conifers as a rule require less attention to pruning than broad-leaved trees. Some are inclined to form double leaders, particularly after an injury to the leading shoot. Duplicate leading shoots should be removed as early as possible. The lower branches of woodland trees that do not die and fall should be removed as close to the trunk as possible, whilst the lower branches of ornamental trees that are becoming weak and unsightly should be removed. In the case of trees in open positions the trunk should not be too quickly cleared of lower branches or the bark may be injured by sun or frost. Pruning may be carried out at any period between June and the end of January. Hedges of yew, Thuya, or Cupressus should be clipped over toward the end of July or early in August. In some instances it may be wise to use secateurs rather than shears for the work. Topiary work of yew may be cut over at the same time.

Diseases.

Conifers are attacked by numerous fungus and insect pests. Once such pests become well established they are difficult to eradicate, and a sharp look-out should be kept for the early stages of an outbreak of disease, for at this stage it may easily be checked. Particulars of various diseases are given elsewhere.

SYNOPSIS OF FAMILIES AND TRIBES

Family Taxaceæ.

Evergreen trees or shrubs. Male and female flowers usually on different trees. Cone formation imperfect. Seed coat either dry or eventually fleshy, more or less surrounded by a fleshy cup-like aril or by a succulent scale, or borne upon a fleshy stalk.

I. Taxeæ (The Yew Tribe).

Seed erect or rarely partly inverted; partially or completely surrounded by an aril or with a fleshy resinous seed-coat.

Cephalotaxus.

Leaves linear, not prickly, in a two-ranked arrangement, mid-rib prominent on upper side. Male flowers crowded. Seed long-stalked, fleshy, olive-like, maturing in one season.

Torreya.

Leaves linear with prickly points, midrib not showing on upper side. Male flowers solitary. Seed sessile or subsessile, surrounded by a thin fleshy aril; olive-like, maturing in two seasons.

Dacrydium.

Leaves scale-like or linear. Male flowers spicate. Seed partly inverted or ultimately erect with a short cup-like aril and an inner, usually dry seed-coat investing the kernel.

Taxus.

Leaves linear, in a two-ranked arrangement. Male flowers in stalked, globose heads. Seed solitary, erect, borne in a fleshy, cup-like scarlet aril, ripening in one season.

Austrotaxus.

Tree, habit of *Podocarpus*. Male flowers in spikes.

Phyllocladus.

True leaves linear or scale-like, succeeded by cladodes or leaf-like branches which perform the function of leaves and bear the female flowers on their margins.

Amentotaxus.

Leaves linear opposite. Male flowers in slender pendulous, branched catkins. Ovule solitary, borne in the axil of a branchlet.

Pherosphæra.

Leaves scale-like, densely arranged in four or five rows. Male flowers erect, egg-shaped or globular. Cones composed of 4–8 thin scales with no ovuliferous scale.

II. PODOCARPEÆ (The Podocarpus Tribe).

Seed inverted, outer coat dry, surrounded by a fleshy cup-like aril or supported by a fleshy bract and stalk.

Microcachrys.

Foliage scale-like, overlapping. Seed small, inverted from the top of the bract, surrounded at the base by a fleshy, scarlet aril.

Podocarpus.

Leaves variable, stamens in tufted spikes, stalk bearing the seeds, often swelling when ripe into a succulent, highly coloured mass around or below the inverted seed.

Prumnopitys.

Foliage as in Podocarpus, but with male flowers branched, and the fruits in a loose spike, the axis of which does not become fleshy.

Saxegothea.

Foliage yew-like. Male flowers in stalked cylindrical spikes. Cones with thickened scales and inverted seeds in grooves.

Acmopyle.

Foliage yew-like, stalkless. Young female flowers apparently composed of several sterile and one fertile bract fused into a warty, fleshy receptacle and bearing a single seed.

Family **Pinaceæ.**

Mostly evergreen resin-yielding trees or shrubs. Male or female flowers usually on the same tree. Cone formation perfect, seeds concealed between scales; seed coat woody or leathery, no aril.

I. Cupressineæ (The Cypress Tribe).

Trees or shrubs usually with the adult leaves appressed; opposite, whorled in 3–4 rows, small, scale-like, rarely linear. Buds not scaly. Cone-scales mostly confluent with the bracts, arranged crosswise, generally woody when ripe. Seeds erect.

Sub-tribe I. Juniperineæ.

Male and female flowers on the same or on different trees. Cone-scales fleshy, at length confluent and berry like. Seeds not winged.

Juniperus.

Foliage scale-like or needle-like, occasionally two kinds on the same plant. Cones fleshy, berry-like, of 3–6 valvate scales.

Sub-tribe II. Callitrineæ.

Cone scales verticillate, dry, valvate. Seeds usually winged.

Callitris.

Twigs brittle, angular. Leaves scale-like, three-ranked, closely clasping the stem except at the triangular tips. Cone scales 6–8 erect, unequal, united at the base.

Tetraclinis.

Twigs flattened. Leaves scale-like, four-ranked. Cones composed of 4 scales. Seeds 2-9 on each scale.

Widdringtonia.

Resembling Callitris, but with the leaves spirally arranged, and numerous seeds to each scale of the cone.

Actinostrobus.

Leaves scale-like, three-ranked. Cone scales 6, equal in size, surrounding a central axis, each with one or two winged seeds.

Callitropsis.

Closely allied to Callitris, but distinct in the Araucaria-like leaves arranged in eight vertical rows and in the cones, which consist of 8 scales in 2 whorls of 4 each.

Sub-tribe III. Thuineæ.

Male and female flowers usually on the same tree. Cone scales woody, truncate and peltate or oblong and joined only at the base. Seeds usually winged.

Fitzroya.

Tree or shrub with three-ranked leaves. Cone solitary, terminal of 2–3 rows of whorled scales, of which only the upper are fertile. Seeds 2–3 winged.

Diselma.

Shrub, with opposite scale-like leaves. Cone scales 4, inner pair fertile. Seeds 3 winged.

Cupressus.

Adult leaves, scale-like, appressed. Cones globular or oblong, woody, with peltate scales. Seeds numerous or (section Chamæcyparis) 2–5 to each scale.

Thuya.

Branch systems flattened, leaves scale-like. Cones with oblong scales which are thickened upwards, the two uppermost pairs fertile, seeds usually winged (not in *T. orientalis*).

Libocedrus.

Branch system flattened. Leaves scale-like, arranged in decussate pairs. Cones oblong, with 2–6 valvate scales, of which the middle pair alone is fertile. Seed with two unequal wings.

Fokienia.

Intermediate in character between Cupressus and Libocedrus. Branch systems flattened. Leaves in four ranks, arising at the same level. Cones like those of Cupressus (Chamæcyparis section), but with numerous unequally winged seeds to each scale.

II. Taxodineæ (The Taxodium Tribe).

Trees with narrow linear leaves, spirally arranged, sometimes apparently two-ranked. Buds not scaly. Male and female flowers on the same tree. Cone scales spirally arranged, more or less woody. Bracts partially consolidated with the scales. Seeds 2–6 to each scale, erect or inverted, winged or wingless.

Cryptomeria.

Leaves linear, awl-shaped, spreading, spirally arranged in five ranks. Cones globular; the scales centrally attached to the axis, each with spine-like processes at the apex; bract combined with the scale for the greater part of its length and showing as a recurved point on its outer surface.

Taxodium.

Leaves deciduous, two-ranked. Male flowers in branched catkins. Cones globular or slightly obovate with scales thick, peltate. Seeds angular, warted, wingless.

Glyptostrobus.

Leaves three-ranked on barren branchlets, scale-like on fertile branchlets. Cones pear-shaped, stalked. Seeds winged.

Sequoia.

Leaves flat in a two-ranked arrangement or awl-shaped and spirally arranged. Cones globular, pendulous, with persistent woody scales.

Athrotaxis.

Leaves small, spirally arranged, crowded. Cones globular, like those of Cryptomeria. Scales with a triangular spine-like process near the apex. Seeds winged.

Sciadopitys.

Leaves of two kinds, small, scale-like and long leaf-like cladodes or double leaves, arranged in whorls.

III. Abietineæ (The Fir Tribe).

Trees with adult leaves linear, spirally arranged but apparently in two or more rows, or in tufts. Buds scaly. Male and female flowers on the same tree. Cones mostly woody with

spirally arranged scales; the bracts[1] though relatively small, remain separate from the scales, except at the very base. Seeds 2 to each scale, inverted, winged.

Pinus.

Leaves needle-like, usually in bundles of 2, 3, or 5, on short shoots within a common sheath. Long shoots with scale leaves only. Cones woody with persistent scales.

Picea.

Leaves flat or angular, leaving projecting peg-like scars when they fall. Cones pendulous with persistent scales.

Abies.

Branches whorled. Leaves needle-like, flat or flattish, leaving a disc-like scar when they fall. Cones erect, ripening in one year. Scales deciduous from a central axis.

Pseudotsuga.

Habit and foliage of Abies, but leaf scars less prominent. Buds beech-like. Cones pendent, ripening the first year. Scales persistent, bracts markedly three-lobed, trident-like.

Keteleeria.

Leaves flat, with a raised midrib on either surface. Buds roundish. Male flowers in tufts or umbels. Cones erect, lateral, the scales long persistent but ultimately separating from one another.

Tsuga.

Leaves flat or angular, usually in a two-ranked arrangement. Leaf-stalk slender, pressed against the shoot. Cones ovoid or oblong, composed of a few persistent scales.

Cedrus.

Leaves needle-like, rigid, scattered on long shoots or tufted on short spurs. Male flowers in erect catkins. Cone scales overlapping, ultimately deciduous.

Larix.

Leaves arranged as in Cedrus, but deciduous, soft. Male flowers in short spikes, cone scales woody, persistent.

Pseudolarix.

Resembling Larix in its deciduous tufted foliage, but with club-shaped short shoots and spike-like male flowers arranged in umbels. Cone scales deciduous.

[1] In Pinus the bract disappears in the ripe cone.

IV. ARAUCARINEÆ (The Araucaria Tribe).

Trees with spirally arranged narrow or broad leaves. Buds not scaly. Male and female flowers on the same or on different trees. Anther cells pendulous. Cones globular; scales very numerous, spirally arranged, apparently single by the consolidation of bract and scale, the latter being relatively small. Seeds 1–6 to each scale.

Cunninghamia.

Leaves flat. Male flowers in terminal umbellate clusters. Cones globular. Scales persistent. Bracts long, leafy, spreading at the points. Seeds 3 to each scale, winged, pendulous.

Taiwania.

Adult leaves, scale-like. Cones sub-globose with numerous scales. Secondary scales absent. Seeds 2 to each scale.

Agathis.

Leaves usually broad and flat. Cones globular, the scales separating when ripe. Seed 1 to each scale, free, obliquely winged, pendulous.

Araucaria.

Leaves lance-shaped or awl-shaped, spirally arranged. Cones globular, scales very numerous, deciduous. Seed more or less winged, united with the scale.

KEY TO THE GENERA IN CULTIVATION

The following key, based on well-marked characteristics of shoots, winter buds and foliage, will enable the beginner to identify the genus of any conifer he is likely to meet with in cultivation and should be used in conjunction with the keys to the species which will be found under the respective genera. The keys are only intended for use with specimens having mature foliage taken from well-developed lateral branches. The diagnostic characters are easily seen with the naked eye or with a pocket lens magnifying 8 diameters. The position and number of the resin canals in Abies and Pinus are best observed by examining a thin transverse section of the leaf under a compound microscope, but in the case of Abies they can often be made out by squeezing the leaf after it is cut across, when the resin will be seen exuding from the two canals.

Section

Leaves needle-like in clusters or whorls (Figs. 63, 85) . I
Leaves linear or needle-like, not in clusters or whorls, often in two ranks. Buds and leaf scars usually conspicuous (Figs. 13, 80) II
Leaves flat, linear, yew-like, often in two ranks, 1 in. or less long. Buds and leaf scars usually inconspicuous (Fig. 8) III
Leaves flat, linear, often two ranked, more than 1 in. long (Fig. 3) IV
Leaves small, scale-like (Figs. 46, 112) V
Leaves awl-shaped, strongly keeled or curved (Fig. 34) . VI
Leaves broad, ovate (Fig. 35) VII

I

Leaves needle-like in clusters or whorls. Buds and leaf scars usually conspicuous.
- Leaves 2, 3, or 5 in a cluster.—*Pinus* (Figs. 83, 84, 92).
- Leaves arranged in two ways, scattered on long shoots and in rosettes on short shoots.
  - Leaves soft, deciduous.
    - Bud scales, long, slender.—*Pseudolarix* (Fig. 102).
    - Bud scales short, closely pressed.—*Larix* (Fig. 65).
  - Leaves stiff, evergreen.—*Cedrus* (Fig. 34).
- Leaves (double needles), 2–4 in. long, arranged in whorls like umbrella ribs.—*Sciadopitys* (Fig. 106).

II

Leaves needle-like or linear, not clustered.
- Plants usually seen as trees.
  - Branches on main trunk not whorled, leaves with a distinct stalk pressed against the shoot.—*Tsuga* (Fig. 114).
  - Branches on main trunk usually whorled, leaves indistinctly stalked or sessile.
    - Leaf scars peg-like. Cones pendulous with persistent scales.—*Picea* (Fig. 69).
    - Leaf scars disc-like. Cones erect with deciduous scales.—*Abies* (Fig. 13).
    - Leaf scars slightly prominent, bright-coloured. Foliage fragrant when rubbed. Cones with persistent scales. Bracts trident-like.—*Pseudotsuga* (Fig. 103).
- Plants usually seen as shrubs.
  - Leaves spreading, small, needle-like, $\frac{1}{8}$–$\frac{7}{8}$ in. long, opposite or in whorls of three, whitened on upper surface.—*Juniperus* (Fig. 55).

Leaves spirally arranged, spreading or recurved. Foliage bronze in winter. - *Cryptomeria japonica*, var. *elegans* (Fig. 35g.).

Leaves opposite, spreading, needle-like, ¼ in. long or more, whitened on lower surface.—*Cupressus* (juvenile forms) (Fig. 45).

III

Leaves flat, linear, yew-like, often two-ranked, 1 in. or less long. Buds and leaf scars usually inconspicuous.

Leaves distinctly two-ranked.

Leaves evergreen, dark green.

Bud scales rounded, leaves yellowish green beneath.—*Taxus* (Fig. 8).

Bud scales acute, leaves glaucous beneath.

Tree with spongy bark. Leaves smaller near base of shoot, grading into bud scales.—*Sequoia sempervirens* (Fig. 108).

Shrub or small tree. Leaves not grading into bud scales.—*Prumnopitys* (Fig. 6).

Leaves deciduous, light green.—*Taxodium* (Fig. 109).

Leaves less distinctly two-ranked, shoots in whorls.

Leaves twisted, up to ¾ in. long, acute.—*Saxegothea* (Fig. 7).

Leaves not twisted, ¼ in. long, obtuse or apiculate.—*Podocarpus alpinus.*

IV

Leaves flat, linear, usually more or less in two ranks more than 1 in. long.

Leaves dark green, linear, two-ranked.

Leaves with the midrib prominent on both sides. Buds with rounded scales.—*Keteleeria* (Fig. 62).

Leaves with midrib not prominent on both sides. Bud scales acute.

Leaves narrowing gradually to the base.—*Podocarpus chilinus* (Fig. 5).

Leaves rather abruptly narrowed into a short foot stalk.

Leaves spine-pointed with two stomatic grooves on lower surface.—*Torreya* (Fig. 9).

Leaves not spine-pointed, without grooves on lower surface.—*Cephalotaxus* (Fig. 2).

Leaves light green, twisted into more or less opposite ranks, narrowly lanceolate.—*Cunninghamia* (Fig. 36).

V

Leaves small, scale-like, closely pressed to the shoot (spreading in *Fitzroya* and *Athrotaxis selaginoides*).

Foliage arranged in a flat spray.

Cones oblong, woody, with the scales overlapping.

Foliage, aromatic when rubbed (usually). Cone scales 8–12, the two upper fertile.—*Thuya* (Fig. 113).

Foliage not aromatic. Cone scales 6, the middle ones only fertile.—*Libocedrus* (Fig. 66).

Cones sub-globose, woody, with scales valvate, peltate or wedge-shaped.

Cones $\frac{1}{4}$–$\frac{1}{2}$ in. in diameter with 2–5 seeds under each scale.—*Cupressus* (sect. *Chamæcyparis* (Fig. 44)).

Cones up to $\frac{3}{4}$ in. diameter with numerous seeds under each scale.—*Cupressus* (sect. *Eu-Cupressus* (Fig. 42)).

Foliage not arranged in a flattened spray.

Shrubs or small trees.

Leaves spreading in whorls of 3, obtuse. Cones globose of 2–3 rows of scales.—*Fitzroya* (Fig. 49).

Leaves spirally arranged, spreading or appressed, acute or obtuse.—*Athrotaxis* (Fig. 31).

Trees.

Bark spongy, leaves spirally arranged, slightly spreading, greyish green.—*Sequoia gigantea* (Fig. 107).

Bark not spongy, leaves not spreading, usually appressed.

Cones roundish, woody. Leaves all scale-like.—*Cupressus* (sect. *Eu-Cupressus*) (Fig. 42).

Cones roundish, fleshy, berry-like. Leaves sometimes scale- and needle-like on the same plant.—*Juniperus* (Fig. 51).

VI

Leaves awl-shaped, spirally arranged, irregularly 4-sided, keeled, pointing upwards.—*Cryptomeria* (Fig. 35).

Leaves awl-shaped, spirally arranged, flattened. Spreading horizontally.—*Araucaria excelsa* (Fig. 30).

VII

Leaves broad, flat, ovate, spirally arranged, densely crowded, 1–2 in. long, $\frac{1}{2}$–1 in. wide.—*Araucaria imbricata.*

PART I

TAXACEÆ

ACMOPYLE, Pilger.[1]

A monotypic genus allied to *Podocarpus* and *Dacrydium* but differing chiefly in its seed-characters.

Acmopyle Pancheri, Pilger.

Dacrydium Pancheri, Brongniard and Gris; Podocarpus pectinata, Pancher.

An evergreen tree, 40–50 ft. high, or occasionally taller, with erect branches. *Leaves* yew-like, stalkless, arranged in two ranks, $\frac{1}{3}$–$\frac{3}{4}$ in. long, $\frac{1}{12}$–$\frac{1}{8}$ in. wide, curved towards the pointed apex, green, with irregular stomatic lines above and two broad, glaucous, stomatic bands separated by the green midrib beneath. *Male catkins* 1–3 together at the tips of branchlets, 1–1½ in. long. *Female flowers* apparently composed of several bracts, all except one sterile, and fused into a warty, fleshy receptacle bearing a single seed.

Native of New Caledonia, where it is abundant in coniferous forests near the summit of Mount Mou.[2] It was introduced to Kew in 1891 from the Botanic Garden, Sydney, but is not hardy.

AMENTOTAXUS, Pilger.[3]

A genus composed of one species found in Hong Kong, Formosa, and W. China, allied to *Podocarpus* and *Cephalotaxus*, from which it chiefly differs in its slender, branched, pendulous male catkins and solitary ovule borne in the axil of a branchlet.

Amentotaxus argotænia, Pilger.

Podocarpus argotænia, Hance; P. insignis, Hemsley; Cephalotaxus argotænia, Pilger.[4]

An evergreen bush, 6–10 ft. high, with the spreading habit of a *Cephalotaxus*. *Leaves* opposite, 1–5 in. long, up to ¼ in. wide, thick, leathery, margins slightly recurved, apex a short, sharp

[1] *Das Pflanz.* IV, 5, Taxaceæ (1903).
[2] Compton, *Journ. Linn. Soc.* XLV, 426 (1922); *Bot. Mag.* t. 7854 (1902).
[3] *Engl. Bot. Jahrb.* 54, 41 (1916).
[4] *Plant. Wils.* ii, 6, 1914.

point, the base narrowed to a short stalk; upper surface dark green, midrib well marked, under-surface with a conspicuous green midrib bordered on each side by a glaucous stomatic band, each of which is again margined with green, thus making five distinct alternating lines of green and silver. *Male flowers* or catkins slender, pendent, branched, 1–1½ in. long. *Ovule* not seen but stated to be solitary in the axils of branchlets.

AUSTROTAXUS, Compton.[1]

A genus closely resembling *Taxus* and *Podocarpus* but differing from these and other taxads in its spicate male flowers.

Austrotaxus spicata, Compton.

An evergreen tree, 45–80 ft. high, with a dense bushy crown of dark green foliage. *Leaves* like those of a *Podocarpus*, spirally arranged, linear 2½–5 in. long, ⅛ in. wide, dark green, shortly pointed, entire with the margins rolled backwards, midrib prominent below, grooved above. *Male flowers* in dense axillary spikes about ½ in. long. *Female flowers* solitary, terminating short bract-covered stalks. *Seed*, 1–1⅛ in. long, acorn-like, enclosed, except at the tip, in a fleshy aril as in yew.

Native of New Caledonia, where it occurs in moist forests on steep slopes between about 1,000–3,000 ft. elevation.

CEPHALOTAXUS, Siebold and Zuccarini.

Evergreen trees or shrubs closely allied to *Torreya*, including seven species which are found in China, Japan, the Khasia Mountains, and Assam. *Branches* opposite or in whorls. *Young branchlets* green, prominently grooved and marked with minute white stomatic dots. *Buds* ovate, obtuse with numerous overlapping scales. *Leaves* spirally arranged and spreading on vertical shoots; on lateral shoots arranged in two opposite ranks; persisting three to four years, scarcely stalked, linear, pointed at the apex; upper surface dark shining green with a conspicuous midrib, lower surface with two broad silvery bands composed of numerous stomatic lines. *Male and female flowers* on different trees or rarely on the same tree. *Male flowers* in globose heads formed in autumn in the axils of the upper leaves, each flower composed of several stamens enclosed in a bract. *Female flowers* few, stalked, composed of opposite pairs of cup-shaped bracts with two ovules at the base of each. Usually only one of these develops into an olive-like "fruit" (seed), ripening the first season, consisting of a fleshy outer covering

[1] *Journ. Linn. Soc.* XLV, 427, pl. 26 (1922).

and an inner, woody, acorn-shaped shell enclosing the kernel (endosperm) and embryo. *Cotyledons* two.

Cephalotaxus is distinguished from *Torreya*, which it closely resembles in foliage, by the non-spiny leaves not longitudinally furrowed beneath and the more numerous bud scales.

Wood yellowish, straight-grained, soft or moderately hard, but usually too small to be of any particular economic value, although used locally for various purposes. A fatty oil is obtained from the seeds of *C. drupacea* and probably from those of other species.

The species of *Cephalotaxus* are hardy in Britain and thrive under similar conditions to yew, although less suited to chalky soils. They form handsome, spreading bushes, either in the open or in partial shade, and make excellent screens for blocking out undesirable objects from the garden. As they withstand pruning well, they could probably be successfully used for hedges. Propagation may be effected by seeds, which ripen freely, or by short cuttings inserted in sandy soil in a close frame during July or early August.

KEY TO CEPHALOTAXUS.

Leaves abruptly pointed, $\frac{3}{4}$–$1\frac{1}{2}$ in. long . . . *C. drupacea.*
Leaves gradually narrowing to a long point, $1\frac{1}{2}$–3 in. long . . . . . *C. Fortunei.*

Cephalotaxus drupacea, Siebold and Zuccarini. (Fig. 2.)

COW'S-TAIL PINE.

A small tree 20–40 ft. high in China and Japan, with wide-spreading branches forming a broad, rounded crown. *Bark* grey, dividing into narrow strips. In cultivation it is shrubby in habit, scarcely exceeding 10 ft. in height. *Leaves* arranged like those of *C. Fortunei*, but much smaller, straighter, and more abruptly pointed, 1–$1\frac{1}{2}$ in. long, not arranged in one plane, but spreading outwards and upwards in a V-shaped manner. *Male flowers* $\frac{1}{3}$ in. in diameter on very short, scaly stalks. *Seeds* brown when ripe, $\frac{3}{4}$–1 in. long, slightly pear-shaped, broadest at the rounded apex, oily.

Var. **pedunculata,** Miquel.

C. pedunculata, Siebold and Zuccarini; Taxus Harringtoniana,[1] Knight and Perry.

Almost intermediate between *C. Fortunei* and *C. drupacea* in foliage, the leaves being less regularly arranged and more curved than in *C. drupacea*, $1\frac{1}{2}$–$2\frac{1}{2}$ in. long, longer than in the latter species, but shorter than in *C. Fortunei*. *Male flowers* in clusters

[1] *Pinet. Woburn.* t. 66 (1839).

of 2–5 on stalks ¼–1 in. long. *Seed* olive-green, ¾–1 in. long, with an ellipsoid circular depression at the apex from which arises a short point.

This variety, unknown in a wild state, has long been in cultiva-

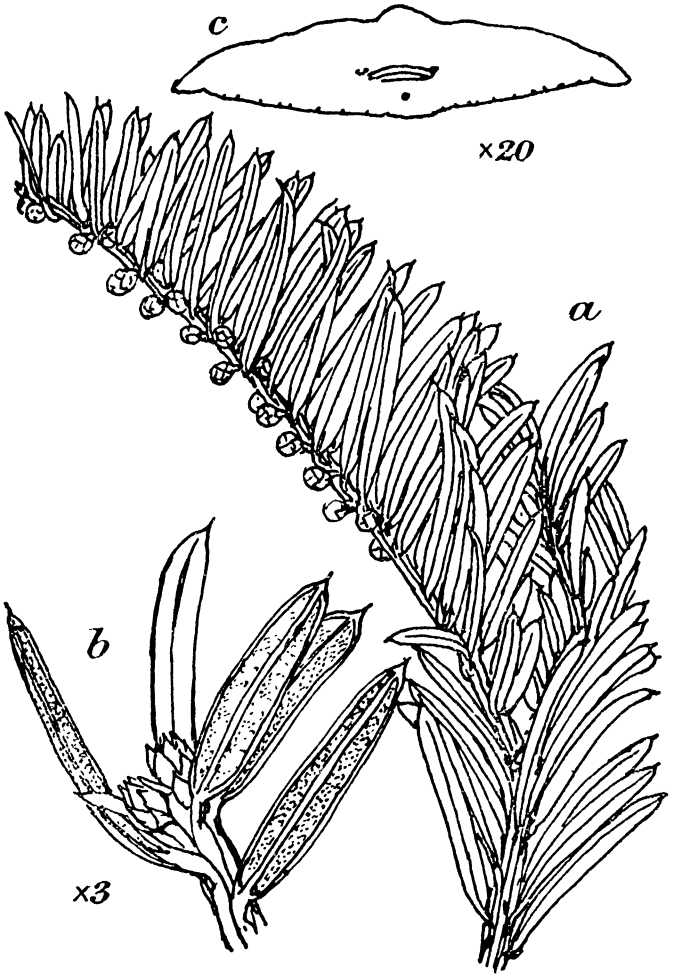

FIG. 2.—*CEPHALOTAXUS DRUPACEA.*

a, shoot with young male flowers; *b*, leaf-buds and under-surface of leaves; *c*, section of leaf.

tion in Japan, having apparently been introduced there from Corea or China by Buddhist monks. Prof. Henry suggests that it is a hybrid between *C. Fortunei* and *C. drupacea*, this supposition being based upon the statement that the seeds of *C. Fortunei* sent by Fortune from China in 1848 to the Bagshot Nursery produced two kinds of plants, one kind with long leaves identical

with the true wild plant of *C. Fortunei*, and the other, with shorter leaves, identical with *C. pedunculata* and including plants which bore fruit.

Forma **fastigiata**, Pilger.

C. pedunculata, var. fastigiata, Carrière; C. Buergeri, Miquel; Podocarpus korianus, Hort; Taxus japonica, Loddiges.

A form with erect branches resembling an Irish yew in habit, the leaves spreading all round the stem. It frequently produces normal foliage. Introduced from Japan in 1861 and now common in cultivation.

Var. **sinensis**, Rehder and Wilson.[1]

This differs from the type in its narrow lanceolate leaves which taper to a long, sharp point. Found in W. Hupeh and Szechuen, China.

C. drupacea is found wild in the mountain forests of Japan, where it is widely distributed at altitudes ranging from 1,000–3,000 ft. It is also common in Central China.

Clinton-Baker, *Illust. Conif.* iii, 64 (1913); *Bot. Mag.* t. 8285 (1909).

Cephalotaxus Fortunei, Hooker. (Fig. 3.)

A tree 40 ft. high in Cent. China, but in cultivation an irregularly branched shrub seldom exceeding 20 ft. in height. *Leaves* spreading outwards from the shoot in two lateral ranks, 2–3 in. long, linear, gradually narrowing to a pointed apex, tapering at the base into a short, twisted petiole; more or less curved, dark shining green above, pale below with a broad band of stomata on either side of the midrib. *Male flowers* $\frac{1}{3}$ in. in diameter, on scaly stalks $\frac{1}{8}$ in. long. "*Fruit*" olive-green, about $1\frac{1}{4}$ in. long and $\frac{5}{8}$ in. in diameter, acorn shaped.

A native of China, occurring in mountain woods in Szechuen, Hupeh, Yunnan, Kiangsu, and Chekiang. Introduced to England in 1848 by Robert Fortune.

Var. **concolor**, Franchet.

A bush 3–4 ft. high. Bands of stomata indistinct. Common in thickets at an altitude of about 4,000 ft. in E. Szechuen.

Elwes and Henry, *Trees of Gt. Brit. and Irel.* VI, 1470 (1912); *Bot. Mag.* t. 4499. (1850); Clinton-Baker, *Illust. Conif.* iii, 65 and 66 (as *C. pedunculata*) (1913).

Cephalotaxus Griffithii, Hooker.

A small tree found at 6,000 ft. elevation in the Mishmi Hills, Upper Assam. *Leaves* about 2 in. long and $\frac{1}{8}$–$\frac{1}{6}$ in. wide, glossy green above, white beneath. *Seeds* about $1\frac{1}{2}$ in. long, borne 3–4 together, oblong with a short point at the apex and a narrowed

[1] *Pl. Wils.* ii, 4 (1914).

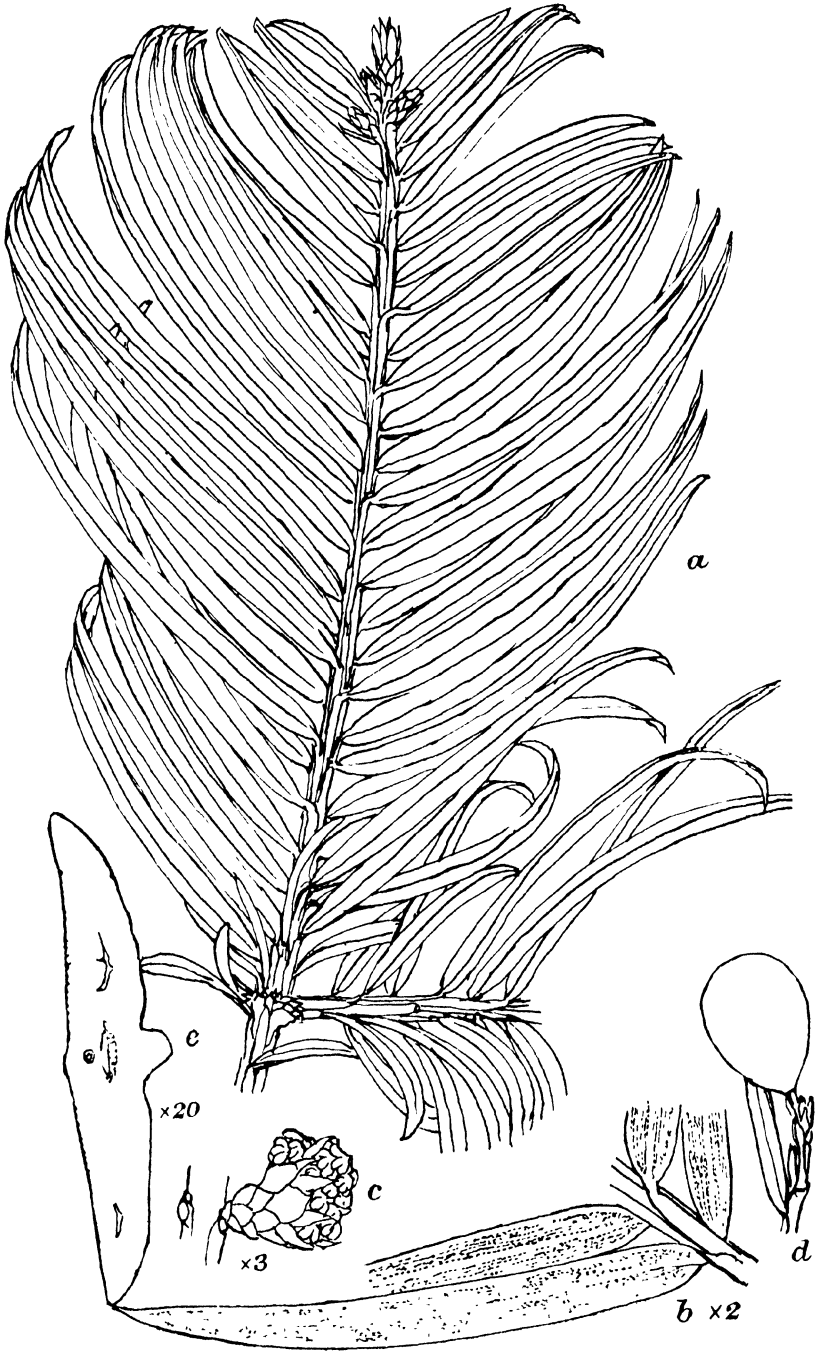

FIG. 3.—*CEPHALOTAXUS FORTUNEI.*

a, shoot; *b*, under-surface of leaves, showing stomatic bands; *c*, male flower; *d*, fruit; *e*, section of leaf.

base. It closely resembles *C. Mannii*, but is distinguishable by the white under-surface of the leaves.

It is not known to possess any economic properties.

Fl. Brit. India, V, 648 (1888).

Cephalotaxus Mannii, Hooker.[1]

A small tree found in the Khasia Mountains, India, closely resembling *C. Fortunei* in habit, but with smaller, narrower leaves which are green, not white, below. *Seeds*, 3–4 on a common stalk, each about 1½ in. long, obovoid with a short apical point, narrowed at the base.

Cephalotaxus Oliveri, Masters.

A shrub with flat, rigid, spreading branches, the leaves horizontal, arranged in two opposite ranks closely set on the branchlets and curving slightly upwards, ¾–1 in. long, ⅛–⅙ in. wide, rounded or truncate at the base, the apex abruptly pointed, dark green above, paler beneath, with two glaucous bands of stomata. *Seed* egg-shaped, 1¼ in. long, on a stalk ½ in. long.

The crowded, regularly two-ranked, shortly pointed leaves make this an easily recognized species.

It is common in rocky places in W. Hupeh and Szechuen, China, up to nearly 2,000 ft. altitude, and was discovered on Mount Omei by Faber in 1900. It has since been introduced by Wilson, but we have seen no cultivated specimens.

Gard. Chron. April, 1903, p. 227; *Pl. Wils.* II, 6 (1914).

DACRYDIUM, Solander.

A genus of evergreen trees allied to *Podocarpus*, including about sixteen species, chiefly natives of New Zealand, but also occurring in the Malay Peninsula, Borneo, Australia, Tasmania, New Caledonia, and Chile. *Leaves* of adult trees, small, scale-like, closely overlapping; of juvenile trees or the lower branches of older ones, linear or awl-shaped. *Male* and *female flowers* on different trees, rarely on the same tree. *Male flowers* in spikes in the axils of the upper leaves, oblong or cylindric with sessile, two-celled anthers; pollen cells winged. *Female flowers* at or near the tips of the branchlets consisting of a few small scales, one or several bearing a solitary reversed ovule seated in a cup-shaped aril. *Seeds* ovoid, nut-like, ultimately more or less horizontal.

Wood yellow or reddish in colour, sometimes handsomely figured, usually very resinous and durable. It is used for building purposes, furniture, and other work.

Few species have been introduced to the British Isles, and

[1] *Fl. Brit. India*, V, 647 (1888).

plants are rarely met with, although at least half of them ought to succeed out of doors in the mildest parts of the country.

Pilger in *Pflanzenreich*, 18, iv, 43 (1903).

Dacrydium araucarioides, Brongniart and Gris.

A tree of candelabrum form, seldom exceeding 20 ft. in height. *Branches* erect, fastigiate. *Branchlets* short, thick, cylindrical. *Leaves* of young plants linear, erect or slightly spreading, those of mature plants scale-like, linear-oblong, about $\frac{1}{8}$ in. long, and densely overlapping in many rows, rigid, strongly curved, keeled beneath, blunt at the apex. *Male flowers* terminal, oblong-cylindric. *Female flowers* on shoots which become purple and fleshy at the apex when the seeds are ripening. *Seeds* 1–3, ovoid, up to about $\frac{1}{4}$ in. long.

A remarkably distinct species found only in New Caledonia, where it is generally distributed in dry situations on serpentine rocks.

Economic properties of no importance.

Compton, *Journ. Linn. Soc.* XLV, 427 (1922).

Dacrydium Balansæ, Brongniart and Gris.

A tree up to 25 ft. high with ascending fastigiate branches. *Leaves* arranged in many rows, thick, rigid, scale-like, densely overlapping, narrowly lance-shaped, strongly curved. *Male flowers* solitary, cylindrical. *Seed* ovoid, compressed.

Native of New Caledonia.

Of no economic importance.

Compton, *loc. cit.* 427.

Dacrydium Beccarii, Parlatore.[1]

A little known species, described as a shrub of elegant habit 12–15 ft. high. *Leaves* crowded on the branchlets, awl-shaped, rigid, prickly, keeled. *Seed* broadly ovoid, about $\frac{1}{5}$ in. long.

Native of Borneo, where it appears to be of no economic value.

Dacrydium Bidwillii, Hooker fil.

MOUNTAIN PINE

Bog-pine; Tarwood.

An erect or prostrate, densely branched shrub 2–10 ft. high, the lower branches sometimes rooting and forming plants up to 20 ft. across. *Leaves* very variable, those of young plants and of the lower branches of old plants, spreading, crowded, linear, stalkless, $\frac{1}{4}$–$\frac{1}{3}$ in. long; the leaves of upper branches, particularly of old specimens, small, scale-like, triangular, blunt, leathery, $\frac{1}{25}$–$\frac{1}{12}$ in. long. *Male flowers* solitary, $\frac{1}{16}$–$\frac{1}{8}$ in. long. *Seeds* one or

[1] De Cand, *Prod.* XVI, 2, 494 (1868).

Photo by F. R. S. Balfour, Esq.

PLATE I. *PICEA BREWERIANA* IN THE SISKIYOU MOUNTAINS.

two, striate, compressed, blunt, about $\frac{1}{12}$ in. long, with a fleshy white aril.

A native of New Zealand, where it occurs chiefly in subalpine localities in the South Island and Stewart Island.

D. Bidwillii is useful in checking erosion on mountain slopes and the branches are used for firewood; otherwise it is too small to be of economic value.

The plant does not appear to be in cultivation in Britain, although it would probably thrive in the milder parts.

Kirk, *For. Fl. of New Zeal.* 57, fig. 37 (1889).

Dacrydium biforme, Pilger.

MANOAO.

Dacrydium Colensoi, Kirk [not Hooker].

A small tree 15–40 ft. high, with a short trunk 3–6 ft. in girth, or becoming shrubby in alpine localities. *Branches* stout, clothed with persistent leaves. *Branchlets* four-sided. *Leaves* on young plants yew-like, spreading, linear, $\frac{1}{3}$–$\frac{3}{4}$ in. long, narrowed into a short, twisted stalk; those of older branchlets scale-like, densely overlapping, closely pressed, $\frac{1}{20}$–$\frac{1}{12}$ in. long, blunt, very thick, prominently keeled on the back. *Male flowers* solitary, about $\frac{1}{8}$ in. long, at the tips of branchlets. *Seeds* solitary or rarely in pairs, oblong, blunt, striate, compressed, about $\frac{1}{10}$ in. long.

A native of New Zealand, where it appears to be widely distributed in mountain forests and occasionally descends to sea-level.

This is the *D. Colensoi* of Kirk and other botanists, but not the plant originally described under that name by Sir William Hooker (*Icon. Plant.* t. 548).

Wood yellowish-brown in colour, straight and even-grained, strong and durable even in contact with the ground. It is used locally for building purposes, railway sleepers, fence posts, and other work.

So far as we are aware it is not in cultivation in Britain, although it might be expected to thrive in the milder parts of the country.

Kirk, *loc. cit.* 189, f. 96, as *D. Colensoi.* Hooker, *Icon. Plant.* t. 544 (1843).

Dacrydium Colensoi, Hooker.

WESTLAND PINE

Dacrydium westlandicum, Kirk; Silver Pine; White Silver Pine.

A tree resembling *D. intermedium* in habit, but taller and more conical (up to 40–50 ft. high, with a trunk usually $4\frac{1}{2}$–$7\frac{1}{2}$ ft. in girth), with a straighter, cleaner trunk and more slender branchlets. *Leaves* of young plants lax, spreading, linear, $\frac{1}{4}$–$\frac{1}{2}$ in. long, gradually becoming shorter and more closely set with age and passing

into the mature type, which has small, scale-like, densely overlapping leaves, pressed close to the branchlets, $\frac{1}{20}$–$\frac{1}{12}$ in. long, leathery, blunt, and often incurved at the apex, keeled on the back. *Male flowers* terminal, $\frac{1}{8}$–$\frac{1}{6}$ in. long. *Seeds* 1–2, oblong, obtuse, about $\frac{1}{12}$ in. long, enclosed for a third or more of their length in a cup-shaped aril.

Native of New Zealand, being chiefly found on the west coast of the South Island, especially in the Westland district. Rare and local in the North Island. By many writers this species has been confused with *Dacrydium biforme*, Pilger (*Podocarpus biforme*, Hooker), which differs in the juvenile foliage and stouter branchlets.

Kirk describes the wood as straight and even in the grain, dense, firm, and compact, yet of low specific gravity; of great strength, toughness, and elasticity, shrinking little when seasoning, and taking a high polish. Mottled wood is highly prized for cabinets and furniture.

Kirk, *loc. cit.* 165, f. 85, as *D. westlandicum*; Hooker, *Icon. Plant.* t. 548 (1843), not t. 544.

Dacrydium cupressinum, Solander.

RIMU.

Red Pine.

A tree pyramidal when young, with graceful pendulous branches, but acquiring a round-topped crown when mature, 60–100 ft. high with a trunk 6–15 ft. in girth. *Bark* dark brown or grey, shed in large scales. *Juvenile foliage* loosely arranged, the leaves awl-shaped, $\frac{1}{6}$–$\frac{1}{4}$ in. long, spreading, decurrent, gradually passing into the mature state, the leaves of which are much smaller, $\frac{1}{12}$–$\frac{1}{8}$ in. long, linear, sharp-pointed, or the upper ones often blunt and incurved, keeled on the back. *Male flowers* small, green, at the tips of branchlets. *Seeds* ovoid, slightly compressed, about $\frac{1}{8}$ in. long, receptacle and bracts occasionally enlarged, fleshy.

The rimu is abundant in the forests of New Zealand, where it is an important timber tree.

Wood dark-reddish in colour, with darker or lighter markings, often finely figured; very durable, strong, and a very useful timber for building purposes, bridge construction, railway sleepers, posts, the indoor finish of houses, furniture, and other work. As the wood takes a good polish, finely figured examples are prized for cabinet work. The bark contains a good deal of tannin and is said to impart a reddish colour to leather.

Examples of the timber are exhibited in the New Zealand Court at the Imperial Institute and in Museum iii, at Kew.

Kirk, *loc. cit.* 29, f. 19.

Dacrydium elatum, Wallich.

A tall tree of pyramidal habit with spreading branches and weeping branchlets. *Leaves* of young plants and barren branchlets awl-shaped, densely arranged, spreading, deeply grooved, $\frac{1}{3}$–$\frac{2}{3}$ in. long ; those on fertile branchlets small, scale-like, densely overlapping, blunt or minutely pointed at the apex. *Male flowers* cylindric. *Seeds* scattered on the sides of the fertile branchlets, ovoid, $\frac{1}{6}$ in. long.

Native of the Malay States, Borneo, the Philippine Islands, and the Fiji Islands.

The timber has no special economic importance.

Dacrydium falciforme, Pilger.

A tree or shrub with spreading branches. *Leaves* spreading in two opposite ranks, leathery, obliquely or broadly lance-shaped, $\frac{3}{4}$–$2\frac{1}{2}$ in. long, $\frac{1}{5}$–$\frac{1}{3}$ in. broad, more or less curved near the base, narrowing into a short stalk, the apex a sharp point. *Female flowers* produced on scaly branches, ovule solitary.

Native of Borneo and the Philippine Islands.

Dacrydium Fonkii, Bentham.

Lepidothamnus Fonkii, Phillipi.

A densely branched shrub with short, erect branchlets. *Leaves* scale-like, closely pressed, keeled on the back, apex blunt and incurved. *Seeds* at the apex of branchlets, ovoid, up to $\frac{1}{4}$ in. long.

Native of Chile.

Dacrydium Franklini, Hooker fil.

HUON PINE.

A pyramidal tree 100 ft. high in Tasmania. *Branchlets* slender. *Leaves* small, scale-like, about $\frac{1}{16}$ in. long, closely pressed, strongly keeled, blunt and concave in mature plants resembling those of a cypress but differing markedly in the presence of scattered white stomata on the back. *Cones* very small, terminating the branchlets, each with 4–8 scales. *Seeds* globular, about $\frac{1}{12}$ in. in diameter.

The Huon pine (so named from the river in D'Entrecasteaux Channel, in the bed of which logs of the timber were found) occurs on the southern and western coasts of Tasmania, where it was first seen by Alan Cunningham in 1818. It is one of the best-known trees in the island and yields a finely marked wood which takes a high polish and is eminently suited for furniture and cabinet work, but unfortunately it is not sufficiently plentiful for regular export. Some good examples of the wood are to be seen in Museum iii at Kew, and at the Imperial Institute.

Dacrydium intermedium, T. Kirk.

YELLOW SILVER PINE.

Mountain Pine.

A small tree 20–40 ft. high, with a trunk 3–6 ft. in girth and spreading branches. *Leaves* on young plants narrow-linear, $\frac{1}{3}$–$\frac{1}{2}$ in. long, acute and curved, becoming closer set and shorter on older plants, passing gradually into those of mature trees which are densely crowded, overlapping, blunt, keeled, leathery, $\frac{1}{15}$–$\frac{1}{10}$ in. long. *Male flowers* abundantly produced, about $\frac{1}{4}$ in. long, with numerous anthers. *Seed* oblong, blunt, or with a minute point, $\frac{1}{8}$–$\frac{1}{6}$ in. long.

The tree is widely distributed in New Zealand, being not uncommon in mountain forests in the North and South Islands and on the western side of Stewart Island.

The reddish-yellow wood is highly resinous and very inflammable, but very strong and durable. It is employed for railway sleepers, boat-building, and for telegraph poles.

Kirk, *loc. cit.* 167, t. 86.

Dacrydium Kirkii, F. Mueller.

MANOAO.

A tree 50–80 ft. high, with a trunk 3–6 ft. in girth. *Bark* greyish-brown. Lower branches spreading, upper ones erect. *Leaves* of young trees and on the lower branches of old ones yew-like, linear, 1–1½ in. long; those of mature branches small, scale-like, closely pressed, $\frac{1}{12}$–$\frac{1}{8}$ in. long, obtuse, thick and leathery, with membranous margins. *Male flowers* solitary, $\frac{1}{8}$–$\frac{1}{4}$ in. long. *Female flowers* forming a short oblong head, $\frac{1}{4}$–$\frac{1}{2}$ in. long. *Seeds* 1–5, oblong, blunt, compressed, about $\frac{1}{8}$ in. long.

Found in the forests of the northern part of the North Island of New Zealand, and most frequent between Hokianga and Manukau Harbour.

Hooker, *Icon. Plant.* t. 1219 (1877); Kirk, *loc. cit.* 191, t. 97.

Dacrydium laxifolium, Hooker fil.

MOUNTAIN RIMU.

A prostrate or sub-erect shrub with slender trailing branches not exceeding 2 ft. in length. *Leaves* of young plants lax, spreading, narrow-linear, acute, curved, $\frac{1}{5}$–$\frac{1}{3}$ in. long, passing gradually into the adult leaves, which are linear-oblong, blunt or sub-acute, $\frac{1}{25}$–$\frac{1}{20}$ in. long, spreading or overlapping scale-like. *Male and female flowers* on the same or on different trees. *Seed* about $\frac{1}{8}$ in. long with a small curved point, borne on a dry or occasionally succulent and swollen receptacle.

This is probably the smallest known conifer, fruiting specimens barely 3 in. high and wide being sometimes found.

Native of New Zealand, where it is common in mountain districts usually between 2,500–4,000 ft. elevation. Its chief value is in checking erosion.

Kirk, *loc. cit.* 169, t. 87; Cheeseman, *Handb. New Zeal. Fl.* 657 (1906).

Dacrydium lycopodioides, Brongniart and Gris.

A tree 30–40 ft. high, of fastigiate habit. *Branchlets* erect, dense. *Leaves* crowded, narrowly lance-shaped, about ¼ in. long, rigid, sharply pointed, keeled beneath. *Seed* ovoid.

Native of New Caledonia. Compton describes it as a tree of slender, graceful habit occurring in coniferous forests at 3,500 ft. altitude.

Dacrydium novo-guineense, Gibbs.[1]

A small tree 30–35 ft. high, with a short trunk and rounded head of erect, rigid branches. *Juvenile leaves* plumose, needle-like, sharply pointed and curved at the apex; adult leaves scale-like, triangular, closely pressed to the shoots. *Seed* small, red, fleshy, from the points of branches.

Found at altitudes of 7,000–9,000 ft. in the Arfak Mountains of Dutch N.W. New Guinea.

Dacrydium taxoides, Brongniart and Gris.

A shrub of conical habit or a tree up to 50 ft. high.[2] Young shoots purple in colour. *Leaves* alternate, but appearing more or less in two opposite rows, oblong-lanceolate, slightly curved, acute or sub-acute at the apex. *Male flowers* in axillary or terminal spikes. *Seed* ovoid, laterally compressed.

Native of New Caledonia.

MICROCACHRYS, Hooker fil.

A monotypic genus distinguished by its prostrate, whip-like, four-angled branchlets and by its translucent, fleshy, cone-like fruits.

Microcachrys tetragona, Hooker fil.

A low, straggling, evergreen bush with long, slender, whip-like, four-angled branchlets. *Leaves* arranged in four regular ranks, scale-like, about $\frac{1}{16}$ in. long, uniform in size, with finely ciliate margins, remaining for many years on the main shoot. *Male* and *female flowers* terminal on separate shoots of the same plant; the former oblong or egg-shaped, about ⅛ in. long with 20 or more stamens. *Cones* egg-shaped or rounded, ¼–⅓ in. long,

[1] *Contrib. Phytogeo. and Fl. Arfak Mount.* 78–80 (1917).
[2] Compton, *loc. cit.* 427.

fleshy and bright red when ripe ; fertile scales round, each with an inverted seed surrounded by a scarlet aril.

Microcachrys occurs on the summit of the Western Range and Mount Lapeyrouse in Tasmania. It was in cultivation at Kew prior to 1862 and was probably introduced about 1845. Trained to a stake, it has grown 10 ft. high in the Temperate House at Kew.

Hooker, *Lond. Journ. Bot.* iv, 150 (1845); *Bot. Mag.* t. 5576 (1866).

PHEROSPHÆRA, Archer.

Evergreen, moisture-loving shrubs, natives of Tasmania and New South Wales, belonging to *Taxaceæ* and allied to *Diselma*, *Microcachrys*, and *Dacrydium*. *Branches* short and stiff or long and slender. *Leaves* scale-like, spirally arranged, often in four or five rows, dense and overlapping. *Male and female flowers* on different plants. *Male flowers* erect, egg-shaped or globular, $\frac{1}{12}$–$\frac{1}{9}$ in. long, composed of 10–15 stamens. *Cones* about $\frac{1}{10}$ in. long, made up of about 4–8 thin scales, thickened at the base, blunt-pointed at the apex. Ovuliferous scale none. *Seeds* several in each cone, each seed at the base of a glume-like scale equalling or slightly exceeding the length of the seed. Individual seeds light brown or greyish, about the size of a clover seed.

The *Pherosphæras* are found at alpine elevations usually on the margins of lakes, streams, and waterfalls, where they are rare. They are not known in cultivation and have no economic value.

Pherosphæra Fitzgeraldi, F. Mueller.

A low many-branched shrub with long slender branchlets, densely clothed with short, olive-green leaves about $\frac{1}{10}$ in. long, keeled, the point incurved, the inner surface white with stomatic lines and the whole leaf clear of the branch above the point of union. Distinguished from *P. Hookeriana* by its looser habit and longer, pointed, and less closely arranged leaves. Found at the base of most of the chief falls on the Blue Mountains, New South Wales.

Hooker, *Ic. Pl.* xiv, 64, t. 1383 (1882).

Pherosphæra Hookeriana, Archer.

A closely branched erect shrub up to 5–7 ft. high, with stiff, short branches, densely clothed with closely overlapping, scale-like leaves which are scarcely $\frac{1}{20}$ in. long and broad, thick, strongly keeled, curved and blunt at the apex. It is restricted to high alpine regions in Tasmania and is easily distinguished from *P. Fitzgeraldi* by its denser habit and smaller, thicker and more closely arranged leaves.

Hooker, *Kew Journ.* ii, 52 (1850).

PHYLLOCLADUS, L. C. Richard.

Brownetera, Richard; Robertia, Richard; Thalamia, Sprengel.

Evergreen trees or shrubs of distinct appearance, natives of Tasmania, New Zealand, the Philippine Islands and Borneo. *Bark* dark brown or black, smooth externally, reddish, compact, and fibrous within, the outer bark shed in thin flakes. *Branches* usually whorled. *True leaves* linear or scale-like, $\frac{1}{4}$–$\frac{3}{4}$ in. long, commonly found on seedling plants. They are succeeded by *cladodes* or *leaf-like branches* which perform the functions of leaves and bear the female flowers on their margins. Those in a lateral position are spirally arranged and bear a resemblance to simple leaves, but the terminal ones are deeply lobed or pinnate and produced in whorls. In a young state they are often brightly coloured. *Male and female flowers* on the same tree or on separate trees. *Male flowers* in stalked or sessile cylindrical catkins, produced in clusters from the points of the shoots. *Female flowers* very small, consisting of a single, erect, naked ovule seated on a short, fleshy scale, solitary or several together in a globular, cone-like body. *Seeds* greenish-brown, nutlike, ovoid or oval, at least twice as long as the swollen scale, each protruding from a cup-like sheath and resembling a miniature acorn in its cup.

The species of *Phyllocladus* are recognized by their flattened, leaf-like branchlets and by the small hard seeds borne in short, fleshy receptacles on the edges of the cladodes.

Timber white, yellowish or pale brown, heavy, straight-grained, easily worked, resembling that of the yew though paler in colour. The bark is rich in tannin and is sometimes used by tanners.

Propagation can be effected by seeds or by cuttings. The latter may be rooted during spring or summer if inserted in sandy soil in a close frame. The various species can be grown out of doors in some parts of Cornwall and in Ireland, but are otherwise tender. Several species are to be seen in the Temperate House at Kew.

Phyllocladus alpinus, Hooker fil.

ALPINE CELERY-TOPPED PINE.

Celery Pine; Mountain Toatoa; New Zealand Hickory; Tanekaha.

A bush or small tree 5–25 ft. high with numerous short, stout branches. *Cladodes* green, irregular in form and size, often narrow and diamond-shaped, $\frac{1}{4}$–$1\frac{1}{2}$ in. long and $\frac{1}{8}$–$\frac{3}{4}$ in. wide, thick in texture, margins almost entire, crenate, serrate, or irregularly and deeply lobed. On stunted specimens the branch system is very compact and the cladodes small and numerous, resembling a stunted *Gaultheria* or *Vaccinium*. The more highly cultivated the plants are, the more deeply lobed are the cladodes. *Male flowers* short, dense, reddish, almost stalkless. *Female flowers*

Nelson and Marlborough in the South Island, ranging from sea-level to 2,500 ft.

Wood of good quality, straight-grained, strong, heavy, easy to work, and useful for building purposes, masts, piles, mine

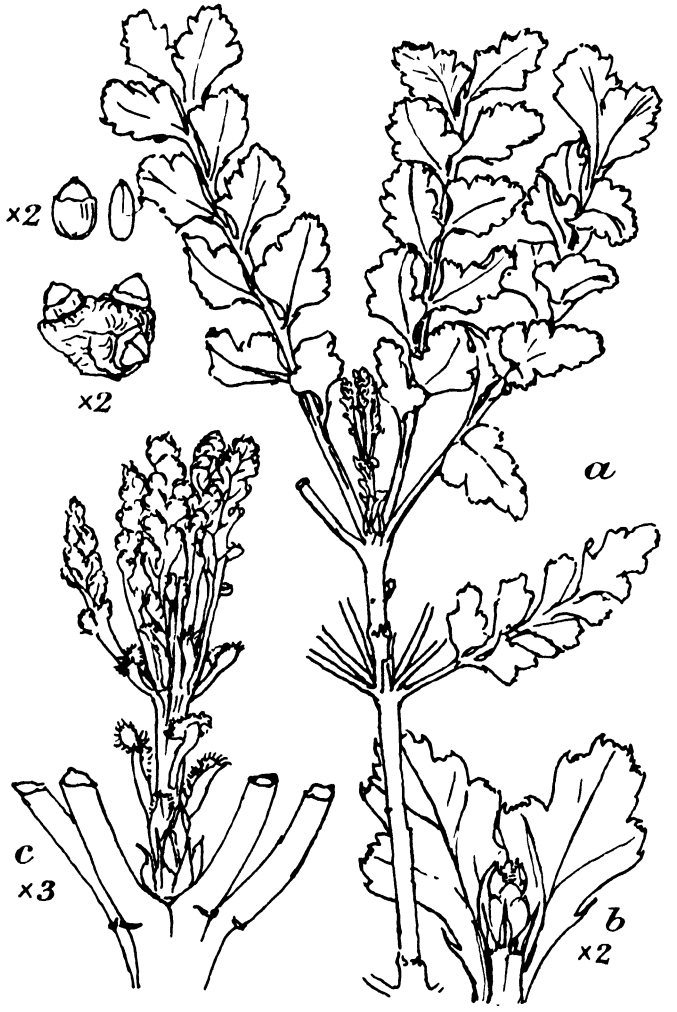

FIG. 4.—*PHYLLOCLADUS TRICHOMANOIDES.*

a, spray with whorls of branchlets; *b*, bud and two mature cladodes; *c*, young spray with minute leaf-scales on the teeth of the cladodes, and large scales on the shoot.

timbers, furniture, sleepers, and other purposes. Specimens at Kew bear a striking resemblance to yew and such wood might be effectively employed for parquet flooring, panelling, and cabinet work. The bark contains from 23–28 per cent. of tannin, and from it the Maoris obtain a bright red dye. Hides tanned

with the bark are said to produce leather which is peculiarly adapted for certain shades of kid gloves.

Plants of this species are growing out of doors in Cornwall, there being a fine one at Ludgvan Rectory. The young cladodes are of a pleasing reddish-brown colour.

Kirk, *loc. cit.* 9.

PODOCARPUS, L'Héritier.

YELLOW WOODS.

Nageia, Gaertner.

Evergreen trees and shrubs yielding valuable timber, largely confined to the mountain forests of warm temperate and sub-tropical regions of the Southern hemisphere, with some occurring in Japan, China, India, the Malay States, and the Philippine Islands. *Branches* whorled or irregular. *Leaves* very variable, dense or distant on the branches, spirally arranged, rarely opposite or sub-opposite in two close ranks, as in *Abies*, or crowded and overlapping; varying in size from mere scale-like bodies to a length of 12 in. and a breadth of 2 in., thin and fragile, or thick and leathery with recurved margins; young leaves often rose or reddish in colour. *Male and female flowers* usually on different trees. *Male flowers* axillary or, rarely, terminal, forming dense, narrow, cylindrical catkins. *Female flowers* stalked or sessile, axillary or terminal with usually 2–4 (occasionally more) scales, one or two of which bear in their axils a fertile scale folded over and united to an inverted ovule; usually one only matures, the sterile scales often fusing with the upper part of the stalk and developing a swollen, fleshy, brightly coloured, edible receptacle on which the seed is borne. The outer seed-coat is skinny or fleshy, the inner shell woody.

The genus includes about 65 species and is divided into the following five sections:—

1. **Dacrycarpus,** Endlicher.—*Leaves* variable in size and shape, thin, flat, soft, ¼–½ in. long, usually two-ranked on young plants; three-sided, needle-like and overlapping on mature trees, but shoots with both kinds of leaves often mixed. *Seed* solitary, terminal on a fleshy receptacle.

2. **Microcarpus,** Pilger.—*Leaves* scale-like, overlapping, the base clasping the branchlet. *Seed* solitary, terminal, on short drooping branchlets: receptacle not fleshy.

3. **Nageia,** Endlicher.—*Leaves* opposite or sub-opposite, many-nerved, wide in comparison to length. *Seed* axillary, round; receptacle fleshy or dry. Male flowers branched.

4. **Stachycarpus,** Endlicher.—*Leaves* sub-opposite, opposite, alternate or whorled, narrow in comparison to length, one-

nerved, usually leathery in texture. *Seed* without a fleshy receptacle, sometimes several together on a single peduncle. *Male flowers* short, stiff, usually branched, or many together on a stiff peduncle.

5. **Eupodocarpus,** Endlicher.—*Leaves* as in Stachycarpus. *Seed* borne on a fleshy receptacle. *Male flowers* usually long, slender.

Wood usually yellowish, occasionally brown or reddish, distinction between heartwood and sapwood not well marked; evenly grained, easy to work, durable, rarely odorous, finishes with a good surface and takes paint, polish, and creosote well. For most purposes for which pine is used, yellow wood is eminently suitable, except in the cheaper manufactures; in these cases it is more expensive to work, as in many instances it does not take nails well except when bored.

Numerous species are important timber trees in their native countries, and in many cases the extension of the area already under *Podocarpus* is desirable. This is specially the case in New Zealand, Australia, S. Africa, E. Africa, and Uganda. Only a few species can be regarded as hardy in Britain, even in the most favoured parts. These are grown as ornamental shrubs or small trees and can be increased by cuttings inserted in sandy soil in a close frame during summer. Several species are worth attention as hedge plants in warm temperate countries.

As in most genera of *Taxaceæ* and *Pinaceæ* the nomenclature of *Podocarpus* is full of pitfalls. An instance of this is found in the S. African species, where recent research has proved that the names in common use have been incorrectly applied. For information on these species see under *P. elongatus*, *P. falcatus*, *P. Henkelii*, and *P. latifolius*.

Pilger (Engler), *Pflanzenreich*, iv, 5, Taxaceæ (1903).

Podocarpus affinis, Seemann (Eupodocarpus).

A tree with short spreading branches and dense foliage. *Leaves* spirally and closely arranged, oblong or lance-shaped, erect, leathery, tapering to a blunt apex and narrowing slightly to the stalk-like base, 1–1½ in. long, ¼–⅓ in. wide.

Native of Fiji.

Podocarpus alpinus, R. Brown (Eupodocarpus).

Podocarpus Lawrencii, Hooker fil.; Nageia alpina, F. Mueller.

A low, straggling, densely branched bush 1–12 ft. high. *Leaves* crowded, ¼–⅓ in. or less often ½ in. long, narrow, straight or sickle-like, pointed, the midrib very prominent beneath. *Male flowers* ⅛–¼ in. long, usually solitary and unstalked from the

leaf axils. *Seed* ovoid, very small, about $\frac{1}{8}$ in. long, on a fleshy receptacle slightly longer than the seed.

Found chiefly at alpine or sub-alpine elevations in Victoria and Tasmania. Specimens growing in rocky situations at 5,000–6,000 ft. altitude become stunted and heath-like in habit. The species was originally described in 1825.

In its natural state it is of value for the protection of mountain sides from erosion.

The plant is quite hardy at Kew, where there are several bushes about 3 ft. high and 3–4 ft. across. They bear female flowers most years.

Podocarpus amarus, Blume (Stachycarpus).

BLACK PINE.

Podocarpus dulcamara, Seem ; P. eurhyncha, Miquel ; P. pedunculata, Bailey ; P. Sprengelii, Blume.

A tree with oblong leaves $2\frac{1}{2}$–5 in. long and $\frac{3}{8}$–$\frac{5}{8}$ in. wide, rich glossy green above, pale green beneath, the margins thickened and rolled backwards, the apex tapering to a sharp point. On young vigorous shoots the leaves are sometimes 10 in. long. *Male flowers* solitary or a few together from the leaf axils, up to $1\frac{1}{4}$ in. long. *Seed* round or oval, reddish with a glaucous coat, slightly ridged or pointed at the apex, $\frac{3}{4}$–1 in. long when mature, on stalks $\frac{1}{2}$–$\frac{1}{3}$ in. long.

Native of Queensland, Java, and the Philippine Islands. The timber is suitable for general joinery and carpentry.

Podocarpus angustifolius, Grisebach (Eupodocarpus).

Podocarpus aristulata, Parlatore.[1]

A small tree with spirally and loosely arranged leaves 1–$2\frac{1}{4}$ in. long and $\frac{1}{16}$ in. wide, narrowly lance-shaped, leathery, with a twisted base and sharp, spine-tipped apex. *Male* flowers solitary, $\frac{1}{3}$–$\frac{1}{2}$ in. long. *Seed* ovate or oblong, $\frac{1}{3}$ in. long, $\frac{1}{6}$ in. wide, seated on a fleshy receptacle.

Var. **Wrightii,** Pilger.

Leaves broader than in the type, about $\frac{1}{4}$ in. wide.

Native of Cuba and Bolivia.

Podocarpus appressus, Maximowicz [2] (Eupodocarpus).

A little-known species, native of Japan, with narrow, erect, rigid, sharply pointed leaves about $\frac{3}{4}$ in. long and $\frac{1}{16}$ in. wide. Only small dried specimens have been seen.

[1] *DC. Prod.* xvi, ii, 513 (1868).
[2] *Bull. Acad. Petersbg.* xv, p. 379 (1871).

Podocarpus Beccarii, Parlatore (Nageia).

A tree with dense branchlets and foliage. *Leaves* short-stalked, up to 1½ in. long and ¾ in. wide, narrowed to a point at the apex. *Seed* seated on a fleshy receptacle ⅓–½ in. diameter.

Native of Sarawak and Borneo.

Podocarpus Blumei, Endlicher (Nageia).

Nageia Blumei, Gordon.

A tree remarkable for the size of its leaves, which are opposite or sub-opposite, 4–7 in. long and 1–1¼ in. wide, narrowed suddenly at the apex to a blunt point. *Male flowers* in short branched spikes. *Seed* shortly stalked.

Native of Java and the Philippine Islands.

Podocarpus cæsius, Maximowicz [1] (Nageia).

A doubtful species closely allied to *P. Nageia.* Branches alternate. *Leaves* sub-opposite, leathery, broadly-oval or rounded, variable in size.

Found in Nagasaki, Japan.

Podocarpus chilinus, Richard (Eupodocarpus). (Fig. 5.)

A tree 50–70 ft. high with slender, drooping branchlets. *Leaves* shortly stalked, narrowly lance-shaped, 2–5 or more in. long, ⅙–¼ in. wide, shortly pointed or blunt at the apex, rich glossy green above. On old or dwarfed trees the leaves may be much shorter. *Male flowers* 1–1½ in. long, very slender, drooping, in small clusters. *Seed* on a long, slender stalk seated on a fleshy receptacle.

This species is a native of Chile and is hardy in the S. of England, where it often grows into a handsome shrub or small tree and is a favourite plant in gardens. There are several plants in the open air at Kew, but this species is less dependable there than in Cornwall. The timber of *P. chilinus* is of value for building purposes in its native country.

Podocarpus coriaceus, Richard (Eupodocarpus).

P. antillarum, R. Brown; P. salicifolia, Klotysch.

A tree 50 ft. high with spirally arranged leaves 3–7 in. long and ⅓–¾ in. wide, on stalks ¼ in. long; thick, leathery, the apex reduced to a long point, the midrib very prominent on the under-surface. *Male flowers* axillary, very slender, up to 2½ in. long. *Seed* ovoid, on a slender stalk, the receptacle thick, red, fleshy.

[1] *Bull. Acad. Petersbg.* xv, 379 (1871).

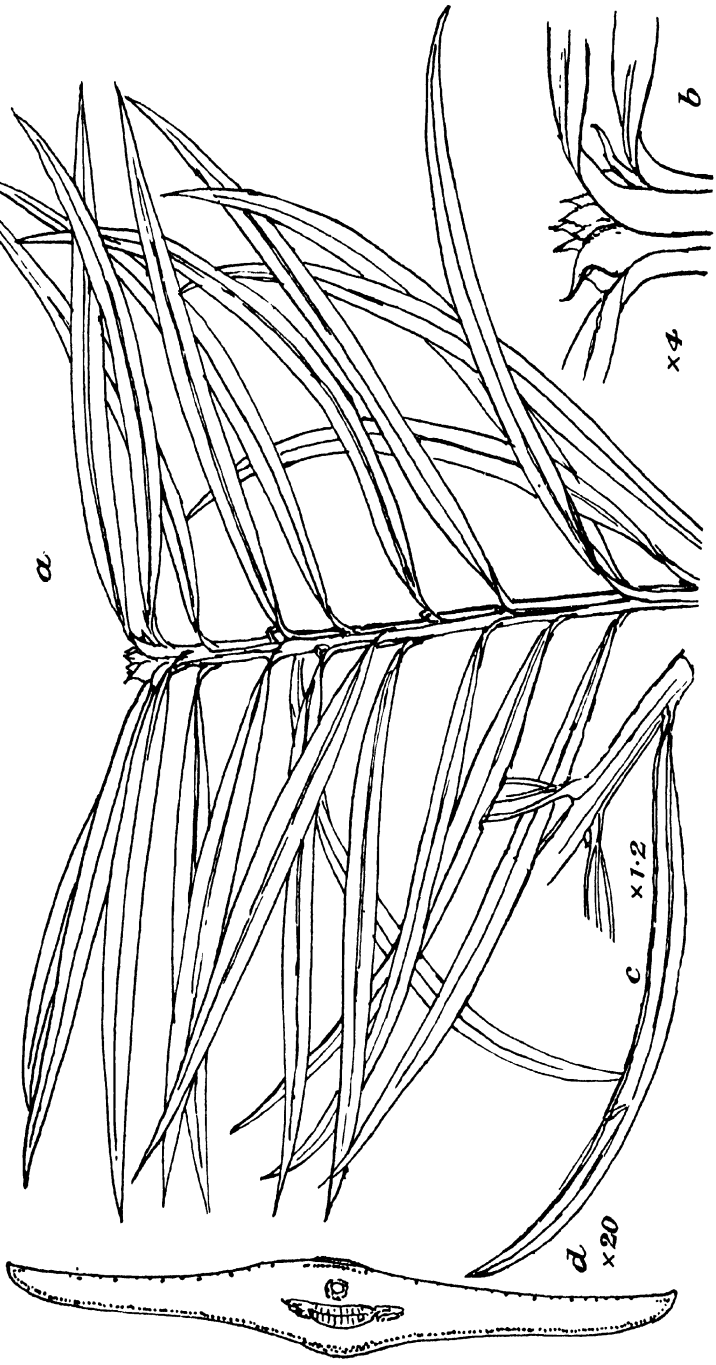

FIG. 5.—*PODOCARPUS CHILINUS.*
a, shoot; *b*, leaf-bud; *c*, under-surface of leaf; *d*, section of leaf.

Var. **sulcatus**, Pilger.

Leaves with a well marked furrow on the upper side. Native of Guadeloupe.

P. coriaceus is found in the mountain forests of New Grenada, Colombia, Venezuela, and the West Indies. The timber is suitable for general joinery and carpentry.

Podocarpus costalis, C. Presl. (Eupodocarpus).

A tree with dense branches. *Leaves* ½–1¾ in. long and up to ⅝ in. wide, thick, leathery, narrowing at the apex to a short point, or sometimes with a rounded apex; stalk about ¼ in. long. *Seed* elliptical, about ½ in. long, on a fleshy receptacle.

Closely allied to *P. Pilgeri* and a native of the Philippine Islands.

Podocarpus curvifolius, Carrière [1] (Eupodocarpus).

Podocarpus antarctica, Van Houtte; P. Humboldtii, Hort.

A large but little-known tree, native of the Andes of Chile and Patagonia. *Leaves* ovate or oblong, shortly stalked, 2–5 in. long, leathery, flat, shining and smooth above, margins thickened, apex blunt.

Podocarpus cuspidatus, Endlicher [2] (Nageia).

Nageia cuspidata, Gordon.

A small tree with opposite, sub-opposite, or sometimes definitely alternate leaves, 1¾–3 in. long and 1¼–1 in. wide, elliptic, deep green above, paler beneath, shortly stalked, usually narrowed abruptly to an apical point.

A native of Japan and apparently closely related to *P. Nageia*, but we have seen no living specimens.

Podocarpus dacrydioides, A. Richard (Dacrycarpus).

KAHIKATEA.

Podocarpus thujoides, R. Brown; Dacrydium excelsum, A. Cunningham; D. ferrugineum, Van Houtte [not D. Don]; Nageia excelsa, O. Kuntze; Rimu; White Pine.

A tree 50–150 ft. high with a girth of 6–12 feet. *Trunk* usually straight with little taper and clear of branches for a considerable height. *Bark* thin, greyish-brown. *Branchlets* fine, drooping. *Foliage* of two kinds: on young trees flat, soft, ⅛–⅓ in. long, bronze or bronzy-green, pointed, arranged in a single row on each side of the shoot; on older trees scale-like, $\frac{1}{16}$–⅛ in. long, spirally arranged, closely or loosely overlapping, in some cases resembling the foliage of a *Cupressus*, usually pointed and incurved, green or bronzy-green; an intermixing of shoots with both

[1] *Conif.* ed. i, 450 (1855). [2] *Syn. Conif.* 207 (1847).

kinds of leaves often occurs. In addition the main branches are clothed with triangular bract-like leaves. *Male and female flowers* produced on different trees. *Male flowers* terminal, scarcely ¼ in. long. *Female* flowers terminal. *Seeds* small, round, ⅛–¼ in. in diameter, seated in a red receptacle with a glaucous bloom.

P. dacrydioides is endemic in New Zealand, where it is widely distributed and an important timber tree. It is found from low elevation to an altitude of 2,300 ft., sometimes occupying swampy ground, where the tree develops large buttresses.

Wood white or yellowish, straight-grained, easily worked and suitable for general carpentry, the inside finish of houses, packing cases, dry cooperage, etc. Small parcels of the timber have been received in this country, but it appears improbable that it can compete satisfactorily with better-known woods, and its use will probably be restricted to New Zealand and Australia.

Small plants are to be seen in the Temperate House at Kew, and it is likely to meet with success out of-doors in the warmest parts of England and Ireland.

Kirk, *Forest Flora of New Zealand*, 41 (1889).

Podocarpus Dawei, Stapf.[1] (Stachycarpus).

An important timber tree 100 ft. high in Cent. Africa, with a long clear trunk and small crown of crowded branches. Leaves spirally arranged, ½–1½ in. long, ⅛–⅙ in. wide, thick, leathery, midrib scarcely noticeable above, more prominent beneath. *Seed* sub-globose, dark brown or purple with a glaucous bloom, about ¾ in. long and wide.

Native of Uganda, found near the Kangera River at an altitude of 4,000 ft.

The timber is of considerable local value for general carpentry.

Podocarpus Drouynianus, F. Mueller (Eupodocarpus).

An Australian species closely allied to *P. spinulosus*. *Leaves* unstalked, spirally arranged as in the Irish yew, up to 3 in. long, $\frac{1}{10}$ in. wide, sharply pointed, margins strongly recurved, midrib prominent, upper surface green, underside glaucous. *Male flowers* stalked, ¼–½ in. long, ⅙ in. wide, solitary or in small clusters. *Seed* ¾ in. long, borne on a fleshy, purple, waxy-coated receptacle ½–1 in. long, on a slender stalk.

Podocarpus elatus, R. Brown (Eupodocarpus).

BROWN PINE.

Podocarpus ensifolia, R. Brown; Nageia elata, Mueller. Plum Pine; Yellow Pine.

A tree 100 ft. high, with a trunk 9 ft. in girth in New South Wales and S. Queensland. *Leaves* variable in length and arrange-

[1] *Fl. of Trop. Africa*, vi, sect. 2, pt. 2, 342 (1917).

ment, often 2–6 in. long, or 9 in. long on young, vigorous trees, and ¼–½ in. broad, oblong or lance-shaped, midrib prominent on the upper surface, apex blunt, narrowed at the base to a short stalk. *Male flowers* slender, up to 2 in. long, produced 2–3 together. *Seed* ovoid or globular, about ¼–⅓ in. long, seated on a fleshy receptacle.

P. elatus is reputed to be one of the largest trees found in the coast-district gullies of New South Wales and S. Queensland.

Timber yellow, turning brownish on exposure, straight-grained, easily worked, and employed for all kinds of joinery and carpentry; its non-resinous character makes it useful for packing-cases for dairy and other produce.

Podocarpus elongatus, L'Héritier (Eupodocarpus).

Podocarpus Thunbergii, var. angustifolia, Sim; Taxus capensis, Lambert; T. elongata, Aiton.

A large tree resembling in habit *P. latifolius*, but with relatively narrower foliage. *Leaves* 1–2 in. long, ₁⁄₂–⅛ in. wide on mature trees, larger on young plants, lance-shaped, tapering to both ends, the apex ending in a short point. *Male flowers* simple or branched, about ¾ in. long. *Seeds* globose, about ¼ in. in diameter, seated on a fleshy, *red* or *crimson* receptacle, stalk short.

This species differs from *P. falcatus* by the seed being raised on a fleshy receptacle, and from *P. latifolius* by the receptacle being red, not green, and by its westerly distribution.

Found in Robertson, W. S. Africa.

Podocarpus falcatus, R. Brown (Stachycarpus).

OTENIQUA YELLOW WOOD.

Podocarpus elongata, Carrière, not L'Hérit.; P. Meyeriana, Endlicher; Taxus falcata, Thunberg. Common Yellow Wood; Bastard Yellow Wood.

A tree 80–110 ft. high and usually 10–12 ft., but occasionally 20–25 ft. in girth. *Bark* thin, brown in colour, shed in thin scales. *Leaves* very variable, sometimes spirally arranged, at others in two opposite or sub-opposite ranks, ¾–2 in. long and ₁⁄₂–⅛ in. wide on mature trees or up to 3 in. long and ¼ in. wide on young plants, narrowing abruptly to a sharp or blunt apex and at the base to a slightly twisted short stalk. *Male flowers* usually in threes, each ¼–⅓ in. long, about ₁⁄₂ in. wide. *Seeds* globose, solitary or in pairs, ¼–½ in. in diameter, with a glaucous green covering, stalk ¼–½ in. long.

This species is widely distributed in Cape Colony, Natal, and the Transvaal.

P. falcatus is one of the most useful trees in S. Africa. The timber is yellowish-brown, light, soft, moderately strong, elastic and non-resinous. It is easily worked, finishes with a good surface, and is useful for beams, rafters, flooring, panelling, furni-

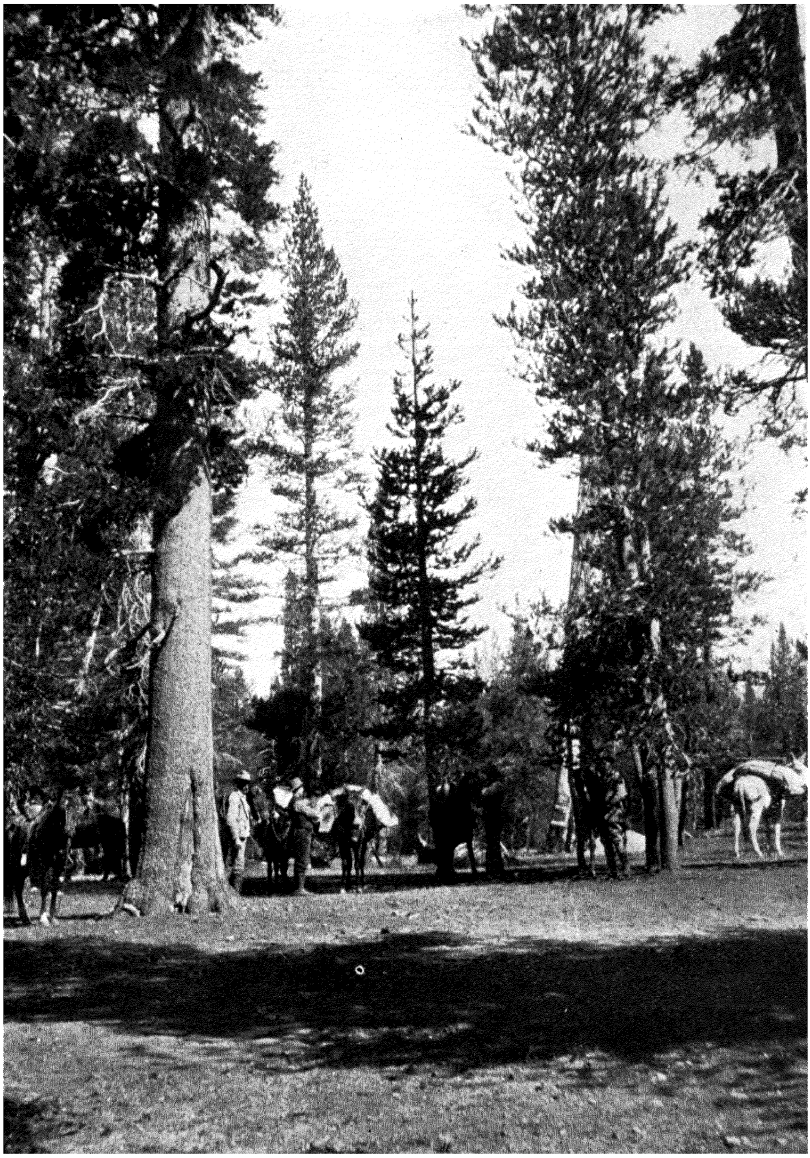

Photo by F R S Balfour, Esq

PLATE II. *PINUS CONTORTA VAR MURRAYANA* ON THE RIDGE BETWEEN KAWEAH AND KING'S RIVER CAÑONS, CALIFORNIA.

ture, railway sleepers when creosoted, general joinery, boxes and other purposes for which the best grades of pine are used in other countries. Planks 20 ft. long are obtainable.

In a critical study of the S. African Podocarps for the *Flora Capensis*, Dr. Stapf examined a large number of specimens at Kew, with the result that several old and well-known names have had to be changed. Thus the true *P. falcatus* described above is known in S. Africa under the name of *P. elongatus* with the common name of "Oteniqua Yellow Wood." The true *P. elongatus* is, however, a distinct tree confined to Western S. Africa. The confusion has been made worse by the name of *P. falcatus* having been used by S. African foresters in connection with still another species, *P. Henkelii*, Stapf.

Podocarpus ferrugineus, D. Don (Stachycarpus).

MIRO.

A tree 50–90 ft. high and 3–9 ft. in girth. *Bark* dark grey or blackish, sometimes deeply furrowed, scaling in large flakes. *Leaves* yew-like, irregularly arranged on each side of the shoot, $\frac{3}{4}$–$1\frac{1}{4}$ in. long on young plants, reduced to half the size on old trees, about $\frac{1}{12}$ in. wide, pointed or blunt at the apex. *Male flowers* solitary, $\frac{1}{4}$–$\frac{3}{4}$ in. long. *Female flowers* on different trees, solitary, shortly stalked. *Seed* oval, $\frac{1}{2}$–$\frac{3}{4}$ in. long and broad, the outer covering bright red with a waxy, glaucous bloom, apex with a short point.

P. ferrugineus is widely distributed in the New Zealand forests, particularly in the South Island.

Wood strong, hard, compact, straight-grained and easily worked. It is sometimes beautifully figured, especially when radially cut. Although not recommended for use in contact with the ground unless previously treated with a preservative, it is excellent for all other parts of house-building and for general carpentry. It is also used for marine piles and is said to resist teredo well. Figured samples are useful for cabinet work.

Kirk, *loc. cit.* 164 (1889); Cheeseman, *Man. New Zeal. Fl.*, 650 (1906).

Podocarpus ferruginoides, R. H. Compton[1] (Stachycarpus).

A tree 30–50 ft. high, with an erect trunk and irregular branch system. *Leaves* spirally arranged, usually erect, leathery, less than $\frac{3}{4}$ in. long, about $\frac{1}{8}$ in. wide, blunt or shortly pointed at the apex. *Seed* rounded or ovoid, $\frac{1}{3}$–$\frac{1}{2}$ in. long, unpointed.

Found in coniferous forest above 3,000 ft. elevation in Nekando, New Caledonia. It differs from *P. ferruginea* in the shorter and relatively broader leaves and the nearly round, non-pointed seeds.

[1] *Journ. Linn. Soc.* XLV, No. 304, 424 (1922).

Podocarpus Forrestii,[1] Craib and W. W. Smith (Eupodocarpus).

Podocarpus microphyllus, Diels.

A shrub up to about 10 ft. high, with fairly stout branches. *Leaves* 2–3½ in. long, ⅓–½ in. broad, oblong or oblong-lanceolate, blunt or rounded at the apex, gradually narrowed at the base into a short winged stalk, dark green above, pale beneath *Male flowers* not seen. *Female flowers* about ⅓ in. long on a short fleshy receptacle.

Closely allied to *P. macrophyllus*, var. *Maki*, but distinguished by its dwarfer habit and shorter and broader leaves.

Found on the eastern and western flanks of the Tali Range, W. China. Collected by Forrest.

Podocarpus glaucus, Foxworthy (Stachycarpus).

A bush or low tree up to 30 ft. high with a dense branch system. *Leaves* box-like, ⅙–⅜ in. long, about ⅛ in. wide, erect, spreading, often sub-opposite, leathery, shining dark green above, paler or glaucous beneath, usually slightly narrowed and rounded at the apex. *Male flowers* solitary, short, cylindrical. *Seed* not known.

Native of the high mountain regions of the Philippine Islands.

Phil. Journ. Sci. ii, 258 (1907).

Podocarpus glomeratus, D. Don (Eupodocarpus).

Podocarpus rigida, Klotzsch; P. Sprucei, Parlatore.

A tree 30–40 ft. high. *Leaves* spirally arranged, ½–1 in. long, ⅛–⅓ in. wide, erect, leathery, narrow lance-shaped, ending in a short, sharp point. *Seed* shortly stalked, ¼–⅓ in. diameter, raised on a fleshy receptacle.

Native of Peru and Ecuador.

Podocarpus gnidioides, Carrière (Eupodocarpus).

Podocarpus alpina, var. arborescens, Brongniart and Gris.

A tree 30–50 ft. high, with crowded, spirally arranged leaves ½–¾ in. long and ₁⁄₆–₁½ in. wide, leathery, rounded at the apex.

Var. **cæspitosus,** Carrière.

A shrub 3–5 ft. high, regarded by Carrière as a dwarf form of *P. gnidioides*, but male and female flowers and seeds of *P. gnidioides* are required before this relationship can be verified. Compton[2] only noted the dwarf plant. Both are natives of New Caledonia.

[1] *Notes Roy. Bot. Gard. Edinb.* xii, 219 (1920).
[2] *Loc. cit.* 426.

Podocarpus gracilior, Pilger (Stachycarpus).

MUSENGERA.

Podo.

A tree up to 60 or more ft. high, with a long, clear trunk crowned with crowded branches. *Leaves* of young plants scattered, up to 4 in. long and $\frac{1}{4}$ in. wide, on mature trees crowded and shorter, usually $\frac{3}{4}$–$2\frac{1}{2}$ in. long, $\frac{1}{8}$–$\frac{1}{3}$ in. wide ; thick in texture, narrow, tapering to a sharp point. *Male flowers* solitary or 2–3 together, usually $\frac{1}{2}$–$\frac{3}{4}$ in. long. *Seeds* solitary, unstalked, at the points of short, leafy branchlets, $\frac{1}{2}$–$\frac{3}{4}$ in. long and nearly as wide, purplish in colour with a glaucous bloom.

Native of Abyssinia, Uganda, and Kenya, ascending to 8,000 ft. altitude in the latter colony and common between 6,000–8,000 ft. in Uganda.

Wood soft, yellowish, works well, is strong, moderately durable, and is said to take nails better than some other species. It is used for general building purposes, particularly for inside work, such as flooring, doors, panelling, and furniture. The timber is shipped from Mombassa to S. Africa and has a considerable local use. The species is one of the most valuable on account of its timber. For work in contact with the ground it should be treated with a preservative.

Stapf, *Fl. Trop. Af.* vi, sect. 2, pt. 2, 342 (1917).

Podocarpus Harmsianus, Pilger (Stachycarpus).

A tree with yew-like, unstalked leaves, somewhat resembling those of *P. montanus* but spirally arranged, $\frac{3}{4}$–$1\frac{1}{4}$ in. long, $\frac{1}{16}$–$\frac{1}{8}$ in. wide, terminated by a spine-like point. *Seed* without a fleshy receptacle.

Native of W. Tropical South America.

Podocarpus Henckelii, Stapf. (Eupodocarpus).

FALCATE YELLOW WOOD.

Podocarpus falcata, Hort. not R. Brown ; P. Thunbergii, var. falcata, Sim.

A South African tree allied to *P. Thunbergii* with pendent branches. *Leaves* on old exposed trees irregularly arranged, sickle-like, 1–2 in. long and $\frac{1}{7}$ in. wide, or, on vigorous specimens sometimes opposite or sub-opposite, up to 5 or 6 in. long and $\frac{1}{3}$ in. wide, narrowing gradually to the pointed apex and to the base. *Male flowers* simple or branched, slender, about $\frac{1}{3}$ in. long. *Seed* globose, about $\frac{1}{3}$ in. diameter, glaucous-green, seated on a glaucous-green swollen receptacle.

This species is found in Griqualand East and Natal, and is known to foresters and lumber men as the " falcate yellow wood." The timber can be used for similar purposes to that of *P. latifolius*.

Podocarpus imbricatus, Blume (Dacrycarpus).

Podocarpus cupressina, R. Brown; P. Horsfieldii, Wallich; Taxodium Horsfieldii, Knight; Glyptostrobus Horsfieldii, Knight.

A tree 50–80 ft. high or occasionally taller, with a trunk 10–15 ft. in girth (but sometimes reduced to a bush), variable in habit but often with pendulous, spreading branches and long, slender, whip-like branchlets. *Leaves* of two kinds. Those of young or vigorous trees $\frac{1}{4}$–$\frac{1}{2}$ in. long, flat, soft, and arranged in two more or less opposite ranks; on branches of old trees closely overlapping, cupressus-like, the points incurved like miniature leaves of *Cryptomeria japonica*. Both types of leaves may appear on the same tree, but in such cases those of the juvenile state are smaller than those on young, vigorous plants. *Seed* solitary, terminal, borne on a slightly thickened, fleshy receptacle.

Native of British N. Borneo, Burma, Java, and the Philippine Islands, where it is an important timber tree.

Pilger records a variety *Cumingii* (*P. Cumingii*, Parlatore), but Foxworthy,[1] who made a careful study of the Philippine species, does not consider it distinct from the type.

Podocarpus Ladei, Bailey [2] (Stachycarpus).

A tall, erect tree with a trunk up to 18 ft. in girth covered with thin, reddish-brown, smoothish bark which is shed in papery scales. *Leaves* usually sessile, about $\frac{1}{2}$ in. long and $\frac{1}{12}$–$\frac{1}{8}$ in. wide, both surfaces green, apex blunt. *Seed* oval, solitary, pointed, about $\frac{3}{4}$ in. long and $\frac{1}{2}$ in. wide, purple with a glaucous bloom.

This species, which is closely allied to *P. ferruginea*, was found in the neighbourhood of Port Douglas by Mr. F. W. H. Lade in 1905.

It is described as a good timber tree of ornamental appearance.

Podocarpus Lambertii, Klotzsch (Eupodocarpus).

A Brazilian tree with densely and spirally arranged, yew-like leaves, which are $\frac{3}{4}$–$1\frac{1}{4}$ in. long and $\frac{1}{16}$ in. wide, erect, sharp-pointed, stalkless, or very shortly stalked. *Seeds* small with a stalked and fleshy receptacle.

Podocarpus latifolius, R. Brown [3] (Eupodocarpus).

REAL YELLOW WOOD.

Podocarpus Sweetii, C. Presl; P. Thunbergii, Hooker; P. Thunbergii, var. latifolia, Sim; Nageia latifolia, O. Kuntze; Taxus latifolia, Thunberg. Upright Yellow Wood.

A tree up to 100 ft. high and 12 ft. in girth, averaging 60–70

[1] *Phil. Journ. Sci.*, Bot. vi, 157 (1911).

[2] *Queensl. Agric. Journ.* xv, 899 (1905).

[3] Although *P. Thunbergii* is a better-known name in S. Africa, *P. latifolius* is the older name for this species, and therefore supersedes *P. Thunbergii*. A note on the nomenclature of this species appeared in the *Kew Bulletin* for 1916, p. 236.

ft. high and 6 ft. in girth. *Bark* thin, fibrous, shed in longitudinal strips. *Branchlets* of mature trees stiff, erect, crowded. *Leaves* spirally arranged, or, on young branchlets, in two alternate ranks, oblong or lance-shaped, sometimes closely beset, at others widely separated, those of old trees usually 1–2 in. long and $\frac{1}{6}$–$\frac{1}{4}$ in. wide, much longer on young, vigorous, or shaded plants. *Male flowers* usually solitary, unstalked, $\frac{3}{4}$–1 in. long, $\frac{1}{8}$ in. wide. *Seeds* globose, $\frac{1}{4}$–$\frac{1}{3}$ in. diameter with a glaucous-green covering, receptacle green, $\frac{1}{6}$–$\frac{1}{4}$ in. wide, with a stalk about $\frac{1}{4}$ in. long.

P. latifolius is widely distributed in S. Africa, where it is an important timber tree.

Wood yellow, strong, evenly grained, easy to work, polishes well, and in demand for general building purposes, flooring boards, panelling, coach and wagon work, dry cooperage, boxes, and railway sleepers. For the latter work it is first creosoted. It is claimed to be superior to pine for many purposes.

Podocarpus macrophyllus, D. Don (Eupodocarpus).

KUSAMAKI.

This species varies from a shrub of 2–5 ft. to a tree 25–50 ft. high. *Branches* usually strong and horizontal, branchlets dense. *Leaves* densely and spirally arranged, up to 5 in., or on very vigorous plants 7 in. long and $\frac{1}{2}$ in. wide, bright green above, glaucous beneath, thick, leathery, the apex usually pointed, sometimes blunt and rounded. *Male flowers* sessile, $1\frac{1}{4}$–$1\frac{1}{2}$ in. long. *Seed* oval, about $\frac{1}{3}$ in. long, seated on a purple, fleshy receptacle $\frac{1}{2}$ in. or more in length.

Var. angustifolius.

Leaves narrower in proportion than those of the type.

Var. Maki, Siebold.

P. chinensis, Wallich; P. Maki, Siebold.

A variety with erect branches and dense foliage. Leaves erect, apex rounded.

Var. luteo-variegatus.

P. chinensis aurea elegantissima.

Leaves longer and broader than in the type; variegated with yellow.

Var. albo-variegatus.

P. chinensis argentea.

Leaves variegated with silver.

P. macrophyllus is a native of China and Japan. It is found in Yunnan at elevations of 8,000–10,000 ft. and would form a

good evergreen for the S. of England. It is sometimes used for hedges in Japan, and stands clipping well.

Podocarpus macrostachyus, Parlatore (Eupodocarpus).

A tree attaining a large size in Central America. *Leaves* 1–2 in. long, ¼–½ in. wide, narrowing to a short, blunt point in aged trees, longer and sharply pointed on young, vigorous branchlets. *Seeds* small, ovoid, mounted on a fleshy receptacle.

Native of Colombia, Venezuela, New Grenada, and Costa Rica. Mr. M. T. Dawe reported it to be one of the most useful timbers of Colombia, where it is found at an altitude of 10,000 ft.

Podocarpus madagascariensis, Baker (Eupodocarpus).

HETATRA.

A large tree. *Leaves* spirally arranged, 5–7 in. long, and up to $\frac{7}{12}$ in. wide, narrowing to a pointed apex and narrow stalk-like base, thick, leathery, the midrib prominent on the under-side, marked by a channel on the upper surface. *Seed* about ½ in. long and wide.

This tree is said to be common in forests in the interior of Madagascar, the wood being extensively used for housebuilding and other purposes.

Podocarpus Mannii, Hooker fil. (Stachycarpus).

A tree 30–50 ft. high with loosely disposed branchlets, or, in old trees, short upward-curving branches. *Leaves* stalkless, varying in length from 3 in. on old trees to 4–6 in. on vigorous young plants; ⅓–½ in. in width, straight or slightly curved, gradually tapering to a fine point. *Male flowers* unstalked, axillary, solitary or in pairs, ½–1 in. long. *Seeds* without stalks, on short, few-leaved branchlets, up to 1 in. long and $\frac{7}{12}$ in. wide.

Native of the island of St. Thomas, W. Africa, from 4,750 ft. elevation to the summit of the Peak, at 7,025 ft.

Fl. Trop. Afr. vi, Sect. 2, pt. 2, 34 (1917).

Podocarpus milanjianus, Rendle [1] (Eupodocarpus).

A shrub or tree up to 100 ft. high with a cylindrical, gradually tapering trunk. *Leaves* spirally arranged, crowded, 2–4 in., or on young trees sometimes 7 in., long, and ⅓–½ in. wide, straight or slightly sickle-shaped, pointed at the apex, narrowed to a short stalk at the base. *Male flowers* solitary or in pairs, cylindric, 1–1½ in. long, pinkish in colour. *Seeds*, globose, ⅓–½ in. long, covered with a glaucous bloom and seated on a bright red glaucous

[1] *Trans. Linn. Soc.* Ser. 2, iv, 61 (1894); *Fl. Trop. Af.* vi, sect. 2, pt. 2, 340 (1917).

receptacle. The variety *arborescens*, Pilger, is not regarded as distinct.

P. milanjianus is found in Uganda, Kenya, and Tanganyika Territories and in Nyasaland. In Kenya it ascends to 11,000 ft., where it occurs as a low, dense bush.

It is a valuable timber tree and worthy of careful preservation in countries where easily worked soft woods are uncommon.[1] The wood is obtainable in lengths up to 20 ft., squaring 12–16 in.

It thrives in swampy places as well as upon better drained land.

Podocarpus minor, Parlatore (Nageia).

Nageia minor, Carrière.

A bush or small tree up to 30–40 ft. high,[1] with spirally arranged, stalkless leaves $\frac{1}{2}$–$\frac{3}{4}$ in. long, $\frac{1}{8}$–$\frac{1}{6}$ in. wide, blunt and rounded at the apex, or sometimes with the leaves arranged in two opposite ranks. *Male flowers* short, sturdy, $\frac{1}{4}$–$\frac{1}{3}$ in. long, at the points of short, axillary shoots. *Seeds* large, 1–$1\frac{1}{8}$ in. long, $\frac{3}{4}$ in. wide, on short, slender, bract-covered shoots; red when ripe.

Native of New Caledonia, where it is frequent in conifer forests all over the island. The wood is described as having a sweet, resinous scent.

Podocarpus montanus, Loddiges (Stachycarpus).

PINO.

Podocarpus Humboldtii, Knight; P. taxifolia, Humboldt; Taxus montana, Willdenow; Dacrydium distichum, Don; Torreya Humboldtii, Knight; Nageia montana, O. Kuntze; Prumnopitys taxifolia, Hort.

A tree up to 60 ft. high with wide-spreading branches and yew-like foliage evenly arranged in two sub-opposite rows. *Leaves* $\frac{1}{2}$–$\frac{3}{4}$ in. long, $\frac{1}{16}$–$\frac{1}{12}$ in. wide, sharply pointed at the apex, the base slightly twisted and shortly stalked, bright green above, pale green or glaucous beneath. *Male flowers* axillary and terminal from shoots $1\frac{1}{2}$–3 in. long, numerous flowers, each about $\frac{1}{2}$ in. long, appearing from the same shoot. *Seed* about $\frac{1}{3}$ in. long, sessile or very shortly stalked.

Var. **diversifolius**, Kunth.

Leaves shorter and more closely arranged than in the type.

Native of the Cordilleras of Peru and Colombia, where it grows at an altitude of 9,000–10,000 ft. Mr. M. T. Dawe records it (see specimens collected by him in the Kew Herbarium) as one of the most useful timber trees of the Cordillera Columbia. The timber is much used for cabinet work. Living specimens are to be seen in the Temperate House at Kew.

[1] Compton, *loc. cit.* 425.

Podocarpus Nagi, Makino (Nageia).

Podocarpus Nageia, R. Brown.

A tree 60–80 ft. high. *Bark* smooth, purple. *Leaves* opposite or sub-opposite, ovate or broadly lance-shaped, 1½–2 in. long, ¾–1 in. wide, narrowing to a blunt apex ; thick, leathery, dark green above, paler beneath. *Male flowers* solitary, simple or branched, up to ¾ in. long, or stalks ¼ in. in length. *Seeds* round, about ½ in. in diameter, covered by a glaucous bloom.

Var. **angustifolius**, Maximowicz.

Leaves shorter and narrower than the type. About ½ in. long.

Var. **rotundifolius**, Maximowicz.

P. ovata, Henkel.

Distinguished by its relatively broader leaves.

Var. **variegatus**.

Leaves shorter and rounder than the type, variegated with yellow.

P. *Nagi* is a native of Japan, China, and Formosa. In the latter country it is regarded as a valuable timber tree. In Japan it is popular as a pot plant for dwarfing, and is also used for landscape effect. Prof. Sargent says of the tree:[1] "A grove of these trees on the hill behind the Shinto temples at Nara is one of the most interesting spots in Japan and in solemn dignity and beauty is only surpassed by the grove of *Cryptomeria* which surrounds the mausoleums of Jeyasu and Jemitsu at Nikko."

Podocarpus neriifolius, D. Don (Eupodocarpus).

THITMIN.

Podocarpus bracteata, Blume ; P. discolor, Blume ; P. Junghuhniana, Miquel ; P. leptostachya, Blume ; P. macrophylla, var. acuminatissima, Pritzel ; P. polystachya, R. Brown ; Nageia bracteata, Kurz. Prince of Woods.

A variable tree, 40–60 ft. high, with branches more or less whorled. *Bark* thin, fibrous, greyish-brown. *Leaves* 4–7 in. long, ⅓–1½ in. wide on old specimens to 5–10 in. long and ½–¾ in. wide on young trees ; thick, leathery, the midrib prominent on both surfaces, apex pointed, dark glossy green above, paler beneath. *Male flowers* stalkless, produced several together, 1–2 in. long, about ⅙ in. wide. *Seeds* usually solitary, globose, about ⅓ in. long, produced on a swollen stalkless receptacle.

[1] *For. Fl. Japan*, 77 (1894).

Var. **brevifolius**, Stapf.[1]

A form with short, dense, spirally arranged leaves, the foliage much denser than in the type; the male flowers also shorter and relatively wider than in *P. neriifolius*.

Widely distributed in the Himalaya, Borneo, Java, and the Andaman Islands. It has also been recorded from China.

Wood yellowish, of good quality, easy to work and useful for masts, spars, tea-boxes, and general carpentry. Timber squaring with a 15 in. side can be procured up to 35 ft. in length.[2]

Podocarpus nivalis, Hooker fil. (Eupodocarpus).

THE ALPINE TOTARA.

A low, dense, widely spreading plant, or an erect densely branched shrub 3–6 ft. high. *Leaves* closely and irregularly arranged, ¼–¾ in. long, $\frac{1}{20}$–$\frac{1}{16}$ in. wide, shortly and stoutly stalked, leathery, pointed or blunt at the apex. *Male* flowers ½–¾ in. long, solitary or several together. *Seed* a small nut-like body seated on a fleshy receptacle.

A native of New Zealand, where it is found in alpine and sub-alpine regions at elevations of 2,000–5,500 ft., its spreading and closely arranged branches assisting in the protection of mountain slopes from erosion.

Podocarpus novæ-caledoniæ, Vieillard (Eupodocarpus).

A shrub with narrow willow-like leaves 1½–4½ in. long and $\frac{1}{8}$–$\frac{1}{5}$ in. wide, the apex narrowing to a long or short point, glaucous when young, dark green later. *Male flowers* short, slender, axillary, ⅓–¾ in. long. *Seeds* oval, about ⅓ in. long, borne on a fleshy receptacle.

Native of New Caledonia, where it is common along river banks in serpentine districts at low elevations.

Podocarpus nubigenus, Lindley (Eupodocarpus).

A large tree in Chile and Patagonia. *Leaves* spirally arranged or in two sub-opposite rows, straight or sickle-shaped, rigid, leathery, 1–1¾ in. long, ⅛–⅙ in. wide, short-pointed, green above, glaucous beneath. *Male flowers* simple or branched, short-stalked, about ⅛–¼ in. long. *Seeds* short-stalked, ovoid or oblong, borne on a swollen fleshy receptacle.

P. nubigenus is found in the mountainous regions of Chile, Patagonia, Valdivia, and the Island of Chiloe.

[1] *Trans. Linn. Soc.* ser. 2, iv, 249 (1894).
[2] Gamble, *Man. Ind. Timbers*, 703 (1922 ed.).

Podocarpus oleifolius, D. Don [1] (Eupodocarpus).

A close dense-branched tree with yellowish-brown bark. *Leaves* spirally arranged, up to 2 in. long and ¼ in. wide, lance-shaped, pointed, with a shallow central channel above and a prominent midrib beneath. *Male flowers* solitary, unstalked, about 1 in. long. *Seed* oval, ⅓ in. long.

Native of the mountains of Chile and Peru.

Podocarpus palembanicus, Miquel.

A tree, native of Sumatra, remarkable for its large, handsome foliage. *Leaves* up to 12 in. long and ⅞ in. wide, channelled above, the midrib very prominent beneath, the apex narrowed to a point, and the base reduced to a stalk ½–¾ in. long.

Podocarpus papuanus, Ridley (Dacrycarpus).

A tree 90–100 ft. high in New Guinea with pendent branches bearing two kinds of leaves. *Leaves* of young trees regularly arranged in two opposite ranks, ¼ in. long, scarcely $_1{}^1{}_6$ in. wide. short-pointed and curving slightly at the apex. *Leaves* on older trees mostly very short, triangular, keeled, terminating in a short spine, the base clasping the stem, only the point free. Branchlets bearing both kinds of leaves may be found on the same tree. *Male flowers* short, dense, about ⅛ in. long, terminating short leafy shoots. *Female flowers* are borne on the same tree as the male flowers. *Seeds* ⅛–⅙ in. long and wide.

Native of Dutch N.W. New Guinea at 7,000–9,000 ft. altitude.

L. S. Gibbs, *Contrib. Phitogeo. and Fl. Arfak Mts.* 80–82 (1917).

Podocarpus parvifolius, Parlatore (Eupodocarpus).

A bush or small tree with short, narrow, leathery leaves, which are scarcely ½ in. long and ⅛ in. wide, ending in a short, sharp point. *Seed* small, pointed.

Native of Australia.

Podocarpus Pilgeri, Foxworthy (Eupodocarpus).

A tree with densely arranged leaves ½–1⅛ in. long and ¼ in. wide with a rounded or blunt-pointed apex.

Native of the Philippine Islands.

Phil. Journ. Sci. Bot. vi, 155–164 (1911).

Podocarpus polystachyus, R. Brown (Eupodocarpus).

A tree with lance-shaped, spirally arranged leaves, which are 2–4 in. long and ¼–½ in. wide, sharp-pointed and leathery. *Male flowers* unstalked, solitary, or in threes. *Seed* solitary. Native of the Malay States.

[1] Lambert, *Gen. Pin.* ed. i (1824).

Podocarpus Purdieanus, Hooker (Eupodocarpus).

Podocarpus jamaicensis, Hort.; P. mucronata, Hort.

A tree up to 120 ft. high, with spirally arranged leaves 1½–4 in. long and ¼–⅔ in. wide, or on vigorous young plants up to 4½ in. long and ⅔ in. wide, the apex rounded or ending in a short point. *Seeds* ovoid, about ⅓ in. long, with a short blunt point.

Native of Jamaica.

Podocarpus Rumphii, Blume (Eupodocarpus).

A tree 40 ft. high with leaves 5–9 in. long and up to ¾ in. wide, narrowed at the apex to a long point. *Seeds* globose, produced on a conspicuous, fleshy receptacle.

P. Rumphii is abundant at elevations of 7,000–9,000 ft. in the forests on the Arfak Mountains, Dutch New Guinea.

Podocarpus Sellowii, Klotzsch (Eupodocarpus).

PINHEIRA BRAVA.

A small tree usually 20–30 ft. high, bearing shortly stalked, lance-shaped, short-pointed, leathery leaves, 1½–3½ in. long and ⅕–⅓ in. wide on mature trees; upwards of 6 in. long and ½–¾ in. wide on vigorous young plants. *Male flowers* solitary from the leaf axils. *Seeds* shortly stalked, smooth, seated on a fleshy receptacle.

Var. **angustifolius,** Pilger.

Leaves up to 1½ in. long and ¼ in. wide.

Native of Brazil.

Endl. Syn. Conif. 209 (1847).

Podocarpus spicatus, R. Brown (Stachycarpus).

MATAI.

Dacrydium taxifolium, Banks; D. Mayi, Van Houtte; Prumnopitys spicata, Kent. Black Pine; Mai; Red Pine.

A tree 60–80 ft. high, with a trunk up to 9 ft. in girth, varying considerably in habit. Young trees 10–20 ft. high, with slender, pendulous branches divided into numerous branchlets with small, narrow, bronze-tinted leaves confined to the extremities, becoming, when mature, a round-headed tree with erect branches which divide into short, close-set branchlets. *Bark* bluish. *Leaves* ¼–½ in. long, about $\frac{1}{20}$ in. wide, green above, glaucous on each side of the midrib beneath. *Male flowers* ⅛–⅙ in. long, unstalked, 20 or more together on short, stiff shoots about 1 in. long. *Seeds* round, the size of a small pea, black with a glaucous bloom, produced several together on short shoots.

A native of New Zealand, where it ascends to 1,800 ft. Specimens were collected by Alan Cunningham in 1826.

Wood smooth when worked, rather similar in texture to good Scots pine and useful for the same purposes. It has been employed for dry cooperage, general house construction, railway sleepers, bridge timbers, flooring, and other uses.

Kirk, *loc. cit.* 5, 299 (1889). Hook. *Icon. Plant*, t. 543 (1843).

Podocarpus spinulosus, R. Brown (Eupodocarpus).

NATIVE PLUM.

Podocarpus pungens, Don ; P. Bidwillii, Hoibr ; P. excelsa, Loddiges ; Taxus spinulosa, Smith ; Nageia spinulosa, F. von Mueller.

A densely branched, yew-like shrub. *Leaves* unstalked, usually spirally arranged, $\frac{3}{4}$–$1\frac{1}{2}$ in. long but sometimes up to 3 in. long, $\frac{1}{12}$–$\frac{1}{16}$ in. wide. *Male flowers* clustered in the leaf axils, $\frac{1}{4}$–$\frac{1}{3}$ in. long. *Seeds* $\frac{1}{3}$–$\frac{1}{2}$ in. long, about $\frac{1}{3}$ in. wide, glaucous when young, receptacle edible, deep purple with a glaucous bloom.

Native of Australia and first collected by Alan Cunningham in New South Wales in 1810.

Podocarpus Teysmanni, Miquel (Eupodocarpus).

A tree with scattered or spirally arranged leaves which are broadly lance-shaped, 4–5 in. long and $\frac{1}{2}$–$\frac{3}{4}$ in. wide, with a pointed apex.

Native of Sumatra.

Podocarpus thevetiifolius, Zippel (Eupodocarpus).

A tree 30–50 ft. high, with narrowly lance-shaped leaves, which are thin, leathery, and sometimes slightly curved towards the rounded or bluntly pointed apex. *Seed* dark green, elliptic, about $\frac{1}{2}$ in. long.

Native of New Guinea.

Podocarpus Totara, D. Don (Eupodocarpus).

THE TOTARA.

A tree sometimes exceeding 100 ft. in height, with a massive, symmetrical trunk 60–80 ft. in length and 6–8 ft. in diameter, clear of branches. *Bark* dark brown, fibrous, furrowed. *Leaves* varying in density, sometimes scattered on the shoot, at others two-ranked, $\frac{1}{2}$–$\frac{3}{4}$ in. long, $\frac{1}{8}$–$\frac{1}{3}$ in. wide on adult trees, 1 in. long, $\frac{1}{8}$–$\frac{1}{4}$ in. wide on juveniles ; stiff, leathery, sharp-pointed, narrowing at the base to a very short stalk. *Male flowers* axillary, stalked or unstalked, solitary or two or three together, $\frac{1}{2}$–$\frac{3}{4}$ in. long. *Seed* a solitary, rounded nut seated on a fleshy, short-stalked, crimson receptacle, the apex of the seed sometimes narrowed but not pointed.

Var. **Hallii**, Pilger.

P. Hallii, T. Kirk.[1]

A tree attaining a height of 60 ft., differing from *P. Totara* in its looser habit, larger leaves (up to 1½ in. long and ¼ in. wide) in a mature state, distinctly stalked male flowers and pointed seeds which are sometimes in pairs.

Both trees are widely distributed in New Zealand. Next to the Kauri pine the Totara is regarded as the most useful timber tree of the country.

Wood red in colour, varying considerably in depth of tint clean, straight-grained, compact, and durable both in and out of the ground. It is used for general building purposes, joinery and cabinet work, piles for bridges and docks where it withstands teredo moderately well, paving blocks, railway sleepers, telegraph and telephone posts, fencing and many other purposes. Finely marked, mottled wood is sometimes found. This is eagerly sought after for furniture and cabinet work.

The Totara gives the best results in cool alluvial soils, but succeeds in light sandy loams and stiff clays. It bears clipping as well as yew and can be used for hedges.

P. Totara is grown out of doors in a few gardens in Britain notably at Enys near Falmouth and in the garden of the late Mr. Osgood Mackenzie at Inverewe in Ross-shire. A fine example may be seen in the Temperate House at Kew.

Podocarpus Urbanii, Pilger (Eupodocarpus).

YACCA.

A yew-like tree up to 50 ft. high with rigid, erect, leathery narrowly lance-shaped leaves ¾–1 in. long and $\frac{1}{6}$ in. wide, or on young plants up to 2 in. long and ¼ in. wide. *Male flowers* about ¾ in. long. *Seed* small, about ¼ in. long, globose, on a fleshy receptacle.

Native of the Blue Mountains of Jamaica, Montserrat.

Podocarpus usambarensis, Pilger (Stachycarpus).

Podocarpus falcata, Engler, not R. Brown.

A large tree 180–250 ft. high, with rather slender scattered branchlets. *Leaves* normally up to 3 in. long and $\frac{1}{6}$–¼ in. wide, sometimes larger on young trees, or smaller and arranged very densely on old specimens; leathery, straight or sickle-shaped, tapering at the apex to a long, fine point, and narrowing at the base to a very short stalk, midrib not prominent above but well marked beneath. *Male flowers* not seen. *Seeds* solitary, globose, about 1 in. long, on slender stalks ½–¾ in. long.

Found in Usambara and other parts of Tanganyika Territory,

[1] *Loc. cit.* 13, 301 (1889).

in mountain meadows and in virgin forest at elevations of 2,500 to over 6,000 ft.

Timber yellowish in colour, clean, easily worked, and useful for general carpentry and joiners' work.

Fl. Trop. Africa, vi, sect. 2, pt. 2, 341 (1917).

Podocarpus ustus, Brongniart and Gris (Microcarpus).

A bush with dense branches divided into very fine cypress-like branchlets. *Leaves* scale-like, densely overlapping. *Seeds* round, very small, about $\frac{1}{8}$ in. diameter, glaucous, on short leafy stalks.

Native of New Caledonia, but apparently very rare. Compton[1] only found it on one occasion, and then in very small quantity.

Podocarpus Vieillardii, Parlatore (Dacrycarpus).

Dacrydium elatum compactum, Carrière; D. tenuifolia, Parlatore.

A tree 40–50 ft. high, with a narrow head of branches. *Leaves* variable, of two distinct types, the juvenile type flat, soft, $\frac{1}{8}$–$\frac{1}{3}$ in. long, pointed, arranged in a single row on each side of the shoot; the adult type $\frac{1}{16}$–$\frac{1}{4}$ in. long, spirally arranged, overlapping, the points curving inwards, the foliage looser and more glaucous than in *P. dacrydioides*, which it resembles in foliage. *Seed* oval or rounded with a pointed apex.

Compton, *loc. cit.* p. 425.

Podocarpus vitiensis, Seemann.

A tree 50–80 ft. high, remarkable for the uniform arrangement of the opposite leaves, which give the shoot a flattened character. *Leaves* symmetrical, narrowly lance-shaped, up to $1\frac{1}{3}$ in. long, $\frac{1}{8}$–$\frac{1}{6}$ in. wide at the base, gradually narrowing to a terminal point, the base clasping the branchlet. *Seed* up to an inch long, the outer coat magenta-coloured, covered by a waxy bloom. *Seed* without the covering, $\frac{1}{2}$–$\frac{3}{4}$ in. long, terminated by a sharp and sometimes curved point.

Native of Fiji, occurring in mixed forests.

Podocarpus Wallichianus, C. Presl. (Nageia).

Podocarpus latifolia, Wallich [not R. Brown]; P. pinnata, Hort.; Nageia latifolia, Gordon; N. Wallichiana, O. Kuntze.

An Indian tree remarkable for its large foliage. *Leaves* opposite or sub-opposite, $3\frac{1}{2}$–$7\frac{1}{2}$ in. long, $1\frac{1}{8}$–$2\frac{1}{2}$ in. wide, ovate, narrowing at the apex to a long, fine point, and at the base to a short, flat stalk. *Male flowers* branched, on stalks $\frac{1}{2}$ in. long. *Seed* round, $\frac{1}{2}$ to nearly 1 in. across, borne on a slightly swollen receptacle, surmounting a stalk $\frac{1}{2}$–$\frac{3}{4}$ in. long.

Widely distributed in Khasia, Assam, and Burma.

[1] *Journ. Linn. Soc.* XIV, 425 (1922).

PRUMNOPITYS, Philippi.

A monotypic genus allied to *Podocarpus*, which has been placed in the *Stachycarpus* section of that genus. This contains species having seeds in a loose spike the axis of which

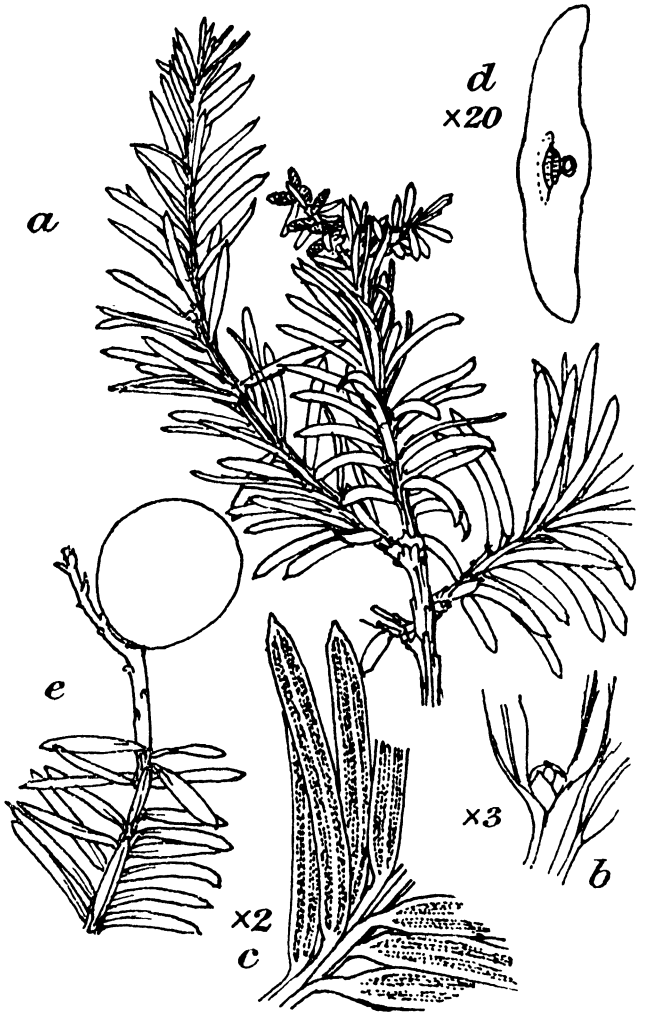

FIG. 6.—*PRUMNOPITYS ELEGANS.*

a, spray, one branchlet bearing young male flowers; *b*, leaf-bud; *c*, under-surface of leaves, showing stomatic bands; *d*, section of leaf; *e*, fruiting branchlet.

does not become fleshy. The plant is no doubt correctly cited as *Podocarpus andinus* by Pilger, but on the ground of convenience we prefer to retain the name of *Prumnopitys*, which has been in common use for many years.

Prumnopitys elegans, Philippi. (Fig. 6.)

PLUM-FRUITED YEW.

An evergreen tree of yew-like habit 40–50 ft. high in S. America. *Bark* dark brown. In cultivation it is usually a shrub, often divided near the ground into several erect branches, the branchlets sweeping the ground and hiding the trunk. *Buds* small, but with valvate acute and not imbricate scales. *Leaves* spirally arranged, but appearing more or less in a two-ranked arrangement and pointing forwards, yew-like but paler in colour, linear ½–1 in. long, straight or sickle-shaped, narrowed abruptly at the apex to a short point and at the base to a short flat stalk, bright green above, paler with two broad glaucous bands of stomata below, the lower surface exposed by a partial twist of the leaf stalk. *Male and female flowers* on the same or on different trees, the former in terminal and axillary clusters, cylindrical, blunt. *Female flowers* on a scaly stalk springing from the upper leaf axils. *Seed* with a yellowish-white fleshy outer covering, resembling a damson in size and shape, and enclosing a hard shell rather like a cherry stone.

The plum-fruited yew occurs wild in the Andes of S. Chile, where it is an alpine tree with a vertical range of 4,000–6,000 ft. Messrs Veitch introduced the plant in 1860 through their collector Robert Pearce.

Prumnopitys elegans is a very useful evergreen for the British Isles. Its foliage is less sombre than that of the yew, for which it might well be employed as a substitute, especially in the S. of England. Although rarely used for hedges, it is excellent for the purpose. Cuttings of side shoots root readily if inserted in sandy soil in a close frame during summer.

Clinton-Baker, *Illust. Conif.* iii, 83 (1913).

SAXEGOTHEA

Saxegothea conspicua, Lindley.

PRINCE ALBERT'S YEW.

An evergreen tree of yew-like habit, attaining a height of 30–40 ft. in S. America, but becoming shrubby at high elevations. *Bark* greyish-brown, scaling off like that of a plane tree. *Branches* widely spreading, drooping at the ends. *Branchlets* opposite or in whorls of three or four. *Young shoots* slender, glabrous. *Buds* minute, globose, with ovate greenish scales. *Leaves* persistent for several years, spirally arranged, spreading radially on leading shoots, two-ranked on lateral shoots, more or less twisted or curved, linear, ½–¾ in. long, shortly stalked, tapering to a sharp, horny point; upper surface dark green with a narrow midrib; lower surface with a narrow green midrib, on each side of which

is a broad, glaucous, stomatic band. *Male and female flowers* on the same tree, the anthers arranged in a spiral and opening longitudinally. *Female flowers* solitary at the ends of branches on

FIG. 7.—*SAXEGOTHEA CONSPICUA*.

a, shoot; *b*, spray with two branchlets bearing young male flowers; *c*, under leaf-surface and four young stalked male flowers; *d*, section of leaf; *e*, fruiting cone; *f*, cone-scale with pendulous seed; *g*, seed with small aril.

short, scaly stalks, consisting of overlapping, triangular, glaucous, carpellary scales, the upper ones each bearing two inverted ovules. *Ripe cones* $\frac{1}{3}$–$\frac{1}{2}$ in. in diameter with fleshy grooved scales, con-

taining 6–12 seeds which are ovoid, compressed, about ⅛ in. long, shining brown. *Cotyledons* two.

This remarkable conifer forms a connecting link between *Pinaceæ* and *Taxaceæ*. It is allied both to *Podocarpus* and *Araucaria*, resembling the former in the foliage and the latter in the female flowers and wingless pollen grains while the ripe fruit suggests that of a juniper.

S. conspicua is a native of Chile and W. Patagonia, where it occurs in dense forests in the lower mountain regions. It was discovered in S. Chile by William Lobb in 1846 and introduced into cultivation by him the following year. It was named in honour of the Prince Consort, who was a great patron of horticulture.

Saxegothea is hardy in a sheltered position at Kew, but grows very slowly. At Strete Raleigh near Exeter there are two fine specimens, probably two of the first introduced plants. A few years ago they were about 35 ft. high and well branched to the ground. There are also good specimens in Irish gardens.

Little is known of the value of the wood in S. America, but there is a sample of paper prepared from it in the Museums at Kew.

Stiles, *New Phyt.* vii, 209, with figs. (1908); Stiles, *Ann. Bot.* xxvi, 446, 463 (1912); Elwes and Henry, *Trees of Gt. Brit. and Ireland*, vi, 1458 (1912); Clinton-Baker, *loc. cit.* iii, 73 (1913).

TAXUS, Linnæus.

YEWS.

Evergreen trees and shrubs of which seven species, indigenous and widely distributed in N. America, E. Asia, and Asia Minor, have been described. Although differing in foliage characters no more than in some forms of common yew, they occupy well-defined geographical areas and from this point of view are probably best kept distinct.[1] The essential characters of the genus, economic uses and cultivation are given under the description of *Taxus baccata*.

Taxus baccata, Linnæus. (Fig. 8.)

COMMON YEW.

A densely branched tree 30–60 ft. high, developing when old a short, massive trunk 20 ft. or more in girth. *Bark* reddish-brown, thin and scaly. *Branchlets* spreading, alternate, surrounded at the base by brownish scales. *Buds* with obtuse, overlapping scales. *Leaves* spirally arranged, spreading all round in erect shoots but appearing more or less two-ranked on horizontal

[1] Pilger, *Pflanzenreich*, iv, 5, p. 110 (1903), ranks all the yews as subspecies.

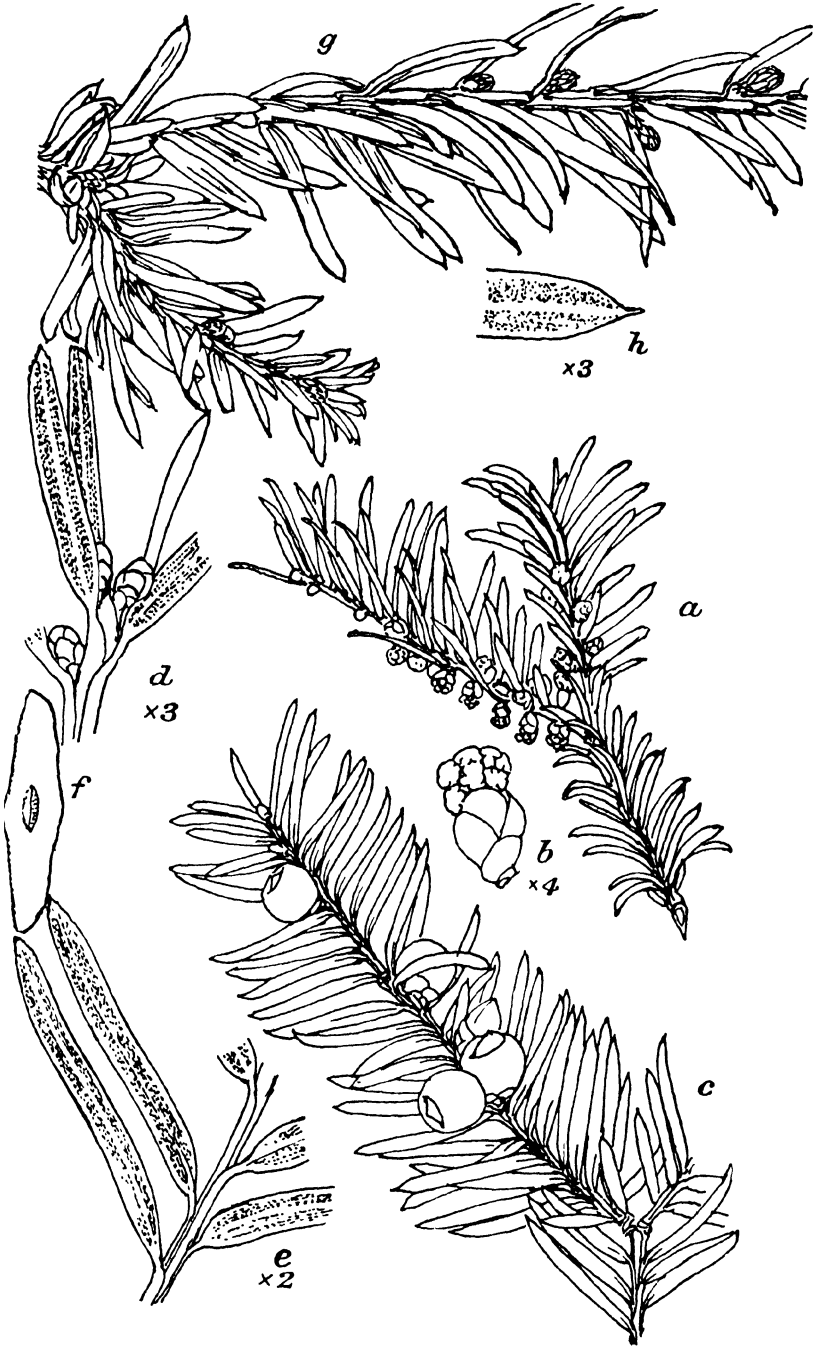

FIG. 8.—*TAXUS BACCATA AND T. CUSPIDATA.*

Taxus baccata—*a*, spray with male flowers; *b*, male flower; *c*, spray with fruit; *d*, leaf-buds *e*, under leaf-surface; *f*, section of leaf. *T. cuspidata*.—*g*, spray; *h*, under-surface of leaf-tip.

shoots, linear, ½–1¼ in. long, convex and shining on the upper side with recurved margins and a prominent midrib, paler and yellowish-green beneath with ill-defined lines of stomata, gradually tapering at the apex to a horny point. *Male and female flowers* usually on different trees (rarely on the same specimen). *Male flowers* in stalked, globose heads arising from the axils of the leaves on the under-sides of the branchlets of the previous year, each consisting of 6–14 stamens with short filaments, anther scales peltate. *Female flowers* solitary, green, from the leaf axils. *Seed* erect with a bony shell, borne in a scarlet fleshy cup or aril, ripening the first year. *Cotyledons* two.

There are numerous varieties, of which the following are the more important :—

Var. **adpressa**, Carrière.

T. adpressa, Gordon ; T. brevifolia, Hort. ; T. tardiva, Lawson.

A female shrub of spreading habit, with densely crowded branches. *Leaves* much shorter and relatively broader than in the common form, dark dull green above, ¼–½ in. long, elliptic linear with a rounded apex ending in a short point. *Seed* three-angled, depressed at the apex, aril broad and shallow. A very distinct variety, which is stated to have arisen as a seedling among other yew seedlings in the nursery of James Dickson & Sons at Chester in 1838, although another account says that it appeared in a bed of thorn seedlings ten years earlier.

Var. **adpressa aurea**, Masters.

Resembles the former in every respect except that the leaves are conspicuously variegated with gold.

Var. **adpressa stricta**, Carrière.

T. baccata adpressa erecta ; T. baccata adpressa fastigiata.

This form differs from the type in its stiff, erect habit and less dense foliage.

Var. **adpressa variegata**, Fisher and Holmes.

The points of the young shoots are sometimes variegated with silver. It is not very effective.

Var. **albo-variegata.**

A form with clusters of white leaves appearing amongst the green foliage. The variegation is not constant and the plant is not ornamental.

Var. **argentea**, Loudon.

Many of the leaves are margined with white. The plant is less useful than the varieties with golden foliage.

Var. aurea, Carrière.

GOLDEN YEW.

A plant of compact habit with the young leaves golden, changing to green before the second year. Seedlings vary considerably in habit and many have green leaves. There are both male and female forms of this plant.

Var. aurea variegata, West.

This chiefly differs from Var. *aurea* in its looser habit.

Var. Barroni, Barron.

A striking variety with rich orange young shoots and leaves changing to a coppery shade with age.

Var. brevifolia.

A small bush with short and dense branchlets, and small densely arranged leaves, rarely more than ½ in. long, which turn bronze in winter. It must not be confused with *T. brevifolia* from W. North America.

Var. cheshuntensis, Gordon.

Intermediate in habit between the common and Irish yews, wider in habit than the latter, but with a similar leaf arrangement. Probably a seedling from the Irish yew.

Var. Dovastoni, Lawson.

WESTFELTON YEW.

A very distinct and handsome variety easily recognized by its erect stem, horizontal, widely spreading branches, and long weeping branchlets. It is a very old variety and appears to have been first noticed about 1777, when Mr. John Dovaston of Westfelton, near Shrewsbury, bought for 6*d*. from a cobbler in the village a young yew. This subsequently developed a distinct form which has since become popular in gardens. Male and female flowers have appeared on the same tree.

Var. Dovastoni aureo-variegata, Beissner.

This differs from the last-named by its leaves being variegated with gold.

Var. elegantissima, Beissner.

A vigorous plant with widely spreading branches, the main branches horizontal. Young leaves and shoots pale gold. Raised in the Handsworth Nurseries.

Var. **epacridioides**, Hort.

A dwarf erect bush with small leaves rarely more than $\frac{1}{2}$ in. long, which turn bronze in winter.

Var. **erecta**, Loudon.

T. baccata stricta; T. baccata Crowderi.

Of close, erect habit and formal outline. Leaves deep green up to $\frac{3}{4}$ in. long. Although of stiff habit it is less compact than the Irish yew.

Var. **ericoides**, Carrière.

T. baccata empetrifolia; T. baccata microphylla; T. baccata Mitchellii.

A low spreading plant suitable for the rockery. Leaves small, bronze or purple in winter.

Var. **expansa**, Carrière.

A very distinct variety of erect and pleasing habit, readily distinguished by its large leaves (1–$1\frac{1}{2}$ in. long), which show the pale green of the under-surface in striking contrast to the rich dark green of the upper surface.

Var. **fastigiata**, Loudon.

IRISH YEW.

T. fastigiata, Lindley; T. hibernica, Hooker. Florence Court Yew.

Columnar and compact in habit, the branches and branchlets directed upwards. *Leaves* spreading all round the shoot, the apex more or less obtuse. Only female trees are known, which is accounted for by the fact that the two original Irish yews found near Florence Court by a farmer named Willis about 1780 were females and from one of these all the existing trees have been obtained by cuttings or by grafts. One of these trees, planted by Willis in his own garden, died in 1865, the other was presented to his landlord and planted at Florence Court. The first cuttings were sent by the Earl of Enniskillen to Comber, County Down, in 1780, and Messrs. Lee and Kennedy appear to have distributed the plant at a later date.

Var. **fastigiata argentea** Hort.

Patches of silvery foliage sometimes occur. The form is of little horticultural value.

Var. **fastigiata aurea**, Standish.

GOLDEN IRISH YEW.

This differs from the type by its golden leaves. It is, however, a variable plant and the colour of the foliage varies in shade

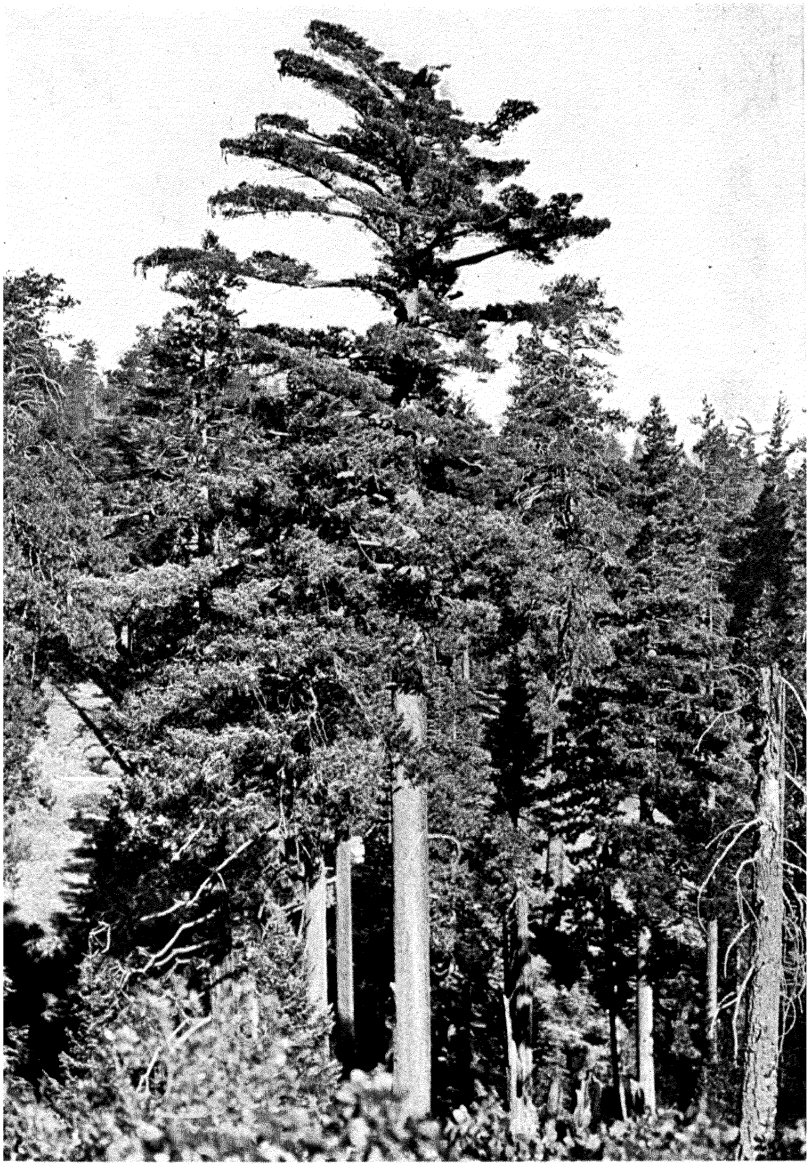

Photo by I. B. S. Balfour, Esq.

PLATE III. *PINUS LAMBERTIANA* IN SISKIYOU MOUNTAINS, CALIFORNIA.

according to the nursery from which plants are procured. The golden colour is most in evidence on the under-surface.

Var. **fastigiata grandis.**

A selected form of the golden Irish yew with the golden colour more pronounced than in the commoner plant, particularly on the upper surface.

Var. **fastigiata Standishii**, Hort

The golden colour is very highly developed in this plant.

Var. **Fisheri.**

This is a green-leaved variety of spreading habit. The main branches are developed more or less horizontally, and there is no marked leader.

Var. **Foxii**, Hort.

A small-leaved variety of spreading habit, forming a low, compact bush suitable for the rock-garden.

Var. **fructo-luteo**, Loudon.

YELLOW-BERRIED YEW.

Differs from the type by the aril being yellow. First found in the grounds of the Bishop of Kildare at Glasnevin about 1817.

Var. **glauca**, Carrière.

Leaves glaucous beneath when young, afterwards like the type.

Var. **gracilis pendula**, Lancke.

A vigorous variety with rich glaucous green foliage. The main branches are more or less horizontal, the branchlets being pendent and hanging to a length of several feet. It forms a natural leader and grows into a handsome specimen.

Var. **horizontalis**, Knight.

Branches horizontal, in several tiers, spreading very widely. The plant has no leader.

Var. **horizontalis elegantissima.**

Leaves variegated with gold. The main branches are more distinctly horizontal than in Var. *elegantissima.*

Var. **imperialis**, Hort.

An erect plant of compact habit, but less stiff than var. *fastigiata.*

Var. **nana**, Dallimore.

A low shrub, rarely attaining a height of 3 ft., but spreading very widely. Leaves small, deep green. Suitable for the higher points of a rockery.

Var. **neidpathensis**, Hort.

NEIDPATH YEW.

A bold, vigorous, green-leaved variety with erect but not stiff branches.

Var. **pendula**, Hort.

Rather similar to var. *gracilis pendula*, but less robust and looser in habit.

Var. **procumbens**, Loudon.

A prostrate variety with longer leaves and stouter branches than var. *nana*.

Var **pyramidalis**, Carrière.

Branches erect, crowded, and rather sparingly clothed with branchlets. It is not a very effective variety.

Var. **pyramidalis variegata**, Hort.

Resembling the last-named in habit, but with golden-variegated leaves.

Var. **recurvata**, Carrière.

Branches wide-spreading and horizontal, leaves recurved.

Var. **semperaurea**, Dallimore.

A golden-leaved variety, the golden colour being retained throughout the first year.

The yew is one of the commonest and best-known hardy evergreens and is one of the three conifers indigenous in the British Isles. It is common on the chalk downs of the south of England, where, in addition to isolated trees and scrub, yew woods, sometimes of considerable extent, are found. It also occurs wild in other parts of the country, and an interesting wilding was found by one of us in 1921 on Great Orme's Head. This plant originated in a crevice of the rock 9–12 in. deep. On reaching the surface it commenced to spread laterally until in 1921 it measured 3 ft. 7 in. across in the widest part, was quite flat and barely 4 in. high. A small piece of stem less than half an inch in diameter, cut from the outer edge, had thirty-three annual rings. There was no other yew near and the dwarf character appeared to be due to poverty of soil and the shearing effect of wind.

T. baccata is widely spread in Europe, and is also found in

N. Persia and Algeria. In the Himalayan forests it occurs at 6,000–11,000 ft. altitude from Afghanistan to Bhutan.[1]

Wood tough, strong, heavy, elastic, close-grained, with well-marked heart- and sap-wood, the former reddish or brown, the latter pale yellow or white, the heartwood toning with age and exposure to an effective brown shade.

It works well, finishes with a smooth, glossy surface, is very durable, and is suitable for furniture, parquet-flooring, panelling, and makes excellent gate and fence posts. In ancient times it was the most popular of all woods for bows and is still used in archery. Transverse sections cut from the base of old trees often show several distinct hearts. This is brought about by erect shoots, springing from near the ground, developing into stems several inches in diameter and then becoming overgrown by the main trunk. Such sections are sometimes utilized for table-tops. Yew wood turns well and can be made into candlesticks and other fancy articles. Well-seasoned wood forms excellent mallets.

The leaves, shoots, and seeds possess poisonous properties[2] and plants should be kept from cattle. The active principle appears to be *taxine*, although other alkaloids are said to be present in both fresh and partly withered shoots; indeed, the latter are considered to be more virulent in their action than the fresh foliage. There is still, however, a good deal to be learned about yew-poisoning, for in some cases cattle have been known to have had access to yew trees all their lives and have constantly nibbled the shoots without the least injury; others, however, have eaten branches with fatal results. It has been suggested that the percentage of poison may vary in male and female trees or in different trees. Prof. Troup[3] says that in Hazara, where *T. baccata* is plentiful, and particularly in the Siran and Kagan valley, the yew is extensively lopped for cattle fodder, perhaps more so than any other conifer, and trees are frequently killed by repeated lopping. The scarlet aril which surrounds the seed is harmless.

The yew succeeds in partial shade and also in full sun. Seedlings germinating beneath the shade of trees grow well, but their habit is usually less dense that that of trees in open places. It thrives in most parts of the country and is very long lived. The theory has often been advanced that a number of the older trees in Britain exceed the age of 1,000 years. We have no direct evidence to prove whether this is actually the case, but it is highly probable, for trees that are known to have been in an advanced state of decay many years ago do not appear to become appreciably worse and bear healthy branches and foliage although

[1] A narrow-leaved Himalayan form has been described as a species, *T. Wallichiana*, Zuccarini, but is doubtfully distinct.

[2] Long, *Plants Poisonous to Stock.*

[3] *Silviculture of Indian Trees*, iii, 1171 (1921).

the trunk is reduced to a shell. These old trees, with attendant legends and associations, have been fully dealt with elsewhere.[1] Yews are widely planted in gardens and are grown in many ways. The common yew is one of the best of all hedge-plants, for it stands clipping well and is always neat. It is used for topiary work and old specimens are still clipped into fantastic shapes in some gardens, as they were a century ago. Such specimens are to be seen at Elvaston Castle, Derby.

The most satisfactory plants for hedges are those that produce several erect branches from the base. Yews thrive in chalky soil, on limestone formations, also on peat and light and heavy loams. They may be transplanted at almost any period in open weather from early September to early May.

Large numbers of plants are raised from seeds sown in beds out of doors, whilst the varieties are increased by cuttings placed in sandy soil in frames during July and August, or by grafting in spring upon stocks of the type previously established in pots. Hedges and formal plants may be clipped in summer, the best time being after the completion of growth in July or August. All clippings must be carefully collected and burnt in order to avoid injury to animals. Galls formed by clusters of leaves are often found on the points of the shoots; these are caused by the mite *Cecidomyia taxi*, Inchbald.

Taxus brevifolia, Nuttall.[2]

A tree 15–50 ft. high or occasionally taller with slightly pendent branches. *Leaves* shorter and more abruptly pointed than in *T. baccata*, $\frac{1}{2}$–$\frac{3}{4}$ in. long, terminating in a bristly point, reduced at the base to a distinct stalk, dark yellowish-green above, paler beneath. *Male flowers* much smaller than in *T. baccata*. *Seed* ovoid, up to about $\frac{1}{2}$ in. long with a scarlet aril.

Native of W. North America, where it is widely distributed on the banks of mountain streams and in deep ravines in British Columbia, Washington, Oregon, and California. Although introduced into cultivation in 1854 it is very rare in collections.

Sargent, *Silva of North America*, x, 65, t. 514 (1896).

Taxus canadensis, Marshall.

Taxus baccata, var. canadensis, Elwes and Henry.

A shrub of straggling and often prostrate habit. *Buds* small, globose, with overlapping blunt, keeled scales. *Leaves* narrow, curved, $\frac{1}{2}$–$\frac{3}{4}$ in. long, $\frac{1}{16}$–$\frac{1}{12}$ in. wide, midrib slightly prominent above, the apex abruptly pointed. *Seed* as in *T. baccata*.

[1] Lowe, *Yew Trees of Great Britain and Ireland* (1897); Dallimore, *Holly, Yew and Box* (1908); Elwes and Henry, *Trees of Great Brit. and Irel.*, i, 98 (1906).

[2] Nuttall, *Sylv.* iii, 86, t. 108 (1849).

Var. aurea.

Leaves faintly variegated with yellow.

Found in E.N. America from Newfoundland to Virginia. Although introduced in 1800, it has never become established in cultivation.

Sargent, *Silva of North America*, x, 63 (1896).

Taxus chinensis, Rehder.

CHINESE YEW.

T. baccata, var. sinensis, Henry ; T. cuspidata, var. chinensis, Rehder and Wils.

A tree 18–50 ft. high with greyish brown or yellowish brown branchlets. *Buds* pale brown with obtuse scales, the lower ones lightly keeled. *Leaves* very dark green, distant or rarely overlapping, falcate, ½–1 in. long, $\frac{1}{12}$–⅛ in. broad. Apex more or less abruptly pointed. Seed broadly ovoid, ⅓–¼ in. long, ⅙ in. broad, scarcely compressed, slightly two-angled, bluntly pointed.

This yew and *T. cuspidata* are distinguished from *T. baccata* by the shorter seed, and fruit much more freely than the common yew.

The Chinese Yew is scattered through Western Hupeh and Szechuen, up to 2,000 ft. being most common on the carboniferous limestone.

Pl. Wils. ii, 8 (1914).

Taxus cuspidata, Siebold and Zuccarini.[1] (Fig. 8.)

JAPANESE YEW.

Taxus baccata, var. cuspidata, Elwes and Henry.

A tree 50 or more feet high in Japan, with a trunk up to 6 ft. in girth, with spreading or ascending branches. *Bark* red or greyish-brown, lightly fissured. In cultivation it is of shrubby habit. *Buds* oblong, chestnut-brown, composed of overlapping concave scales more or less keeled on the back. *Leaves* standing more or less vertically on the branchlets, straight or slightly sickle-shaped, linear, ½–1 in. long, $\frac{1}{12}$–⅛ in. wide, dark green above, paler beneath with two yellowish-green bands of stomata, tapering to a slender stalk at the base and ending abruptly in a horny point at the apex. *Seed* similar to that of *T. baccata*, but a little longer and produced in greater profusion.

Var. aurescens, Rehder.[2]

T. tardiva.

A low and apparently slow-growing plant, with the leaves of the current year's growth coloured deep yellow. Introduced to the Arnold Arboretum from Japan.

[1] *Fl. Jap.* 61, t. 128 (1842). [2] *Journ. Arn. Arb.* i, No. 3, 191, Jan. 1920.

Var. **contorta**, Hort.

Shoots and branchlets twisted.

Var. **nana**, Rehder.

Of dwarf habit, suitable for the rock-garden.

T. cuspidata is distinguished from the common yew by its larger, oblong buds and vertically placed leaves with abrupt points and distinct, yellowish, stomatic bands.

Although widely distributed in Japan it is not common in a wild state. Introduced by Fortune about 1855 and quite hardy in cultivation, thriving under similar conditions to the common yew.

Taxus floridana, Chapman.

Taxus baccata, var. floridana, Elwes and Henry.

A shrub or small bushy tree up to 25 ft. high with numerous stout, spreading branches. *Buds* with loosely overlapping, ovate-obtuse scales. *Leaves* very narrow, curved, dark green, ¾–1 in. long, $\frac{1}{20}$–$\frac{1}{16}$ in. wide, the midrib obscure, the apex shortly pointed. *Seed* similar to *T. baccata*.

Native of W. Florida.

Sargent, *Silva of North America*, x, 67 t. 515 (1896).

Taxus globosa, Schlechtendal.

Taxus mexicana, Semlis.

Described as a small tree about 20 ft. in height, and discovered in 1837 by Ehrenberg in S. Mexico, but of which little is known. The foliage of specimens we have seen so labelled differs but little from that of the common yew, except that the leaves are somewhat larger and more sharply pointed.

TORREYA, Arnott.

Tumion, Rafinesque.

Evergreen trees allied to *Cephalotaxus*, found in California, W. Florida, China, and Japan. *Bark* furrowed, branches opposite or whorled. *Buds* ovate, acute, with a few shining scales in opposite pairs. *Leaves* often aromatic or pungent, spirally arranged, but on lateral shoots thrown by the twisting of their bases into two opposite ranks, linear, rigid, tipped with a bristle-like point, upper surface green, convex, lower surface with a raised midrib and two glaucous stomatic bands sunk in longitudinal furrows. *Male and female flowers* often on different trees, but in cultivated specimens usually on different branches of the same tree. *Male flowers* solitary in the axils of the leaves of the current year's branchlet, composed of numerous stamens in

whorls of four, each with four pollen sacs. *Female flowers* in pairs towards the base of the current year's shoot. Ovule completely covered with a fleshy aril-like coat, resembling a plum or olive when ripe. *Seed* with a woody outer coat, the inner layer irregularly folded into the kernel which appears like a nutmeg in section. The species of *Torreya* resemble *Cephalotaxus* in foliage but may easily be recognized by the sunken bands of stomata on the lower surface of the leaves, which are distinctly bristle-pointed.

Wood yellowish, straight-grained, easy to work, durable, usually strong ; used for furniture, cabinet work, and fence posts, but not a general commercial timber. The seeds of one species are edible and an oil used in cookery is obtained from them.

In the warmer parts of Britain the Torreyas form useful evergreens for gardens or parks. They succeed in loamy or peaty soil and compare in usefulness with the hardy species of *Podocarpus*. Cuttings of short side-shoots may be rooted by inserting them in sandy soil in a close frame in summer, but the best method of propagation is by imported seeds. Specimens of *T. californica*, *T. grandis*, and *T. nucifera* may be seen at Kew.

Key to Torreya.

I. Foliage aromatic when bruised ; shoots reddish or brown in the second year.

Leaves linear, 1¼–3 in. long, ⅛ in. wide, glaucous beneath with broad midrib and slightly depressed narrow stomatic bands.—*T. californica*.

Leaves lanceolate linear, ¾–1¼ in. long. ⅛–⅙ in. wide, green beneath with deeply depressed stomatic bands.—*T. nucifera*.

II. Foliage not aromatic when bruised, shoots green in second year.

Leaves lanceolate-linear, ½–1 in. long, ⅛ in. wide, thinner in texture than those of *T. nucifera*, but with similar stomatic bands.—*T. grandis*.

Torreya californica, Torrey. (Fig. 9.)

California Nutmeg.

Torreya Myristica, Hooker.

A tree up to 90 ft. high with a girth of 9 ft. in California but usually much smaller and often only a shrub. *Bark* rather smooth and thin. Wood and foliage aromatic. *Young shoots* without down, green becoming brown in the second year. *Buds* prismatic, acute, up to ⅛ in. long, with closely overlapping brown scales. *Leaves* rigid, linear, 1¼–3 in. long, ⅛ in. wide, tapering to a spiny

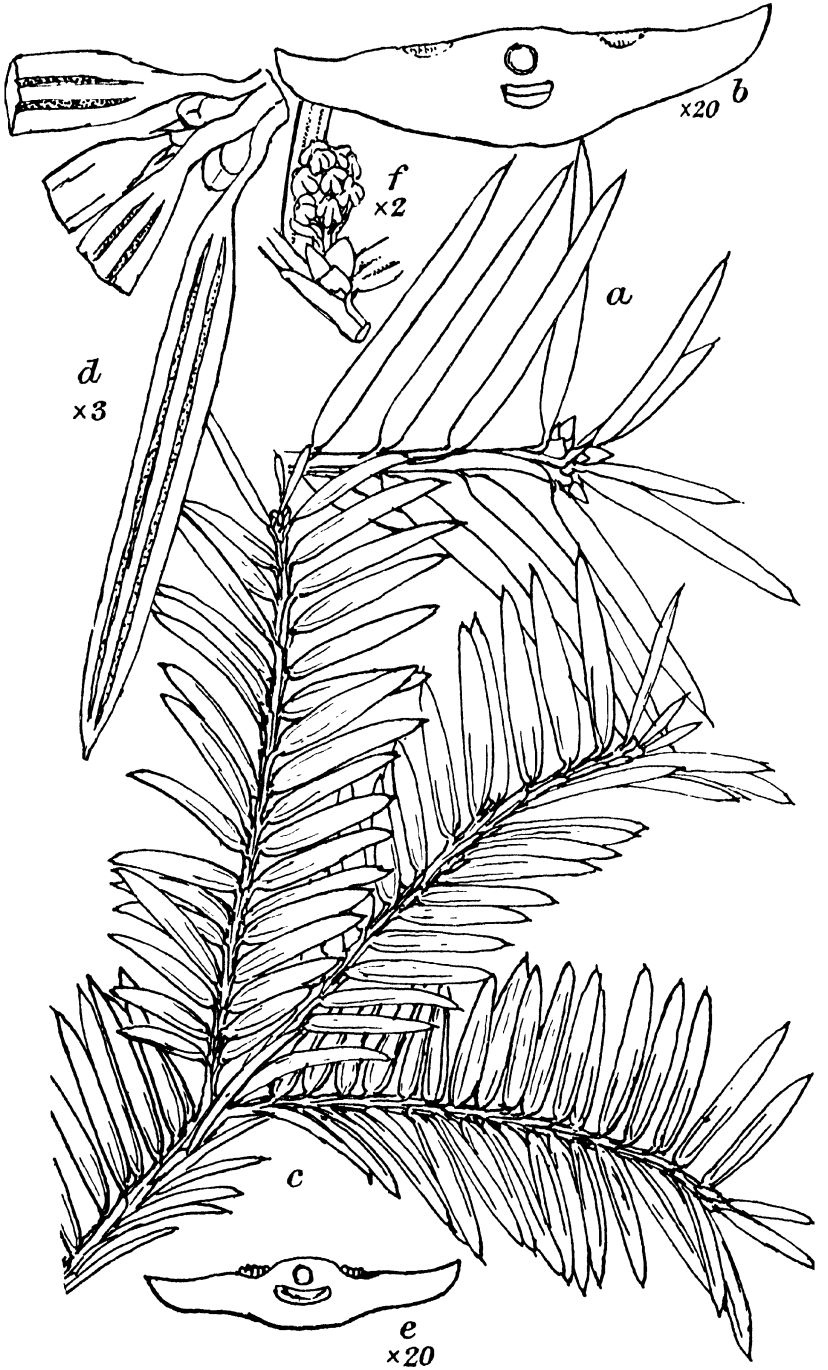

FIG. 9.—*TORREYA CALIFORNICA AND T. GRANDIS.*

Torreya californica—*a*, shoot with leaf-buds; *b*, section of leaf. *T. grandis*.—*c*, spray; *d*, under-surface of leaf and leaf-buds; *e*, section of leaf; *f*, male flower.

point, dark shining green on the upper surface with two longitudinal glaucous grooves beneath. *Male flowers* globose, about $\frac{1}{3}$ in. in diameter, in the axils of the leaves of the terminal shoots. Seeds elliptical or obovoid in outline, green, streaked with purple when ripe, $1\frac{1}{8}$–$1\frac{3}{4}$ in. long, flesh thin and resinous, shell of the seed furrowed.

Distinguished from other species by its long, flat, rigid leaves.

This handsome conifer is only found wild in California, where it grows sparingly on the borders of mountain streams from Mendocino County to the Santa Cruz mountains in the coast region and along the western slopes of the Sierra Nevada from Eldorado to Tulare County at 3,000–5,000 ft. elevation. It was discovered in 1851 by Wm. Lobb, who sent specimens and seeds to Messrs. Veitch the same year.

Wood light yellow or nearly white, used locally for fence posts.

Torreya grandis, Fortune. (Fig. 9.)

Torreya nucifera, var. grandis, Pilger.

A tree occasionally 60–80 ft. high in China but more often a shrub. *Young shoots* green, glabrous, becoming yellowish-green in the second year. *Leaves* similar to those of *T. nucifera* in size and shape, but yellowish-green in colour and without the aromatic odour of that species, and thinner in texture, with similar deeply impressed stomatic bands. *Seeds* broadly ellipsoid or sub-globose, $\frac{3}{4}$–1 in. long with a reddish-brown shell.

T. grandis may generally be recognized from *T. nucifera* by the yellowish-green colour of the two-year-old branchlets and the other characters mentioned above.

It was discovered by Fortune in the mountains of Chekiang on the east coast of China in 1855, and has since been found in the central provinces of Hupeh and Szechuen, but usually in bush form. Although introduced in 1855, it is a rare plant in cultivation.

Torreya nucifera, Siebold and Zuccarini. (Fig. 10.)

KAYA.

Tumion nuciferum, Greene.

A tree 20–80 ft. high and 12–15 ft. in girth in Japan. *Bark* smooth, light red.[1] *Branches* numerous, stout, horizontal. *Branchlets* opposite, green when young, changing to reddish brown in the second year. *Buds* prismatic, about $\frac{1}{8}$ in. long, with shining membranous scales. *Leaves* with a pungent odour when rubbed, linear, rigid, curved, $\frac{3}{4}$–$1\frac{1}{4}$ in. long, ending abruptly in a spiny point, dark shining green above, with two stomatic lines, about equalling the midrib in breadth, beneath. *Male flowers*

[1] Sargent, *For. Fl. of Jap.* 76 (1894).

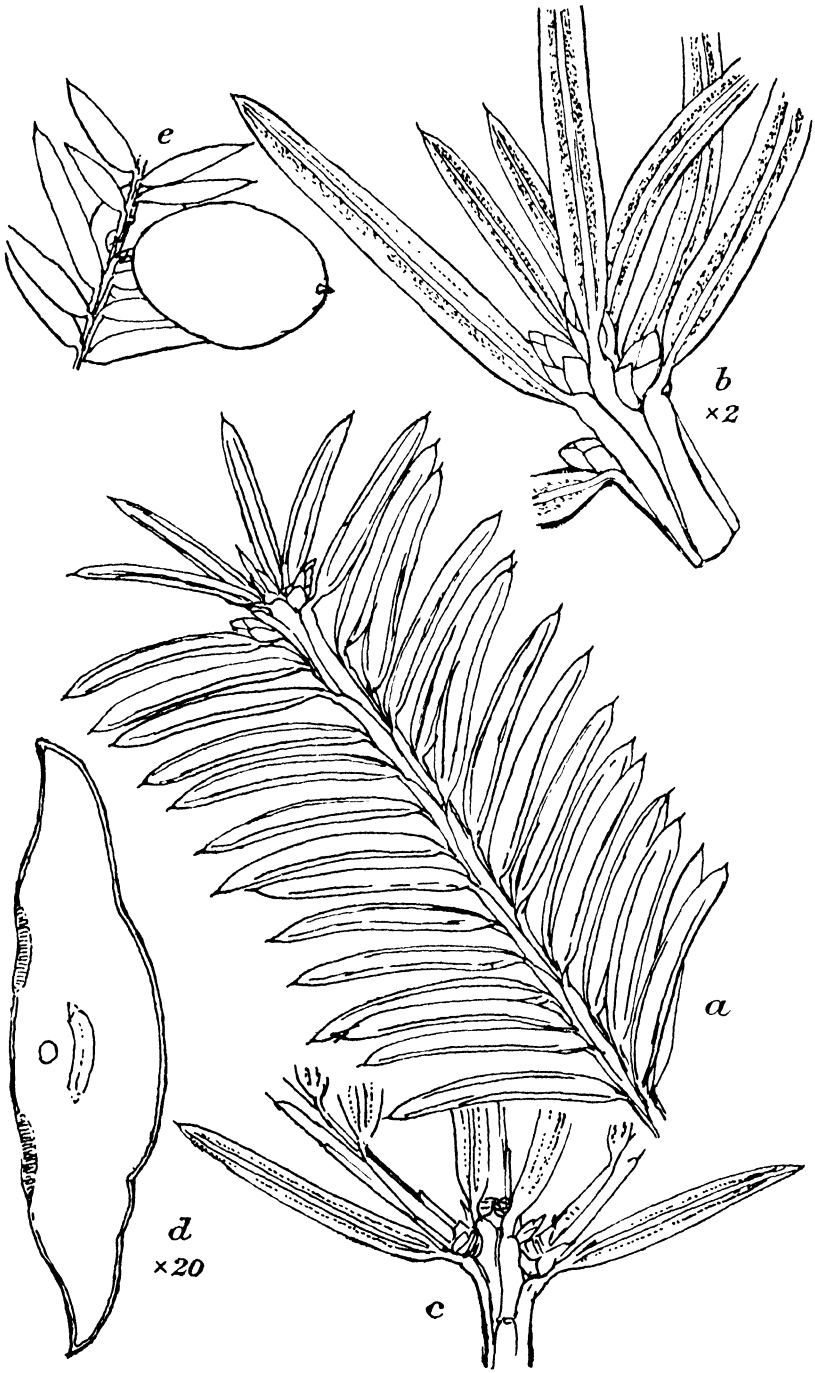

FIG. 10.—*TORREYA NUCIFERA.*

a, shoot; *b*, leaf-buds and under leaf-surface; *c*, under-side of a node; *d*, section of leaf; *e*, fruit (after Shiraswa).

about $\frac{1}{3}$ in. long. *Seed* narrowly obovoid, $\frac{3}{4}$–1 in. long, green tinged with purple.

This species may be recognized by its branchlets being reddish brown or reddish purple in the second year and by its strongly curved deep green leaves.

A native of Japan, where it occurs as a rare tree in the southern islands and in the forests of S. and Central Hondo. It was described by Kaempfer in 1712 and was introduced, according to Aiton, in 1764. In this country it is only seen as a shrub.

Wood lustrous yellow to pale brown, durable under water, used for chests, boxes, cabinets, furniture, water-pails, and for Japanese chessmen. The seeds are rich in oil and are largely eaten in Japan.

Torreya taxifolia, Arnott.

STINKING CEDAR.

A tree up to 40 ft. high with a girth of 3–6 ft. in Florida. *Branches* spreading, slightly pendulous, forming an open pyramidal head. *Bark* irregularly fissured and scaly. *Branchlets* bright green with occasional minute hairs, becoming dark yellowish-red when older. *Buds* as in *T. californica*. *Leaves* $\frac{3}{4}$–$1\frac{1}{2}$ in. long, $\frac{1}{8}$ in. wide, tapering to a spine-tipped apex, shining green above, lower surface pale green with the two stomatic bands scarcely depressed and narrower than the midrib; rounded at the base, with a stalk about $\frac{1}{25}$ in. long. *Fruit* obovoid, 1–$1\frac{1}{2}$ in. long, the flesh with a fœtid smell.

This species resembles *T. californica*, but has much shorter leaves.

Native of N.W. Florida, where it grows on limestone soil and in river swamps in the region bordering the Appalachicola river. It was introduced into England in 1840, but no trees are known to exist in this country and it is probably too tender for our climate. Young plants, however, have been recently received in England from the Arnold Arboretum.

Sargent, *Silva of N. America*, x. 57, t. 512 (1896).

PART II

PINACEÆ

ABIES, Linnæus.

Silver Firs.

Evergreen trees confined to the temperate regions of the northern hemisphere, but widely distributed in Europe, N. Africa, Asia, from the Himalaya northwards, and North America. In the more northerly latitudes they occur at sea-level but at a considerable elevation in Central and S. Europe, the Himalaya, N. Africa, Mexico, and W. North America.

Young trees are of pyramidal or cylindrical outline with the branches more or less regularly whorled, forming flat sprays, each whorl usually marking one year's growth. The trunks of mature trees taper very gradually in the forest and are clear of branches for a considerable height, but in the open rapidly decrease in girth and retain the branches low on the trunk. *Bark* of young trees smooth or beset with resin blisters; in old trees deeply furrowed at the base. *Young shoots* smooth or grooved, with or without down, marked at the base by persistent bud scales of the previous year. *Winter buds* ovate or oblong, blunt or pointed, resinous or non-resinous; the terminal bud of the main axis surrounded by four or five secondary buds, three buds terminating the branches. *Leaves* variously arranged on the branchlets, according to species, those on lateral shoots either pectinate, spreading all round the shoot or crowded and directed forwards in overlapping ranks; on leading shoots widely spreading and on coning branches directed upwards. The leaves are dark green, pale green or glaucous, linear, rounded or short-pointed, but usually notched at the apex; flattened, rarely four-angled, marked below with two waxy bands of stomata, sometimes with a few stomata on the upper surface, especially on the uppermost shoots. Each leaf is traversed by two resin ducts which are either marginal or median. Bruised leaves emit an odour of turpentine. The foliage persists several years and on falling leaves circular, disc-like scars on the shoots. *Male* and *female flowers* borne on the same tree in spring. *Male flowers* in short catkins from the leaf axils on the under-side of the branchlets which, on falling, leave gall-like scars. *Female flowers* in cones composed of numerous bracts each bearing

a large scale with two ovules at the base. *Mature* cones erect on the upper branchlets, with closely overlapping, fan-shaped scales and hidden or protruding bracts ; scales and bracts falling as soon as the seeds are ripe and leaving the persistent axis on the tree. *Seeds* winged, ripening during the first autumn. *Cotyledons* usually 5–7, with stomata on the upper surface.

The genus Abies is easily distinguished from all other conifers by the disc-like leaf scars and by the erect cones which break up as soon as the seeds are ripe.

The wood is odourless and varies in colour from white to yellowish or reddish brown according to species, no very distinct line separating sapwood and heartwood. Resin ducts normally absent, but sometimes occurring after an injury ; medullary rays very fine. Wood soft, easily worked, finishing with a good surface, taking paint and polish well, and suitable for the indoor finish of houses, the commoner kinds of joinery, pit props, scaffold poles, matchwood, wood wool, paper pulp, and box boards. Owing to its inodorous character it is in demand for butter, lard, and grocery boxes. After treatment with a preservative it is sometimes used for telephone poles and for piles.

From resin blisters on the bark oleo-resin is obtained. It is known commercially as Canada balsam and Strasburg turpentine, and is used for varnishes, mounting microscopic specimens, and for medicinal purposes. An essential oil obtained from the leaves is sometimes used in pharmacy.

The silver firs require moist soil and give the best results in a damp climate. They are injured by an impure atmosphere and are unsuitable for the vicinity of manufacturing towns, but thrive in the moist glens and valleys of W. England and Scotland. They withstand a good deal of shade, and some species are useful for underplanting thin woods. Although less suitable for exposed positions than some of the pines, they may be grown at the limit of tree growth in Britain if shelter is provided.

The rarer silver firs are sometimes increased by grafting upon commoner species, but this method of propagation is not recommended, as grafted plants rarely grow into good specimens. Whenever possible plants should be raised from seeds. These may be sown in early spring ; those of rare species in pots or boxes indoors and those of the commoner kinds in nursery beds in light, well-worked soil. Seedlings will usually stand for two summers in nursery beds when they should be transplanted into nursery lines. For forest planting trees should not exceed 15 in. in height, but for decorative work specimens up to 5 ft. high may be moved successfully, provided they have been transplanted biennially whilst in the nursery. They bear moving better than pines and may be transplanted during open weather between early October and late March, or in late districts until the end of May.

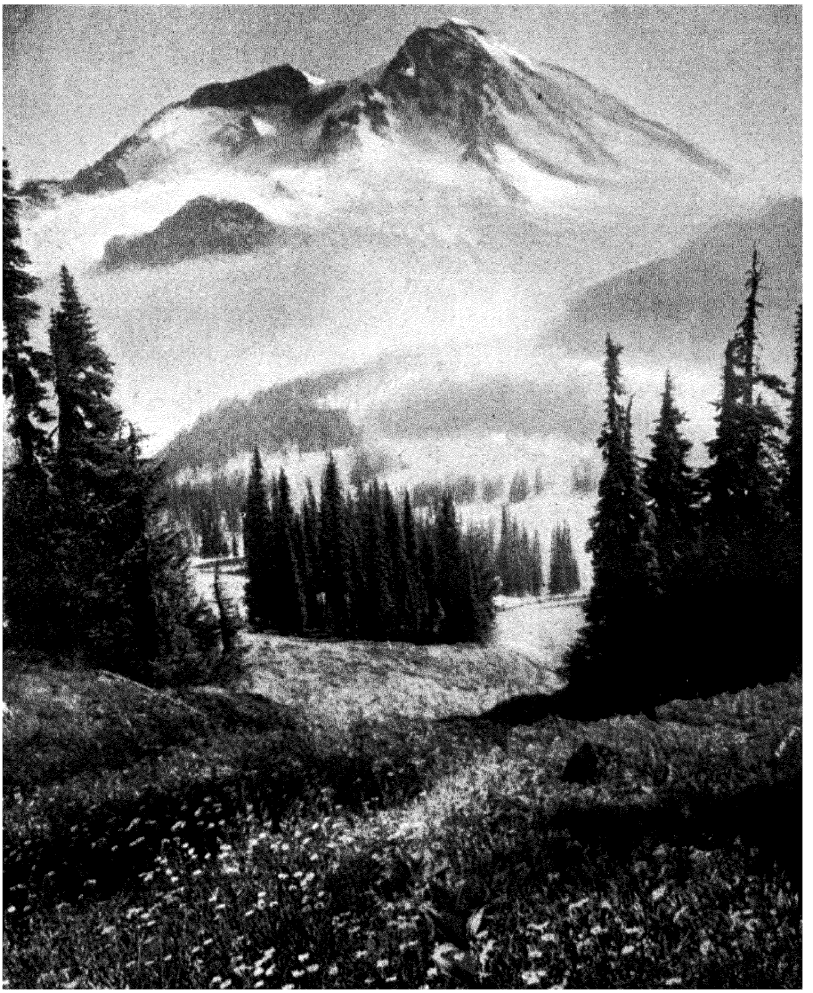

Photo by I. K. S. Balfour, Jr.

PLATE IV. *ABIES AMABILIS ON* MOUNT RAINIER.

Several insect pests attack the silver firs, species of *Chermes* (*Dreyfusia*) being the most injurious. *Chermes picea*, var. *bouveri*, attacks the buds of *A. nobilis*, *A. amabilis*, *A. grandis*, *A. magnifica*, *A. Fraseri*, and other species, whilst *Chermes nüsslinii* injures the young shoots of *A. pectinata*, *A. Nordmanniana*, etc. The first-named, by puncturing the buds, occasions derangement of tissue. The buds are unable to develop, although the branches live for several years. Apparently a concentration of food material occurs about the points of the shoots causing large gouty swellings. All growth buds are eventually suppressed and the trees die. *C. nüsslinii* injures the young woody tissue of *A. pectinata* and *A. Nordmanniana*, and badly affected young plants rarely recover. Research work on these insects is being conducted by Mr. R. N. Chrystal for the Scientific and Industrial Research Committee, and much new information on these important forest pests is being brought to light. The vital time when the attention of cultivators, should be directed to these pests is when the plants are in the nursery. Plants are then easy to handle, and by keeping them thoroughly clean at this period much future trouble and loss may be avoided. Slightly affected trees, either in the nursery or garden, should be sprayed several times at intervals of eight to ten days with a paraffin wash. Badly infested stock should be burnt.

Key to Abies.

Leaves radially arranged on the branchlets; apex of the leaves not notched.

Leaves rigid, less than ¾ in. long, thick, obtuse at apex; resin canals median.—*A. Pinsapo.*

Leaves flattened, about 1 in. long, ending in a sharp horny point; resin canals marginal.—*A. cephalonica.*

Leaves flattened, up to about 1 in. long, ending in a sharp horny point, ultimately strongly reflexed on the main shoots.—*A. recurvata.*

Leaves on lateral branchlets pectinate, with a distinct parting between the two lateral sets:—

Resin canals marginal:—

Buds ½ in. or more long.

Leaves 2 in. or more long, rigid ending in a spiny point; shoots glabrous; buds spindle-shaped, ½–¾ in. long, with light brown non-resinous scales.—*A. bracteata.*

Buds less than ½ in long.

Leaves all in one plane, those in the upper rank about half as long as those below; up to 2 in. long, upper surface without stomata; shoots minutely hairy; buds small, resinous.—*A. grandis.*

Leaves and buds like those of *A. grandis*, but glaucous not dark green, with lines of stomata on upper surface.—*A. Lowiana*.

Leaves in a V-shaped arrangement, rigid, shining green, up to 1½ in. long, ending in two sharp horny points; shoots slightly hairy in the furrows.—*A. firma*.

Leaves up to about 1 in. long, the upper ranks the shortest; shoots hairy; buds ovoid, non-resinous.—*A. pectinata*.

Leaves in two or more ranks, similar in arrangement to *A. pectinata* or *A. grandis*, apex notched or ending in two distinct points; shoots red brown or purplish, glabrous or hairy in the grooves; buds ovoid resinous, reddish. —*A. Faxoniana*.

Leaves in a V-shaped arrangement, up to 2½ in. long, notched at apex, silvery white beneath; shoots deeply grooved, with reddish hairs in the grooves; buds large, globose, resinous.—*A. Webbiana*.

Leaves arranged as in *A. Webbiana*, but shorter, about 1 in. long, often conspicuously curved, white beneath, margins sometimes strongly recurved; shoots reddish, glabrous or slightly hairy; buds globose or ovoid, resinous. *A. Delavayi*.

Leaves sharply pointed, not notched at apex; shoots bright red.—*A. squamata*.

Resin canals median :—

Leaves slender, barely 1 in. long, stomata in 6–8 lines; shoots smooth, grey with scattered erect hairs; buds globose or conic, resinous.— *A. balsamea*.

Leaves as in *A. balsamea* but shorter and white beneath; stomata in 8–12 lines; shoots smooth, yellowish, with dense curved hairs; buds globose, resinous.—*A. Fraseri*.

Leaves in a V-shaped arrangement barely an inch long, white beneath; shoots deeply grooved; buds conical, resinous. —*A. brachyphylla*.

Leaves on lateral branches, overlapping and not pectinate above, arranged below in two lateral sets :—

Resin canals marginal :—

Leaves up to 1¼ in. long with rounded notched apex; shoots with scattered short hairs or the leading shoot glabrous; buds ovoid, brown, non-resinous.—*A. Nordmanniana*.

Leaves arranged like A. *Nordmanniana* but of a darker green with a truncate, notched apex; shoots emitting an odour of orange peel when cut, hairy; buds small, globose resinous.—*A. amabilis*.

Leaves about 1 in. long, gradually tapering to the entire or

notched apex, arranged like those of *A. Nordmanniana* but much less crowded; shoots minutely hairy, grooved; buds shortly cylindrical, resinous.—*A. religiosa.*

Leaves less than 1 in. long; shoots brown with dense chocolate-coloured hairs; buds small, globose, resinous.—*A. Mariesii.*

Resin canals median:—

Leaves up to 1 in. long, very white beneath; stomata 9–10 lines; shoots smooth, densely hairy; buds resinous.—*A. Veitchii.*

Leaves up to 1¾ in. long, slender, white beneath; stomata in 7–8 lines; shoots hairy in the grooves; buds resinous.—*A. sachalinensis.*

Leaves up to 1½ in. long, slender; stomata 4–5 lines; shoots ashy-grey, with scattered, minute hairs; buds globose, resinous.—*A. sibirica.*

Leaves glaucous or greyish green, partly appressed to the branchlet and curving upwards: those on lower side of the shoot in two lateral sets:—

Leaves flattened, grooved on the upper surface, concealing the shoot, which is covered with reddish-brown hairs.—*A. nobilis.*

Leaves quadrangular in section, not grooved on the upper surface, not completely concealing the shoot.—*A. magnifica.*

Leaves on lateral branches either like Fig. 14 or Fig. 23 and depending upon the vigour of the shoots:—

Leaves arranged like *A. Nordmanniana* but less white beneath and often acute at apex; buds ovoid, acute, non-resinous; the tips of the scales slightly spreading.—*A. cilicica.*

Leaves either showing a V shaped arrangement or standing vertically on the shoot and directed backwards, up to ¾ in. long, with stomata on both surfaces; buds ovoid, non-resinous.—*A. numidica.*

Leaves irregularly arranged, those on the lower side of the shoot not truly pectinate:—

Leaves all directed more or less forwards, bright green, up to 2½ in. long, apex ending in two horny points; shoots grey, glabrous.—*A. Pindrow.*

Leaves imperfectly pectinate, some in the middle line directed forward, glaucous green, apex entire; shoots smooth, olive-green, glabrous; buds large, conical, resinous.—*A. concolor.*

Leaves imperfectly pectinate or crowded on upper side of shoot 1½ in. long. entire at apex, with lines of stomata on both surfaces; resin canals median; shoots hairy; buds small, resinous.—*A. lasiocarpa.*

Leaves mostly standing erect on the upper side of the shoot, about 1 in. long, conspicuously white below, notched at the apex. Shoots smooth, silvery-grey, with scattered hairs. Buds sub-globose resinous.—*A. koreana.*

Abies amabilis, Forbes. (Fig. 11.)

RED SILVER FIR.

Abies grandis, A. Murray [not Lindley]; A. grandis, var. densiflora, Engelmann; Picea amabilis, Loudon; Pinus amabilis, Douglas; Pinus grandis, Lambert [not Douglas]. Amabilis Fir; Lovely Fir; Lovely Red Fir; Red Fir.

A tree attaining in America a maximum height of 250 ft. and a girth of 18 ft.. *Bark* thin, pale or silvery-white, becoming thick and fissured at the base of old trunks. *Young shoots* greyish-brown, smooth, with dense, short, pale-brownish hairs, with a tangerine orange odour when cut or bruised. *Winter buds* small, globose, very resinous. *Leaves* arranged much as in *A. Nordmanniana* but on the lower side of the shoot spreading more at right-angles to the stem, those on the upper side curved and pointing forwards, more or less covering the shoot; up to 1¼ in. long, $_1{}^1{}_4$ in. broad, flattened, dark shining green and grooved above with a truncate, notched apex, the under-surface with two broad white bands of stomata; resin canals marginal. *Cones* ovoid, cylindric, slightly narrowed at the apex, dark purple when young, brown when mature, 3½–6 in. long, 2–2½ in. wide; *scales* an inch or more wide, nearly as long as broad; bracts rhombic or obovate-oblong, hidden by the scales. *Seed* ½ in. long, wing ¾ in. long. This species closely resembles *A. Nordmanniana* in its leaf arrangement, but is distinguished by its small resinous buds and the peculiar odour of the cut or bruised shoot.

A. amabilis is a native of W. North America, occurring on high mountain slopes from British Columbia southwards along the Cascade Mountains to N. Oregon, and on the coast ranges of Oregon and Washington. It was introduced into cultivation in 1830, but is not common in collections and rarely grows to a large size.

Wood light, moderately hard and strong, even-grained, pale brown, heartwood a little darker than sapwood. Occasionally used for general carpentry, the indoor finish of houses, etc., and in commerce appears to be mixed with the wood of other species, although it would probably meet with a better market as a distinct timber. If *A. amabilis* occurred in a country less bountifully supplied with good timber trees the timber would be more highly appreciated.

This species is best adapted for gardens in the moist highland valleys of Wales, Scotland, and Ireland, and is not suitable for dry situations. The reason for its rarity may be the fact

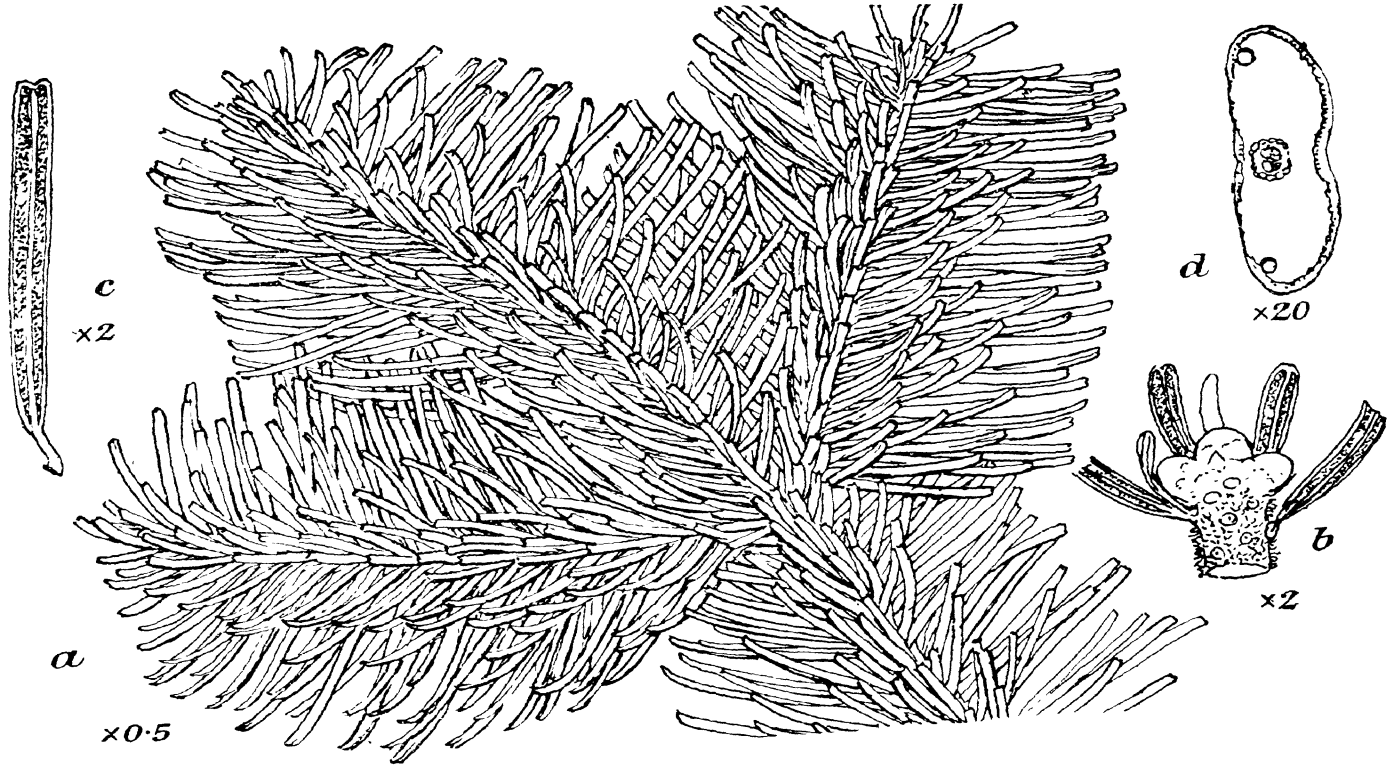

FIG. 11.—*ABIES AMABILIS.*

a, spray, upper surface ; *b*, resinous winter buds ; *c*, leaf, under-surface ; *d*, leaf in section, showing marginal resin canals.

that grafting was at one period resorted to as a means of propagation and plants raised by that means were rarely successful. Young trees should be raised from imported seeds.

Trees of the Pacific Slope (U.S. Dept. of Agric.), 125 (1908).

Abies balsamea, Miller.

BALSAM FIR.

Abies aromatica, Rafinesque; A. balsamifera, Michaux; A. minor, Dunham; Picea balsamea, Loudon; Pinus balsamea, Linnæus. Balm of Gilead; Balsam, Blister Pine, Fir Pine, Fir Tree, Silver Pine, Single Pine.

A tree 25–60 or occasionally 75 ft. high and 2½–5 ft. in girth. *Bark* of old trees about ½ in. thick, dull reddish-brown, divided into thin scales; of young trees, thin, smooth, ash-coloured and covered with resin blisters. *Young shoots* smooth and covered with fine, soft, greyish hairs. *Winter buds* small, rounded or conic, resinous. *Leaves* very variable on different parts of the tree, ⅝–1 in. long, $\frac{1}{20}$–$\frac{1}{16}$ in. wide, horizontally arranged in two lateral sets with a V-shaped parting between them; shortest on the upper side of the shoot, flattened, rounded, slightly notched at the apex; upper surface dark shining green, with interrupted lines of stomata towards the tip, lower surface with two grey bands of stomata; resin canals median. *Cones* ovoid or cylindrical, purple except when ripe, 2–4 in. long, 1–1¼ in. wide; *scales* about ⅝ in. wide and the same in length, bracts variable in length, protruding or concealed by the scales. Seeds about ½ in. long, with a wing of the same length.

Var. hudsonia, Sargent.

Abies Hudsonia, Bosc.

A dwarf spreading shrub, 1–2 ft. in height, with densely crowded branches and small broad leaves about ¼ in. long; resin canals marginal. Found in the White Mountains, New Hampshire.

Var. macrocarpa, Kent.

A form described as having longer leaves and larger cones than the type. It was found near the Wolf River, Wisconsin, and young plants were raised at Waukegan Nursery.

Var. variegata, Hort.

Leaves variegated with white.

The arrangement of the foliage of *A. balsamea* is very similar to that of *A. pectinata*, but it may be at once distinguished from that species by its resinous buds and median resin canals. *A. Fraseri*, with which *A. balsamea* is often confused, has shorter leaves which are whiter beneath, and the shoots are densely hairy.

The balsam fir has a wider distribution than any other N. American species. It extends far northwards in the Dominion of Canada, where it is common in the eastern provinces from Newfoundland to Lake Superior and spreads southwards through the N. United States to the Alleghany Mountains, and S.W. Virginia. It is common in low-lying, swampy ground, but ascends to an altitude of 5,000 ft. *A. balsamea* has been in cultivation for at least 200 years, but it is a short-lived tree and has no value for ornamental purposes.

Wood light, soft, weak, knotty, and generally too poor in quality for any work of importance. It is however used to some extent in inferior buildings and for box-making, whilst increasing attention is being paid to it as a pulp wood. For paper-making it is usually mixed with spruce. Canada balsam is obtained from the bark blisters. This is an oleo-resin largely used for mounting microscopic specimens, and it is also used in varnishes. A considerable number of people are employed in the collection of the oil or resin. Several other species produce a similar balsam.

The balsam fir is not amenable to cultivation in the British Isles and very few specimens of even moderate growth are known, the best, perhaps, being in Scotland. Even as an ornamental tree it has little to commend it.

Sudworth, *The Spruce and Balsam Fir Trees of the Rocky Mountain Region*. Bull. No. 327, U.S. Dept. of Agric. 20–24 (1916), with figs.

Abies Beissneriana, Rehder and Wilson.[1]

A tall tree attaining a height of about 200 ft. in China, with a trunk 20 ft. in girth, developing in open country wide-spreading branches and forming a rather round or flat-headed tree, or in the forests becoming very tall and spire-like with shorter branches. *Young shoots* yellowish, shining, becoming pale grey with age, glabrous. *Winter buds* ovate, resinous. *Leaves* ascending spreading, or vertical in arrangement, with a V-shaped arrangement between them, yellowish-green, ⅝–¾ in. long, smooth or slightly grooved above, paler and keeled beneath, often sharply pointed; resin canals marginal. *Cones* cylindrical or ovoid, stalked, 2–3 in. long, 1–1¼ in. wide, violet purple when growing, greyish-brown when mature; scales obovate, cuneate with rounded margins.

According to Wilson this is the tallest of the Chinese firs. It is a native of Western Szechuen. It resembles the Japanese *A. firma* in its foliage, but the latter species has the winter buds scarcely resinous, dark grey or reddish shoots, and much larger cones.

We have seen *A. Beissneriana* in cultivation at Wakehurst, Sussex, where there is a small plant.

[1] *Pl. Wils.* iv, 46–47 (1914).

Abies brachyphylla, Maximowicz. (Fig. 12.)

NIKKO FIR.

Abies umbilicata, Hort.; Picea brachyphylla, Gordon; P. pinnosa, Hort.; Pinus brachyphylla, Parlatore.

A tree usually 80–90 but occasionally 100 ft. or more high and up to 16 ft. in girth in its native country. *Bark* rough and scaly like that of a spruce. *Young shoots* light brown or buff-coloured, deeply grooved with prominent ridges, without down. *Winter buds* conic or ovoid-conic, blunt, resinous. *Leaves* on the lower side of the shoot horizontal and spreading at right-angles to the shoot, those on the upper side directed outwards and upwards, with a V-shaped depression between them and gradually becoming shorter; flattened, up to about 1 in. long and $\frac{1}{12}$–$\frac{1}{16}$ in. wide, rigid, dark shining green and grooved above, with a blunt or pointed, horny, slightly notched tip, lower surface with two conspicuous white bands of stomata separated by a green ridge; resin canals median. *Cones* cylindrical, 4 in. long by $1\frac{1}{2}$ in. in diameter, purple at first but becoming brown when mature; *scales* very thin, fan-shaped, $1\frac{1}{8}$ in. long by $\frac{3}{4}$ in. wide, bracts concealed by the scales, finely toothed and tipped by a minute point. *Seed-wing* $\frac{3}{4}$ in. long.

Var. Tomomi, Dall. and Jacks.

A. Tomomi, Bollink and Atkins.

A slender, more sparingly branched tree than the type with shorter leaves 0·8–1·5 cm., rarely 2 cm. long. Cultivated at the Arnold Arboretum and in the New York Botanic Garden.

Var. umbellata, Dall. and Jacks.

Young shoots, buds, and foliage similar to those of typical *A. brachyphylla*. The cones, according to Mayr, are greenish-yellow, the flattened apex with a raised centre. Bracts at the base of the cone protruding.

A. brachyphylla is the common fir of the mountains of Central Japan at 2,500–5,000 ft. elevation. *A. homolepis*, Siebold and Zuccarini,[1] which is said to differ from *A. brachyphylla* in the shoots and leaf arrangement, is apparently only a juvenile form of that species. One sometimes meets with plants having longer and more acuminate leaves, entire at the tips and with buds only slightly resinous.

The timber is not known in European markets and has little value in Japan, as the trees grow in such inaccessible places that the cost of extraction is prohibitive.

As an ornamental tree in Britain it has much to commend

[1] *Fl. Jap.* II, 17, t. 108 (1870); *Bot. Mag.* t. 7114 (1890).

it, for it thrives under conditions that are fatal to more tender firs. Although the best results are obtained by planting it in rich, moist soil, it succeeds fairly well under dryer conditions, even where the atmospheric conditions are not very good. It is

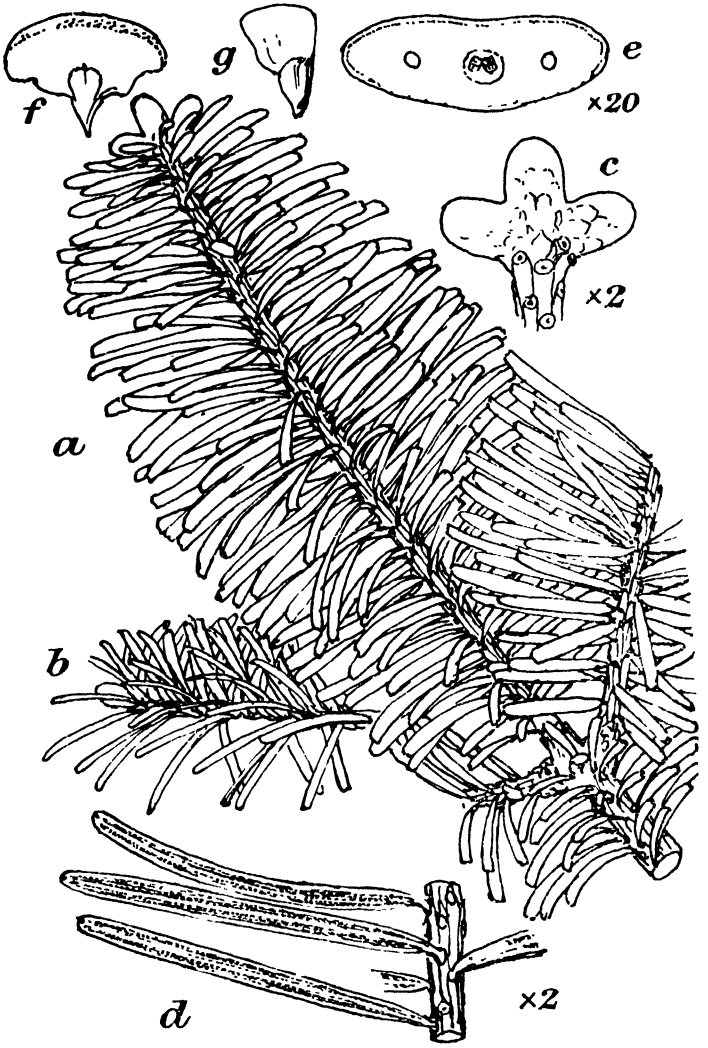

FIG. 12.—*ABIES BRACHYPHYLLA*.

a, spray, upper surface; *b*, end of branchlet seen in profile, *c*, resinous winter buds; *d*, under-leaf-surface, showing stomatal bands; *e*, leaf in section, showing median resin canals, *f*, cone-scale, consisting of a bract and seed-bearing scale; *g*, seed.

the most satisfactory of the silver firs at Kew, where the conditions are generally unsuitable for firs and spruces. It is worth trying under forest conditions in places where *A. pectinata* does not succeed.

Abies bracteata, Nuttall. (Fig. 13.)

SANTA LUCIA FIR.

Abies venusta, C. Koch; Picea bracteata, Loudon; Pinus bracteata, D. Don; Pinus venusta, Douglas. Bristle-cone Fir; Fringed Spruce; Silver Fir.

A handsome tree, attaining in California a height of 100–150 ft. with a trunk 9 ft. in girth. *Bark* light reddish-brown, smooth, becoming slightly fissured in old trees. *Branches* short, closely set, the lowest ones often sweeping the ground and forming a tree of pyramidal outline, abruptly tapering above into a narrow spire. *Young shoots* greenish, without hairs. *Buds* unlike those of any other fir; spindle-shaped, $\frac{3}{4}$ in. long, made up of thin, light-brown, non-resinous scales. *Leaves* spreading horizontally into two opposite sets, those on the upper side of the shoot being slightly shorter and pointing forwards, often 2 in. long, flattened, rigid, with long, spine-like, horny points, abruptly tapering at the base, upper surface dark green, slightly concave in the lower half, flat near the apex; lower surface with two white lines of stomata. *Cones* 3–4 in. long, $1\frac{1}{2}$–2 in. broad, remarkable for the long protruding spines of the scale bracts, which are from 1–2 in. long and are generally tipped with globules of resin. *Seeds* dark reddish-brown, $\frac{3}{8}$ in. long, with similar-coloured wings about $\frac{1}{2}$ in. long.

This singular fir is one of the most beautiful of the genus, and at the same time one of the rarest. It occurs wild only in the Santa Lucia Mountains, Monterey County, California, where it grows in the moist bottoms of cañons and on dry rocky summits at about 3,000 ft. elevation.

A. bracteata appears to have been first found by Coulter in 1831. The locality was afterwards visited by Douglas, Hartweg, Lobb, and other botanical explorers, who procured seeds for European gardens It was introduced to cultivation by Lobb when collecting for Messrs. Veitch in 1853.

Wood not known in Britain. Hough [1] describes it as rather light and hard, coarse-grained with very fine medullary rays, colour pale yellowish-brown with little distinction between heart-wood and sapwood. Even in America it is not used much owing to the difficulty of extraction, there being other useful timbers in more accessible places.

The Santa Lucia Fir should be included in all collections in the milder parts of the country. In a state of nature it is found both on dry ridges and also in moist valleys. In the British Isles the best results may be looked for in places where both soil and atmospheric conditions are on the moist side. Soil, however, must not be waterlogged.

Jepson, *Silva of California*, 124 (1910); *Bot. Mag.* t. 4740 (1853).

[1] *American Woods*, x., 50.

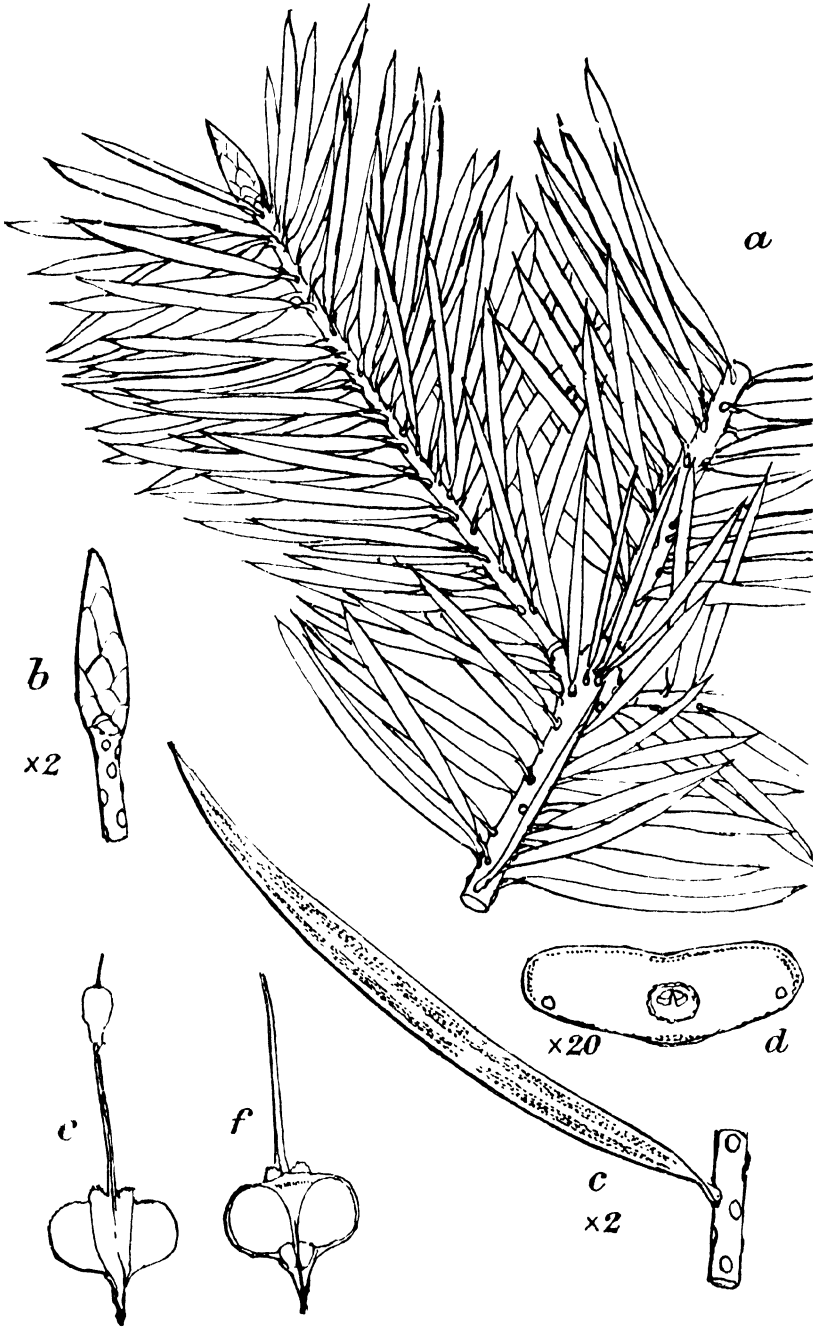

FIG. 13.—*ABIES BRACTEATA.*

a, part of spray from above; *b*, winter bud; *c*, leaf showing stomatal bands on under-surface; *d*, leaf in section, showing marginal resin canals; *e*, cone-scale with long pointed bract, bearing a lump of resin; *f*, inner side of cone-scale, showing two seeds.

Abies cephalonica, Loudon. (Fig. 27.)

GRECIAN FIR.

Abies panachaica, Heldreich; A. Lusćombiana, Loudon; A. peloponnesiaca, Haage; A. Reginæ-Amaliæ, Heldreich; Picea cephalonica, Loudon; Pinus Abies, var. cephalonica, Parlatore. P. cephalonica, Endlicher.

A tree about 100 ft. high and 9–15 ft. in girth. *Bark* greyish-brown, smooth on young trees, becoming fissured into oblong plates on old trunks. *Young shoots* smooth, light brown, without down. *Buds* conical or ovoid, resinous, the scales prominent at the tips. *Leaves* spreading more or less all round the shoot, but more numerous on the upper side where they are more or less erect, those of the upper ranks shorter than those beneath; flattened, curved, about 1 in. long, $\frac{1}{16}$–$\frac{1}{12}$ in. wide, abruptly tapering at the base, ending in a sharp, horny point; upper surface shining green, grooved, with a few broken lines of stomata near the apex; lower surface with two white bands of stomata separated by a green ridge; resin canals marginal. *Cones* about 6 in. long by $1\frac{1}{2}$ in. in diameter, cylindrical, brownish, with golden-brown reflexed bracts ending in a triangular point, protruding between the narrowly fan-shaped scales. *Seed* with a wing about 1 in. long.

Var. Apollinis, Beissner.

Abies Apollinis, Link.

Differing from the type in the irregular arrangement of the leaves which stand crowded on the upper side of the shoot, those on the lower side curving upwards. Leaves thicker and broader than in the typical form, with acute, not acuminate, points. It appears to be connected with the type by intermediate forms.

A. cephalonica is a native of the higher mountains of Greece between 2,700 and 5,700 ft. elevation. On Mount Enos in Cephalonia there was formerly a forest of this fir 12–15 miles in length and thirty-six miles round, but its area has been much reduced by fires.

The Grecian fir was introduced into cultivation by General Sir Charles Napier, who sent seeds to England in 1824.

Wood very similar to that of *A. pectinata*, but it has no commercial value outside its native country.

In the British Isles this species is only planted for decorative purposes. It gives the best results in moist but not water-logged soil in the cooler and moister parts of the country.

Elwes and Henry, *Trees of Great Brit. and Irel.*, iv, 739 (1909).

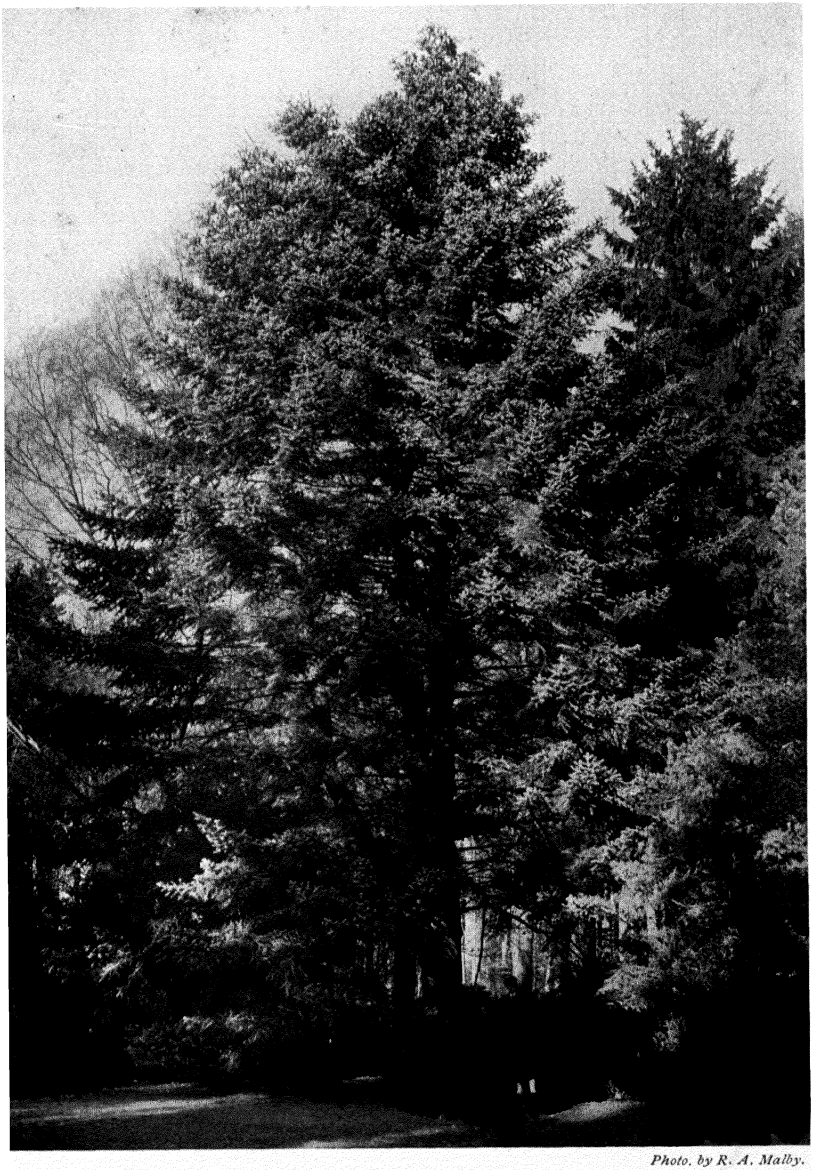

Photo. by R. A. Malby.

PLATE V. GREEK FIR (*ABIES CEPHALONICA*) AT WESTONBIRT, GLOUCESTER.

Abies chensiensis, Van Tieghem.

A Chinese fir attaining 120 feet in height allied to *A. firma* and *A. Beissneriana*, characterised by its relatively long, shining green leaves, glabrous, yellow-grey branchlets, ovoid, slightly resinous winter buds and ovoid-cylindric pale brown cones. It appears to be a well marked species which superficially resembles *Keteleeria Davidiana* in its winter buds and foliage.

Discovered in the Tsinling mountains, Shensi, by David, in 1872, and since seen in the forests of Fang Hsien by Wilson, who states that it is a comparatively rare tree in that region. Introduced to the Arnold Arboretum in 1907.

Pl. Wils. ii., 44 (1914).

Abies cilicica, Carrière. (Fig. 14.)

CILICIAN FIR.

Abies Rinzi, Hort.; A. selinusia, Carrière; Pinus cilicica, Parlatore.

A tree up to 100 ft. high and 7 ft. in girth. *Bark* ashy-grey, smooth, becoming deeply fissured and scaly on old trees. *Young shoots* smooth, greyish-brown, with short, scattered hairs or occasionally without hairs. *Winter buds* ovoid, without resin, the scales keeled and free at the tips. *Leaves* arranged either in two lateral sets, or more or less covering the upper side of the shoot also, the central leaves shorter and more or less erect; slender, 1–1¼ in. long, linear, flattened, apex rounded or short-pointed, slightly notched, upper surface light green and grooved, lower surface with two narrow greyish bands of stomata; resin canals marginal. *Cones* sub-sessile or shortly stalked, cylindrical, tapering to a short-pointed apex, 6–9 in. long by 2–2½ in. wide, smaller in cultivated specimens; *scales* large, fan-shaped, 1¾ in. wide by ⅞ in. long; *bracts* hidden, ¼–½ the length of the scale, mucronate. *Seed-wing* about 1 in. long.

A. cilicica resembles *A. Nordmanniana* in the arrangement of the foliage, but the leaves are less crowded on the shoot, narrower, more or less pointed at the apex, and the buds are rough with the prominent tips of the scales.

The Cilician fir is a native of Asia Minor and N. Syria, where it occurs on Mount Lebanon and the Antitaurus associated with the Cedar of Lebanon in extensive forests. It was introduced into cultivation about 1850, but is still very rare in gardens.

Little is known of the wood of this species, but it appears to be very similar to that of *A. Nordmanniana*. The Cilician fir may be expected to thrive under similar conditions to *A. Nordmanniana*, but it is not so susceptible to insect attacks.

Elwes and Henry, *loc. cit.* iv, 744 (1909).

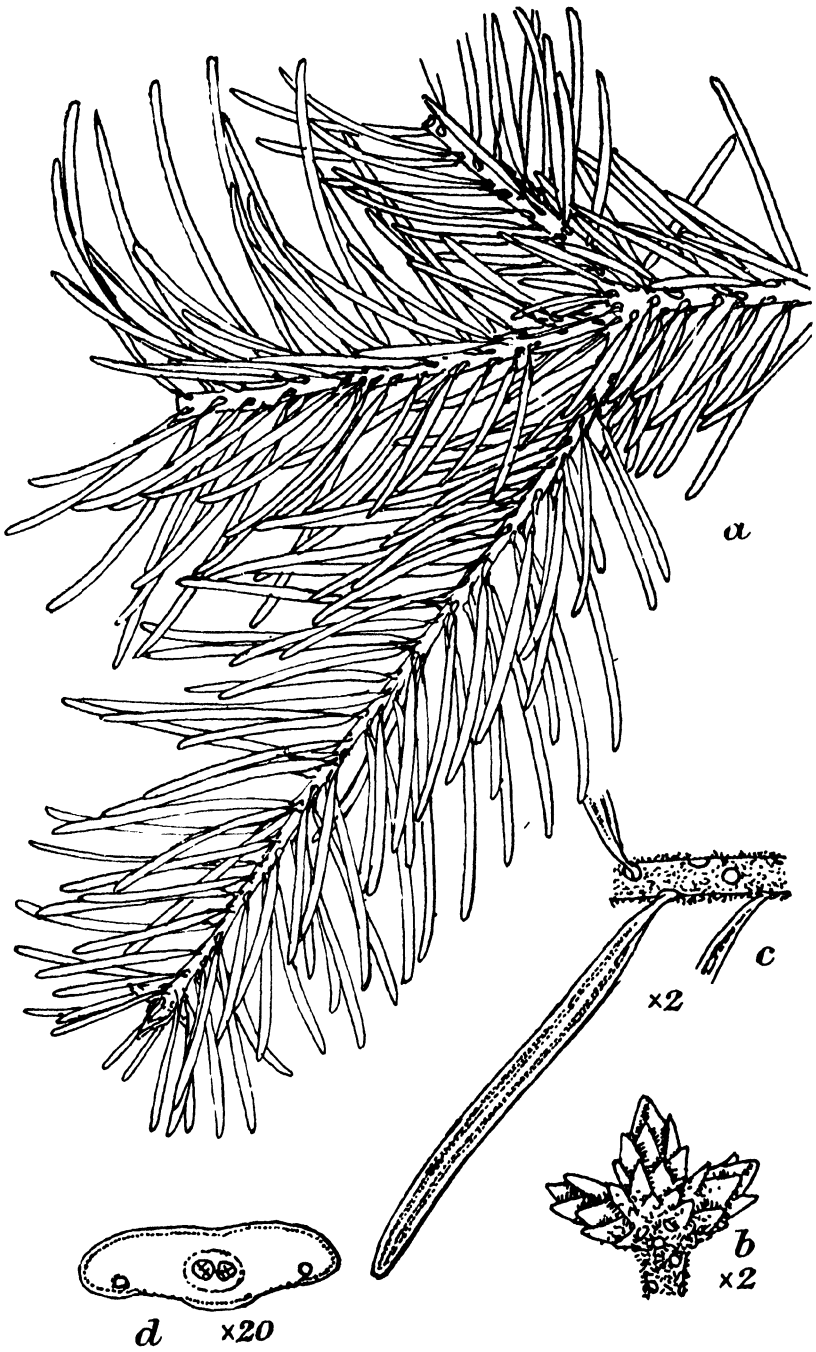

FIG. 14.—*ABIES CILICICA*.

a, part of spray, upper surface; *b*, winter buds, non-resinous; *c*, under-surface of leaf and pubescent shoot; *d*, leaf in section, showing marginal resin canals.

Abies concolor, Lindley and Gordon. (Fig. 15.)

COLORADO WHITE FIR.

Picea concolor, A. Murray; P. lasiocarpa, Balfour [not Hooker]; Pinus concolor, Parlatore. Balsam Fir; Colorado Fir; Colorado White Balsam; White Balsam; Silver Fir; White Fir.

A fir 100–150 ft. high, with a girth of 9–12 ft. *Bark* of young trees furnished with resin blisters as in *A. balsamea*. *Young shoots* without down, olive-coloured, the second year's shoots greyish or silvery. *Winter buds* usually larger than in *A. Lowiana*, covered with resin which conceals the scales. *Leaves* curving outwards and upwards or almost vertically arranged on the shoots, 2–3 in. long and $\frac{1}{12}$–$\frac{1}{16}$ in. broad, flattened, glaucous on both surfaces, apex short-pointed or rounded, upper surface slightly convex, not grooved, with faint lines of stomata, lower surface with two faint bands of stomata separated by a green band. Resin canals marginal. *Cones* 3–5 in. long by $1\frac{1}{4}$ in. in diameter, cylindrical, greenish or purple when growing, brown when mature; scales about 1 in. wide by $\frac{1}{2}$ in. long. Bracts concealed, minutely mucronate. *Seed-wing* about $\frac{3}{4}$ in. long.

Var. **violacea**, Beissner.

The foliage is more glaucous than in the type.

This fir is closely allied to *A. Lowiana* and the two are regarded as forms of one species by some American botanists. In *A. concolor*, however, the leaves are more obliquely arranged than in *A. Lowiana*, have entire points, are convex and not grooved on the upper surface and are more uniformly glaucous in colour. In *A. Lowiana* erect leaves do not occur on the centre of the branch. The cones are similar in size and shape, but in cultivated specimens of *A. concolor* the immature cones are purple and not chestnut-brown. The distribution of the two trees in America is quite different.

A. concolor grows wild in the Rocky Mountains of S. Colorado and extends southwards over the mountains of New Mexico and Arizona into N. Mexico. It also occurs in Utah and the extreme S. of California. It was introduced into cultivation about 1873.

Wood light, moderately strong, without odour, easy to work, whitish in colour, finishing with a good surface, and useful for joinery. It is suitable for boxes for butter, lard, and other provisions that become tainted by contact with odorous woods. The timber is chiefly reserved for home use, but is obtainable from Californian ports. Timber from old trees is often affected by heart-rot. Liquid resin obtained from bark blisters possesses similar properties and uses to Canada balsam.

It is tolerant of shade and can be used for underplanting thin woods. Its use in Britain is purely decorative. As a garden tree

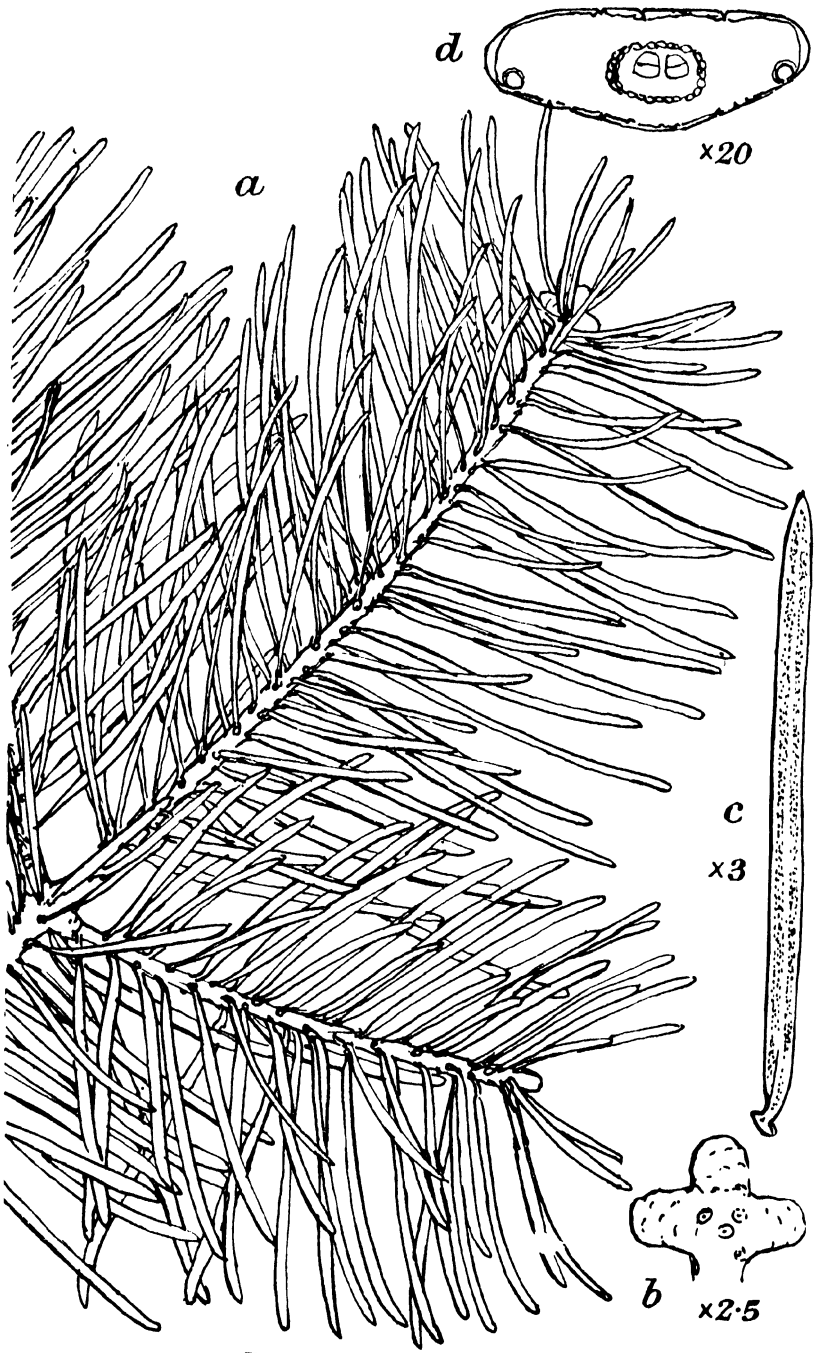

FIG. 15.—*ABIES CONCOLOR.*

a, spray from above; *b*, resinous winter buds; *c*, under-surface of leaf; *d*, leaf in section, showing marginal resin canals.

it grows well (particularly in the moister parts of the country). It could be used in the West of England and in Scotland for forest work, but would probably be of no more use for the purpose than the better known *A. pectinata*, except that it is less subject to insect pests. Both the type and the variety *violacea* may generally be found in the same batch of seedlings.

Sudworth, *The Spruce and Balsam Fir Trees of the Rocky Mountain Region*, 33 (1916).

Abies Delavayi, Franchet. (Fig. 16.)

Keteleeria Fabri, Masters; Abies Fargesii, Masters [not Franchet].

A tree 60–100 ft. high, with massive branches when old. *Young shoots* reddish-brown, shining, grooved, glabrous or hairy in the grooves. *Winter buds* large, ovoid, reddish-brown, up to ¼ in. long, resinous, scales persistent at the base of the shoots. *Leaves* on lateral branchlets arranged in two opposite sets with a V-shaped parting between them, crowded, in three or more ranks, those of the upper side of the shoot much shorter than the lower leaves which are directed outwards and downwards; up to about 1 in. long, dark shining green and furrowed above, lower surface with two broad white bands of stomata separated by a prominent green midrib equalling in breadth the two marginal green bands; margins more or less revolute.[1] *Cones* barrel-shaped, 3–4 in. long, dark violet-black, the apex of the bract slightly exserted when the cone is ripe.

According to Wilson this is the common silver fir of W. and especially of S. W. Szechuen, and it has a greater altitudinal and latitudinal range than any other Chinese species.

The timber, though soft and not very durable, is valued on account of the large size of the logs which it yields.

Young plants are growing vigorously in several gardens in the British Isles.

Abies Fargesii, Franchet.

A tree 100 ft. or more high in W. China with a trunk of nearly uniform thickness for half its height and short massive branches. *Young shoots* glabrous, red-brown or purplish. *Leaves* horizontally spreading in two or more ranks, the upper rank about half the length of the lower, more or less notched at the apex. *Cones* with exserted and spreading bracts.

We have chiefly seen native specimens of this fir, which is rare in cultivation.

[1] In some native specimens collected by Forrest in Yunnan and by Faber on Mount Omei, the margins of the leaves are so strongly revolute as to completely cover the stomatic bands beneath; in others they are only slightly so. The latter form, which is the one in cultivation, has been separated by Craib (*Notes, Roy. Bot. Gard. Edinb.* xi, 278, 1919) as a distinct species under the name of *A. Fabri*; he considers the true *A. Delavayi* is not in cultivation, but leaves of both types are occasionally found on the same plant, and this character depends apparently on situation.

Wilson states that this is the common silver fir of N.W. Hupeh, China, where remnants of old forests of it are still met with. It also occurs in E. Szechuen.

Journ. de Bot. xiii, 256 (1899); *Pl. Wils.* ii, 48 (1914).

Abies Faxoniana, Rehder and Wilson.

This species is described as a tree 60–100 ft. high. Bark of old trees greyish, fissured below. *Young shoots* reddish-brown with shaggy hairs. *Winter buds* ovoid, purplish, very resinous. *Leaves* arranged in one plane, ½–1¼ in. long, margins slightly recurved, apex acute or rounded, notched; bright shining green and grooved above; lower surface with two white stomatic bands. *Mature cones* violet purple, ovoid or ovoid-oblong, 2–3½ in. long by 1–1½ in. broad; *scales* with bracts more or less exserted, erect or recurved.

Closely allied to *A. Delavayi* which is said to differ in its usually glabrous shoots and much longer, more barrel-shaped cones and longer leaves revolute at the margins.

It is found in the forests of W. Szechuen, China, at 8,000–11,000 ft. elevation. Seedling plants raised from seeds collected by Wilson and cultivated as *A. Faxoniana* have young shoots red brown or purplish, glabrous or hairy in the grooves; leaves arranged in two or more ranks, those of the upper rank only about half as long as the lower ones.

Pl. Wils. ii, 42 (1914).

Abies firma, Siebold. (Fig. 17.)

JAPANESE FIR.

Abies bifida, Siebold and Zuccarini; Pinus firma, Antoine. Momi.

A tree attaining in Japan a height of 150 ft. and a girth of 16 ft., with massive horizontal branches forming an oval or flattened crown. *Bark* on old trees rough and dark grey, breaking up into small plates. *Young shoots* light brown, grooved, hairy in the grooves on young trees, but often becoming hairless in older specimens. *Winter buds* small, ovoid, blunt, with slightly resinous scales. *Leaves* arranged in two opposite sets spreading outwards, and upwards with a V-shaped depression between them, those on the upper side gradually shortening; up to about 1½ in. long, $\frac{1}{16}$–⅛ in. wide, flattened, stiff, leathery, apex ending in two horny points; bright glossy green, grooved above, lower surface with two greyish bands of stomata; resin canals two to four, marginal. *Cones* cylindric or cylindric-conic, yellowish-green before ripening, 4–5 in. long by 1½–1¾ in. wide, with the tips of the bracts visible between the scales, which are about an inch wide, kidney-shaped, suddenly contracted to a short claw; bracts narrow, longer than the scale, terminating in an acute point.

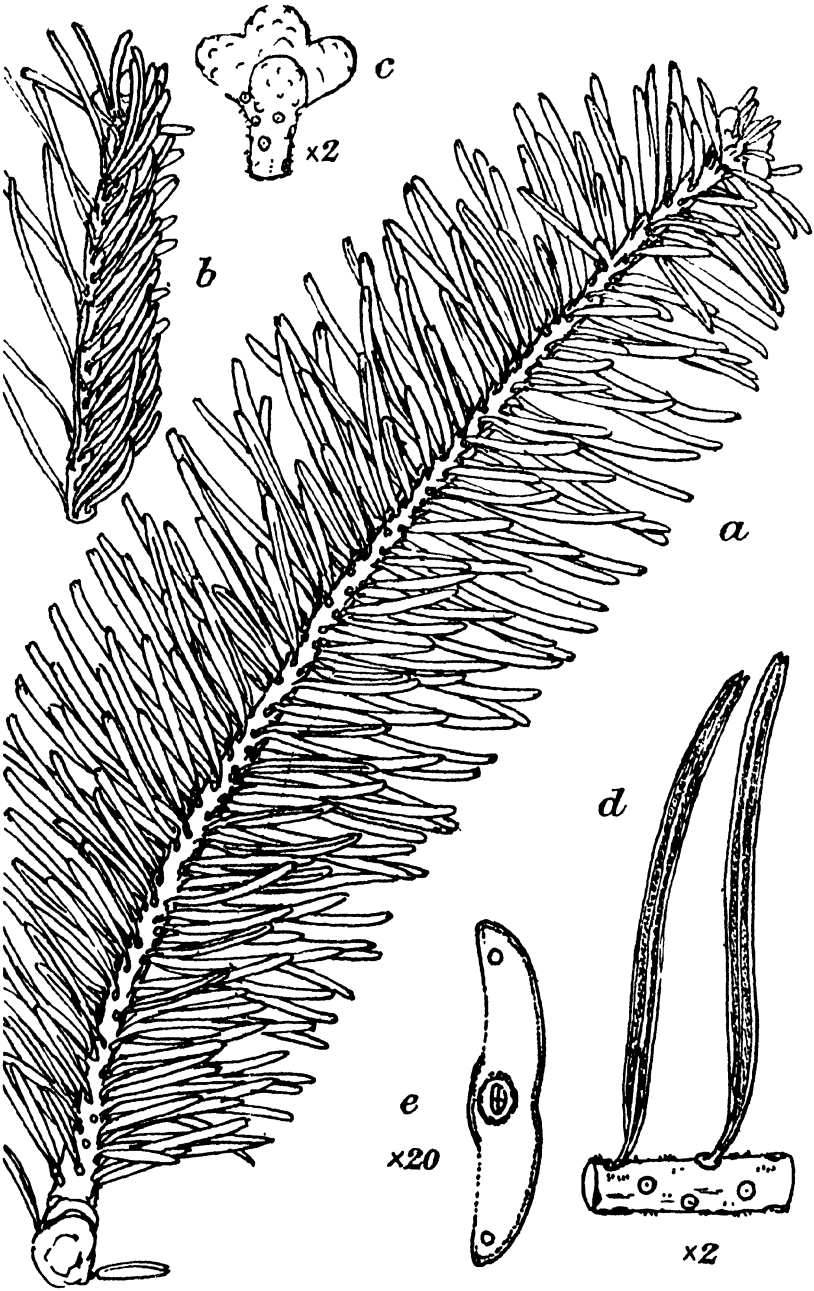

FIG. 16.—*ABIES DELAVAYI.*

a, spray from above; *b*, from the side; *c*, resinous winter-buds; *d*, under-surface of leaves and shoot; *e*, leaf in section, showing marginal resin canals.

A. firma is readily distinguished by its grooved shoots, bright green leathery leaves, each leaf being tipped by two horny points.

This is the only fir found in S. Japan where it is widely distributed, attaining a large size in the plains and ascending to an

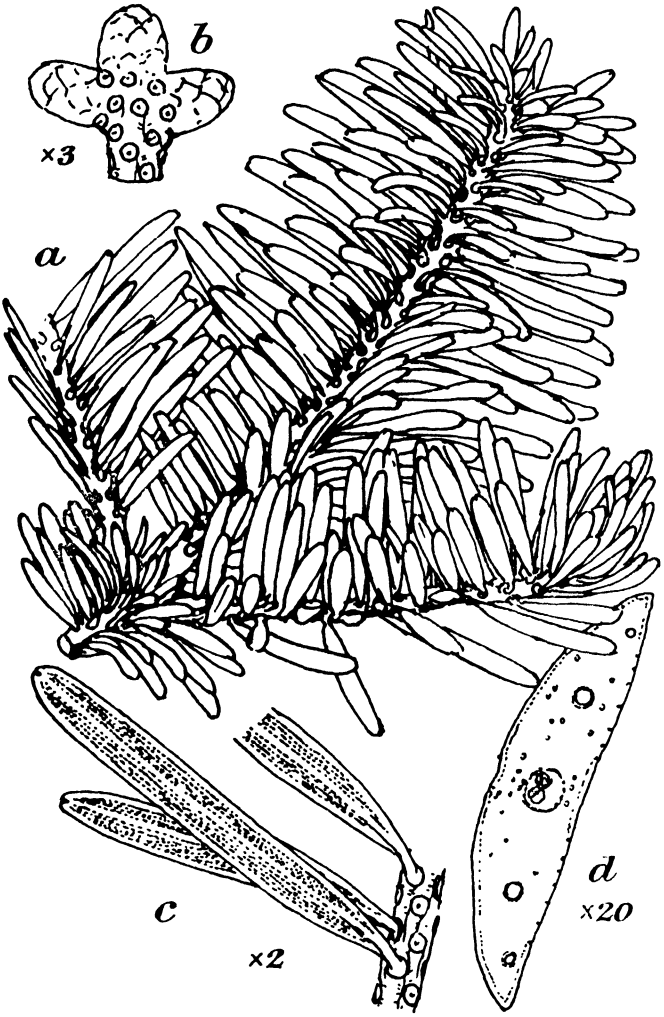

FIG. 17.—*ABIES FIRMA.*

a, spray from above ; *b*, resinous winter buds ; *c*, under surface of leaves and shoot ; *d*, leaf in section, showing both marginal and median resin canals.

altitude of 7,000 ft. It is one of the principal trees in the primitive forests in S. Honshu, Kyushu, and Shikoku.[1]

The wood resembles that of *A. pectinata* and is one of the

[1] *Forestry of Japan* ; Bureau of Forestry, Tokyo, 29 (1910) ; Clinton-Baker, *Illust. Conif.* ii, 12 (1909) ; Wils., *Conif. of Japan*, 54 (1916).

commonest fir woods of Japan. It is light, soft, straight-grained, easily worked, but requires careful seasoning, otherwise it warps and shrinks. Although not regarded as a high class timber it is in demand for cheap buildings, packing cases, and various other common kinds of joinery and carpentry. It is one of the principal Japanese woods used in the manufacture of paper pulp.

A. firma is the largest and most beautiful of the Japanese firs, its rich, glossy leaves making it specially attractive. It withstands a good deal of shade and is useful for planting amongst deciduous trees. In the British Isles it can only be used as a decorative tree, and the best results are obtained by planting it in deep, moist soil of good quality. It is not very subject to insect injury in Britain.

Abies Forrestii, Craib.[1]

A tree 30–60 ft. high in China. *Young shoots* rusty red, minutely corrugated, not grooved, glabrous or with a few scattered hairs. *Buds* ovoid, thickly coated with whitish resin, the scales persistent at the base of the branchlets. *Leaves* arranged more or less in two lateral sets with a narrow V-shaped parting between them, those on the upper side of the shoot standing almost vertically, those on the lower side curving outwards and upwards, 1–1½ in. long by $\frac{1}{12}$ in. broad, dark shining green and grooved above, conspicuously white below with two broad bands of stomata, the green marginal bands about equalling the midrib in width, margins slightly recurved, apex notched. *Male flowers* in clusters near the tips of the shoots, ½ in. or more long. *Cones* purple, 3½ in. long., 1¾ in. wide, with exserted bracts.

A very distinct and beautiful fir, easily recognized by its bright rusty-red corrugated young shoots, which contrast strongly with the dark shining green foliage. The glaucous under-surface of the leaves is conspicuous at a considerable distance.

Native of the eastern flank of the Lichiang Range, Yunnan, W. China, where it forms forests at 10,000–11,000 ft. elevation. It was introduced by Forrest, and a young tree at Stanage Park, Radnorshire, is now (1923) 15 ft. 8 in. high.

Abies Fraseri, Poiret.

FRASER'S BALSAM FIR.

Abies humilis, La Pilaye ; Picea Fraseri, Loudon ; Pinus Fraseri, Parlatore. Balsam Fir ; Double Fir Balsam ; Double Spruce ; Healing Balsam ; Mountain Balsam ; She Balsam Fir ; Silver Fir.

A tree 40–70 ft. high, with a trunk up to 7 ft. in girth and rather stiff, fragrant branches, forming an open pyramidal head. *Bark* smooth, thin, bearing numerous resin-blisters on young trees, becoming scaly on old trunks. *Young shoots* grey, bearing dense

[1] *Notes Roy. Bot. Gard. Edinb.* xi, 279 (1919).

reddish down. *Winter buds* small, broadly ovoid or globe-shaped, resinous. *Leaves* arranged like those of *A. balsamea*, but shorter, rarely more than ¾ in. long, rounded and notched at the apex; the upper surface dark green, shining; the lower surface with two broad white bands of stomata; resin canals median. *Cones* ovoid, cylindrical, about 2 in. long by 1¼ in. wide, purple; *scales* like those of *A. balsamea* but with the bracts protruding and reflexed. *Seed* with a wing about half an inch long.

This fir may always be known from its near ally *A. balsamea* by the dense reddish down on the young shoots and the shorter and comparatively broader leaves which are whiter beneath. It is constantly confused with *A. balsamea* in nurseries.

A. Fraseri, named after its discoverer, John Fraser (1750–1811), a keen collector of N. American plants, has a very local distribution in N. America, being found wild only on the Alleghany Mountains in S.W. Virginia, N. Carolina, and E. Tennessee, where it forms forests at 4,000–6,000 ft. elevation. It was first cultivated in this country in 1811.

Wood light, soft, rather weak, whitish, works with a fine surface, heartwood not well marked. Very little used for lumber on account of the inaccessibility of the trees, but the timber is suitable for indoor finish of houses and for boxes. As is the case with *A. balsamea*, the fragrant branches are popular with travellers for beds.

A. Fraseri does not succeed very well in the British Isles, and well-developed specimens are rarely seen. The moist valleys of Wales and Scotland appear to afford more suitable conditions than the drier parts of England.

Two trees at Colesborne planted in 1897 were 15 ft. high in 1917. One was coning freely in an experimental plantation (very subject to late frosts) 500 ft. above sea-level, on Midford sand.

Abies grandis, Lindley. (Fig. 18.)

GIANT FIR.

Abies amabilis, A. Murray [not Forbes]; A. Gordoniana, Carrière; A. lasiocarpa, Lindley and Gordon [not Hooker]; Picea grandis, Loudon; Pinus grandis, Douglas.

Grand Fir; Great Silver Fir; Oregon Fir; Silver Fir; Western White Fir; White Fir.

A tall tree, occasionally reaching a height of 300 ft. and a girth of 16 ft. *Bark* smooth in young trees with many resin blisters, becoming dark brown, fissured and scaly in old trees. *Young shoots* smooth, olive-green, minutely hairy. *Winter buds* small, conical, blunt, resinous. *Foliage* aromatic when bruised. *Leaves* horizontally arranged, spreading to right and left, those on the upper side of the shoot much shorter than those on the lower side, flattened, 1½–2 in. long, $\frac{1}{12}$–$\frac{1}{16}$ in. wide, notched at the apex, upper surface dark shining green, grooved, under surface with

two white bands of stomata, resin canals marginal. *Cones* cylindrical, narrowed towards the apex, 2–4 in. long by 1–1¼ in. wide, with concealed bracts ; *scales* closely overlapping, crescent-

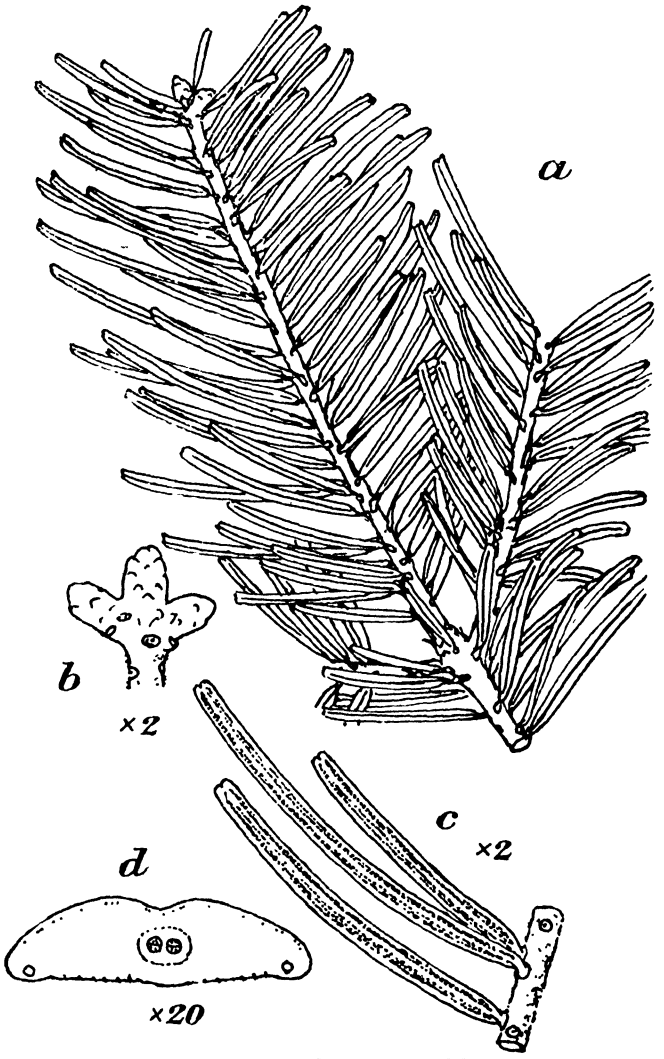

FIG. 18.—*ABIES GRANDIS.*

a, spray from above ; *b*, resinous winter buds ; *c*, under-surface of leaves and shoot ; *d*, leaf in section, showing marginal resin canals.

shaped to fan-shaped, bracts small, quadrangular, with a short point. *Seed-wing* about ⅝ in. long.

Var. aurea, Hesse.

Leaves yellowish.

Var. **compacta**, Hesse.

Compact in habit.

Distinguished from all other firs except *A. Lowiana* by the pectinate arrangement of the leaves. In the latter species the leaves are similarly arranged, but have a grey or silvery colour, stomatic lines on each surface, and the leaves in the upper rank are only slightly shorter than those in the lower rank.

This handsome fir has a wide range in W.N. America, extending from Vancouver Island through Washington and Oregon to California. It grows at altitudes from sea-level up to 3,500 ft. Discovered by Douglas on the Columbia River in 1825 and introduced to Britain by him about 1832.

Wood light, soft, rather weak, not durable, pale yellow or brownish, finishing well, and used in joinery in the indoor finish of houses and for boxes and crates. It is a second-rate fir wood, but there are many uses for which it is suitable. The large number of excellent timber trees found within its range make it less sought after than would otherwise be the case. An oleo-resin obtained from the bark-blisters is used in the same way as Canada balsam.

A. grandis thrives and grows rapidly in the British Isles, where it is used as an ornamental specimen and for planting under sylvicultural conditions. The best results follow planting in moist ground in places where the atmospheric conditions are on the moist side. It gives excellent results in many parts of Scotland up to 1,200 feet elevation, where annual growths 12–15 in. in length are often formed. In an open position it retains its branches to the ground-line for many years. In America the most luxuriant growth occurs on moist land at low elevations. It is one of the least tolerant of shade amongst the firs.

Sudworth, *The Spruce and Balsam Fir Trees of the Rocky Mountains*, 29 (1916).

Abies holophylla, Maximowicz.

MANCHURIAN FIR.

A tree 100–150 ft. high, with a trunk 12 ft. in girth and moderately stout spreading or ascending branches, and dark green foliage. It is closely allied to *A. firma*, but differs in the leaves not being notched at the apex and in the bracts of the cone, which are only about one-third the length of the scales. It is found in mountain woods in the Manchurian provinces of Ussusi, Kirin, and Mukden, and also in N. Corea, where it is cultivated at low levels.

A. holophylla is cultivated in Russia and at the Arnold Arboretum, where seeds were received from Corea in 1904. Wilson,[1] states that it is of little value as a timber tree, but for garden purposes ranks with *A. brachyphylla*. We have seen young trees cultivated under the name in England, but cannot be sure of their identity.

[1] Phytogeographical Sketch of Corea, *Journ. Arn. Arb.* i, 39 (1919).

Abies insignis, Carrière.[1]

A hybrid fir originally raised in the nursery of M. Renault at Bulgnéville in the Vosges. A branch of *A. Pinsapo* grafted on the common silver fir produced cones and from the seedlings raised half were like the graft, the remainder being intermediate in character between *A. Pinsapo* and *A. pectinata*. The variations were supposed to be the result of a graft hybrid. It is probable however that the male parent was *A. Nordmanniana*, a tree of which was growing near.

Var. speciosa, Rehder.

A. Nordmanniana, var. speciosa Hort.

A hybrid of the same parentage in which a reciprocal cross was made by placing pollen from *A. Pinsapo* on the female flowers of *A. Nordmanniana*. Four varieties of this hybrid described as *A. Kentiana*, *A. Andreana*, *A. Beissneriana* and *A. Mastersiana* by Mottet, in which *A. Pinsapo* was made the mother tree, were obtained by M. Moser at Versailles in 1878.

Rev. Hort. 1902, p. 163.

Abies Kawakamii, Ito.[2]

A. Mariesii, var. Kawakamii, Hayata.

A Formosan fir of which we have not seen specimens, found on and near Mt. Morrison at 11,000–12,000 ft. altitude. It is said to differ from *A. Mariesii* chiefly in its longer cylindrical cones with black seeds and seed-wings. Wilson [3] describes it as a handsome tree 50–120 ft. high, of pyramidal habit, with nearly white bark, and resinous violet-purple cones, but at its highest limits on Mt. Morrison and on wind-swept slopes above Noko reduced to a bush 5–8 ft. high.

Abies koreana, Wilson.[4] (Fig. 19.)

COREAN FIR.

Abies nephrolepis, Nakai [not Maximowicz].

A tree 30–50 ft. high in Corea, with a trunk 3–6 ft. in girth. *Bark* of young trees smooth, purplish to pale ashen in colour, rough, deeply fissured in old trees. *Branches* numerous, spreading. *Branchlets* slightly furrowed, sparingly hairy. *Buds* subglobose, slightly resinous with somewhat acute membranous, chestnut-brown scales. *Leaves* about 1 in. long and $\frac{1}{10}$ in. broad, notched at the apex or sometimes entire and sharply pointed, dark green and grooved above, white with two broad bands of stomata below, resin canals two, marginal. *Cones* cylindrical,

[1] *Rev. Hort.* 1890, pp. 230, 231. [2] *Encyclopædia Jap.* ii, p. 167.
[3] Phyt. Sketch, Formosa, *Journ. Arn. Arb.* i, 38 (1920).
[4] *Journ. Arn. Arb.* i, 188 (1920).

2–2¾ in. long by about 1 in. broad, flattened at the apex; *scales* kidney-shaped, ⅓–¾ in. broad, bracts slightly exceeding th. scales in length, reflexed at the apex with a rigid point. *Seeds* violet-purple, ⅓–½ in. long, including the wing. According to the

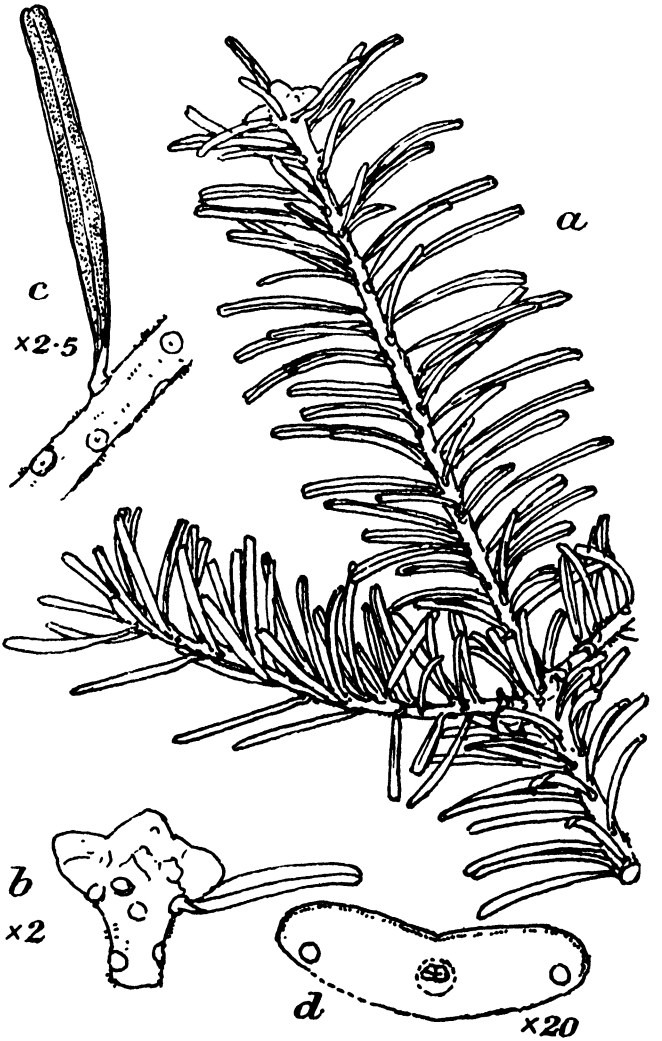

FIG. 19.—*ABIES KOREANA*.

a, spray from above; *b*, resinous winter-buds; *c*, under-surface of leaf and shoot; *d*, leaf in section showing marginal resin canals.

describer, *A. koreana* is characterized by its pyramidal habit, deeply fissured bark, and exserted cone bracts, with leaves combining most of the characters of the three related species *A. sachalinensis*, *A. Veitchii*, and *A. nephrolepis*.

This interesting fir is an alpine species confined to the volcanic island of Quelpaert, where it was discovered by Faurie in 1907 on Hallai-san (Mt. Auckland), and seen there ten years later by Wilson, who also found it on the Chiri-san range of mountains in the south of the Corean peninsula. It is abundant above 3,000 ft. altitude, either forming pure forest or associated with deciduous trees and *Picea jezoensis*.

Young trees in cultivation at Les Barres and Verrières in France, and at Kew, are thriving and very distinct in their smooth, silvery-grey young shoots with scattered hairs, resinous buds and widely spreading leaves which are conspicuously glaucous on the lower surface. It seems likely to prove hardy in cultivation and a desirable addition to our ornamental conifers. It has already produced cones at Les Barres.

Abies lasiocarpa, Nuttall.

ALPINE FIR.

Abies bifolia, A. Murray; A. sub-alpina, Engelmann; A. sub-alpina var. fallax, Engelmann; Picea lasiocarpa, W. J. Hooker.

Balsam; Downy-cone Fir; Mountain Balsam; Oregon Balsam Fir; Pumpkin Fir; Rocky Mountain Fir; White Fir.

A tree 60–90, or occasionally 130 ft. high and 9–12 ft. in girth. *Bark* of young trees silvery-grey; of old trees, ashy-grey or white; 1–1¼ in. thick, hard and but slightly fissured. *Young shoots* ashy-grey, covered with minute hairs or rarely smooth. *Branches* drooping. *Winter buds* small, globose, pale brown, resinous. *Leaves* dense, irregularly pectinate or curving upwards, those in the middle line closely covering the shoot; flat, linear, up to 1½ in. long on the lower branches, usually less than 1 in. long on the upper branches of old trees, apex entire or slightly notched, rounded on the lower branches, pointed on the higher ones, particularly on the leading shoot; stomata in conspicuous lines on both surfaces, giving a glaucous or blue-green tint; resin canals median. The foliage on the upper part of the tree is less dense than on the lower parts. *Cones* cylindrical, slightly narrowed at the apex; 2–4 in. long by 1½ in. broad, dark purple, downy; *scales* ⅞ in. long, ¾–1 in. wide, the bracts with long, slender points hidden by the scales. *Seeds* ¼ in. long with a shining purplish wing.

Var. arizonica, Lemmon.

CORK FIR.

Abies arizonica, Merriam; Arizona Cork Fir.

Bark yellowish-white, thick, soft, corky. *Leaves* very similar to those of the type. *Cones* smaller and scale-bracts shorter than those of *A. lasiocarpa*. A specimen of the bark of this remarkable fir may be seen in Museum 3, at Kew.

Var. *compacta*, Rehder. a dwarf form of compact habit.

The irregular arrangement of the foliage, the pointed leaves of the terminal shoot, and the conspicuous stomatic lines on the upper surface of the leaves are distinguishing features of this species.

A. lasiocarpa is an alpine fir and the most widely distributed species in W.N. America. It ranges from Alaska to the San Francisco Mountains in N. Arizona, whilst the variety *arizonica* is found in Arizona, New Mexico, and S. Colorado. It was discovered by Douglas in 1832, but the date of introduction is uncertain. Although it has been known for 90 years, it has made little headway in cultivation and most of the trees we have met with are stunted and unhealthy in appearance.

Wood slow-growing, very light, soft, cream-coloured to light brown, straight-grained, easy to work, finishes well, and decays rapidly in contact with the earth. It is used locally for the indoor finish of houses, boxes, etc., but has little commercial value owing to much of the wood being knotty and there being better timbers available.

The species attains its largest dimensions at altitudes of 5,000–8,000 ft., but good trees are found up to an elevation of 10,000 ft. The best stands are stated to occur on north slopes in fairly deep, loose, and moist soil. In dry and poor soils it is usually small, and it does not succeed in clay. Seed is produced freely even by young trees, and heavy seed years occur triennially. Seedlings and young trees withstand shade well. It is probable that the most suitable conditions in Britain will be found in the Scottish Highlands and amongst the mountains of Wales and N. and Central England. A long winter's rest appears to be necessary for its well-being.

Sudworth, *The Spruce and Balsam-Fir Trees of the Rocky Mountain Region*, 27–30 (1916).

Abies Lowiana, A. Murray.

Low's White Fir.

Abies concolor, Sargent (in part); A. concolor, var. lasiocarpa, Engel. & Sarg. A. concolor, var. Lowiana, Lemmon; A. grandis, var. Lowiana, Masters; A. lasiocarpa, Masters [not Nuttall nor Murray]; A. Lowii, Annesley; A. Parsonsiana, Hort.; Picea Lowiana, Gordon; Pinus Lowiana, McNab. Low's Fir; Low's Silver Fir.

On the Californian Sierras this tree reaches 250 ft. in height with a girth of 18 ft., forming a narrow crown composed of flat sprays of foliage. *Bark* thin and blistered on young trees; very thick on old trunks and deeply fissured into scaly ridges; in cultivated specimens dividing into small, irregular plates. *Young shoots* olive or yellowish-green, minutely downy. *Winter buds* small, conical, blunt, resinous. *Leaves* horizontally arranged

Photo, by F. J. Wallis

PLATE VI. ABIES MAGNIFICA.

or curving upwards, those on the upper side of the shoot slightly shorter than those on the lower; greyish, glaucous or pale green in colour, up to 2½ in. long and about 1½ in. broad, strongly twisted at the base, flat, rounded, and slightly notched at the tip, furrowed on the upper surface with lines of stomata in the furrows; lower surface with two white bands of stomata; resin canals marginal. *Cones* resembling those of *A. concolor*, but in cultivated specimens they are chestnut brown and not purple, as is sometimes the case in *A. concolor*.

A. Lowiana is regarded by many American botanists as a variety of *A. concolor*, but the two trees are easily distinguished, in cultivation, as mentioned under the latter species. As a wild tree *A. Lowiana* is said to have shorter and paler green leaves than *A. concolor*,[1] but this is not noticeable in cultivation.

This species occurs as a native tree on the Siskiyou Mountains in S. Oregon, on Mount Shasta and the Sierra Nevada ranges in California. It was introduced by Wm. Lobb in 1851 and is often grown under the name of *A. lasiocarpa*.

Wood and uses similar to *A. concolor*, which see.

Under cultivation in Britain *A. Lowiana* forms a handsome tree of fairly rapid growth. The best results are obtained in the West of England, Wales, Ireland and in Scotland, the drier eastern counties being rather less favourable for its development. When planted in good soil, however, where soil and climatic conditions afford regular moisture, it may be expected to thrive. Fine specimens exist in many gardens. Generally, the conditions suitable for *A. concolor* meet the requirements of *A. Lowiana*. Seedling trees may show some degree of variation in habit and leafage.

A tree at Linton Park, near Maidstone, when measured by one of us in 1922, was over 100 ft. high.

Elwes and Henry, *loc. cit.* iv, 779 (1909).

Abies magnifica, A. Murray. (Fig. 20.)

Californian Red Fir.

Abies campylocarpa, A. Murray; Picea magnifica, Gordon; Pinus amabilis, Parlatore [in part]. Great Red Fir; Magnificent Fir; Red Fir; Red Bark Fir.

A tree attaining in America a height of 200 ft. and a girth of 12–25 ft., with a narrow, cone-shaped crown, composed of numerous horizontal tiers of branches which are very short and slender in proportion to the height and girth of trunk. *Bark* of young trees smooth; of old trees 2 in. or more thick and divided into ridges by deep fissures. *Young shoots* smooth, clothed with short, reddish-brown down. *Winter buds* more or less hidden

[1] Sudworth, *The Spruce and Balsam Fir Trees of the Rocky Mountain Region*, 34 (1916).

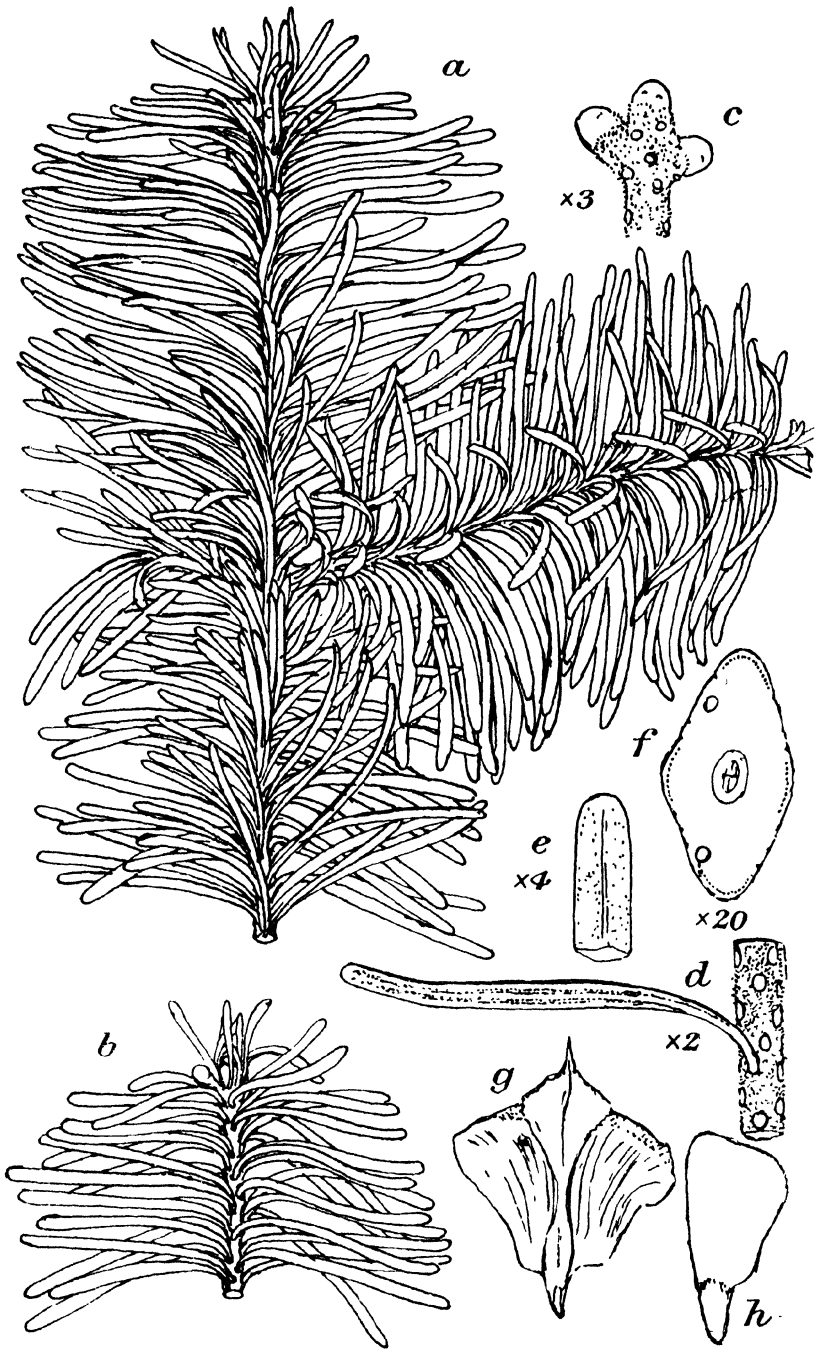

FIG. 20.—*ABIES MAGNIFICA.*

a, spray from above; *b*, from beneath; *c*, resinous winter buds; *d*, under-surface of leaf and shoot; *e*, upper surface of leaf-tip, showing stomata; *f*, leaf in section, showing marginal resin canals; *g*, cone-scale with long bract; *h*, seed.

by the leaves at the tips of the shoots, small, ovoid or globose, resinous at the tip, the outer scales elongated and free. *Leaves* on the lower side of the shoot arranged horizontally, spreading right and left, those on the upper side curving upwards, their bases pressed against the shoot; greyish or glaucous-green, up to 1¾ in. long and $\frac{1}{16}$ in. broad, obscurely four-sided, apex rounded and entire; upper surface with a central ridge and several rows of stomata; lower surface with two bands of stomata, resin canals marginal. *Cones* large, cylindrical, slightly tapering at the apex, 6–9 in. long, 3–5 in. wide, violet-purple when growing, brown when mature; *scales* downy, fan-shaped, 1¼–1½ in. broad, 1 in. long, claw nearly ½ in. long; bracts about ⅔ as long as the scale, with a small point at the apex. *Seed* about ½ in. long, with a wing little exceeding that length.

Var. **shastensis**, Lemmon.

SHASTA RED FIR.

Abies shastensis, Lemmon; A. nobilis, var. robusta, Masters.

A tree rarely exceeding 125 ft. high and 9 ft. in girth. *Bark* of young trees chalky-white; of old trees purplish-brown, 2–3 in. thick, deeply fissured into zigzag sections. *Winter buds* sharp-pointed, light chocolate-brown, non-resinous, about ¼ in. long. *Leaves* more or less curved, ¾–1¼ in. long, four-sided, those on the higher parts of the tree shorter and more distinctly angled than those lower down. *Cones* shorter than in *A. magnifica*, 4½–5½ in. long by 2½–3 in. in diameter. *Scale-bracts* longer in proportion than those of *A. magnifica*, protruding beyond the scales and reflexed. Pacific slope region. Rare in cultivation.

Sudworth, *The Spruce and Balsam Fir Trees of the Rocky Mountain Regions*, 38–42 (1916).

Var. **xanthocarpa**, Lemmon.

GOLDEN FIR.

A smaller tree than the type with cones 4–5 in. long, which are golden during the growing period. Probably not in cultivation. Found in the high sub-alpine regions of Mount Shasta and Mount Whitney.

A. magnifica is distinguished from all firs except *A. nobilis* by its narrow, conical habit, glaucous foliage, and peculiar curve of the leaves on the upper side of the shoot. From *A. nobilis* it may be known by the absence of a groove on the upper side of the leaves, which are thicker and less flattened than in the latter species. They are also less crowded on the shoot which is visible from above.

It is a native of the mountains of Oregon and California and is common (particularly as represented by vars. *shastensis* and

xanthocarpa) on Mount Shasta. In its northerly range it is most common at elevations of 6,000–8,000 ft., reaching in southerly localities an altitude of 10,000 ft. It extends along the entire length of the western slope of the Sierra Nevada at altitudes of 6,000–9,000 ft. The California red fir, which is one of the most ornamental species, was introduced in 1851 by John Jeffrey, who confused it with *A. amabilis*. It was afterwards distributed by Messrs. Veitch under the name of *Abies robusta*.

Wood light, soft, close-grained, rather weak, fairly durable for outdoor work, with light reddish-brown heartwood and rather lighter sapwood. One of the best of the fir woods. Used in America for bridge timbers, in general construction, and largely for various classes of joinery work. It is very useful for boxes and is much used for fuel. As the timber is obtainable in quantity in large sizes it will probably meet with an extended future demand in foreign markets.

A. magnifica is essentially a mountain tree, thriving in cool, moist valleys and on rolling mountain sides, as well as in deep ravines, preferring north and east exposures. It is also found in wind-swept places, but in such situations does not attain its best dimensions—exposure, poor soil, and dry conditions inducing stunted growth. Moist, well-drained, light or gravelly loams are said to produce the best trees in its native country. As a forest tree it withstands less shade than most of the firs, but forms pure stands, or the dominant tree in mixed stands where conditions are favourable. It is not a very good tree for general cultivation in Britain, and fine specimens free from disease are rare in the S. of England. It is better suited for the cool, moist valleys of Wales and Scotland than for the S. of England. In places where mild winters are experienced and periods of drought occur in summer, this fir is often seriously injured by *Chermes picea*, var. *bouveri*, an aphid which punctures the shoots and induces ugly, gouty swellings, the trees being eventually killed. Once a tree has been badly injured it cannot recover. Grafting is resorted to for the propagation of this species, but grafted trees are never satisfactory and it is better raised from seed.

Abies Mariesii, Masters.

MARIES' FIR.

A tree up to 80 ft. high and 6 ft. in girth in Japan. *Bark* pale grey or nearly white on old trees, becoming rough near the base of the trunk. *Branches* stout, rigid, spreading, forming an oval or flattened crown. *Young shoots* clothed with reddish brown or chocolate-coloured down. *Winter* buds small, globose, resinous. *Leaves* arranged as in *A. Nordmanniana*, on the lower side of the shoot, spreading horizontally right and left, those on the upper

side shorter, overlapping and directed forwards, more or less covering the shoot, flattened, gradually widening above, about ¾ in. long, 1½–1⅝ in. wide; apex rounded and notched, upper surface shining yellowish green, grooved; lower surface with two white bands of stomata; resin canals marginal. *Cones* about 4 in. long and 2 in. in diameter, deep blue before ripening, dark brown when mature, more or less elliptical with a blunt apex; *scales* fan-shaped, about 1 in. wide by ⅞ in. long; bract hidden by the scale. *Seed* with a wing about ⅞ in. long.

This species differs from *A. Veitchii* in its more downy shoots, leaves with a rounded apex and larger cones.

A. Mariesii is an alpine species found in the mountains of Central Japan. It is the only native species in Hondo, where it was discovered by Maries on Mount Hakkoda in 1878. It was introduced into cultivation about 1879. A tree at Tregrehan, Cornwall, is 30 ft. high.

This species has little commercial importance, for it is too scarce in Japan for any except local use. It is a very attractive plant under cultivation, but is rather fastidious in its requirements. The best results are obtained by planting it in rich, moist soil where atmospheric conditions are pure and on the moist side. It grows well on the rich, light soils of Hampshire and Surrey.

Wils. Conif. Taxads of Japan, 59. Clinton-Baker, *Illust. Conif.* ii, 18 (1909).

Abies nebrodensis, Mattei.

An extremely rare fir, of which apparently only one tree exists on Monte Cervo near the Valley of Pines in the region of Polizzo, Sicily. It is distinguished from *A. pectinata* by its glabrous shoots and non-pectinate needles, and from *A. cephalonica* (of which it has the resinous buds) by its short needles rounded at the apex with a minute point and less white below. The cones are described as being about a quarter the size of those of *A. pectinata* and cylindrical in form like those of *A. cephalonica*.

This fir, which seems to have been frequent in Sicily at the beginning of the eighteenth century, was already very scarce before 1750. A small branch obtained from the old tree on Monte Cervo in 1914 is preserved in the Kew Herbarium. Another tree formerly grew near a Capucin convent on the Hill of Pines near Polizzo, but no longer exists. Grafts obtained from the above tree through the instrumentality of M. Dode of Paris are being tried in French nurseries.

Bull. de Jard. Bot. de Palerme, vii. 64 (1908); Hickel, *Bull. Soc. Dendr. France*, 20 (1909).

Abies nephrolepis, Maximowicz.

Abies sibirica, var. nephrolepis, Trautvetter.

A Manchurian fir described by the Japanese botanist Maximowicz in 1866. It is closely allied to *A. Veitchii*, but is chiefly

distinguished by the leaves of the cone-bearing branches being sometimes acute and not notched, and by the smaller, broader cones with scales exceeding the bracts.

This tree, which occurs in Amurland, and is plentiful in the mountains of Corea, is imperfectly known, and large trees have not been seen in English gardens. The late Dr. Masters considered it to be a form of *A. Veitchii*.

Abies nobilis, Lindley. (Fig. 21.)

NOBLE FIR.

Picea nobilis, Loudon: Pinus nobilis, Douglas. Bracted Fir; Feathercone Fir; Noble Red Fir; Red Fir; Oregon Larch.

A tree attaining in America a maximum height of 250 ft. with a girth of 24 ft. *Bark* smooth at first, becoming reddish brown in old trees and deeply divided by broad flat ridges. Resinous blisters often occur on the trunks of cultivated specimens. *Young shoots* rusty brown and downy like those of *A. magnifica*. *Winter buds* more or less hidden by the leaves at the tips of the shoots, small, ovoid, globose, resinous at the tips, the outer scales elongated and free. *Leaves* more closely set on the branches than in *A. magnifica*, the middle ones completely concealing the upper side of the shoot, pressed against the shoot for a short distance at their base, then curving upwards; shorter than in *A. magnifica*, up to 1¼ in. long, more or less glaucous, flattened, rounded, and entire at the tip; upper surface grooved with stomata arranged in definite bands or irregular lines; lower surface with two narrow bands of stomata separated by a green ridge; resin canals marginal. *Cones* very large, cylindrical but narrowing slightly upwards, 6–10 in. long by 3–4 in. in diameter on cultivated trees, but only about half this size on wild specimens, purplish brown with green bracts when growing, the bracts becoming brown as the cone ripens; *scales* variable in shape, 1¼–1½ in. broad, 1 in. long, bracts protruding, curving backwards, and covering the greater part of the scale below. *Seed* about ½ in. long with a wing considerably longer.

Var. **glauca**, Beissner.

This differs from the type by its more glaucous foliage.

A. nobilis can only be confused with *A. magnifica*, from which it differs in habit and arrangement of leaves. The grooved upper surface of the leaves is a useful distinguishing character. The cones of *A. magnifica* are only likely to be mistaken for *A. nobilis* in the variety *shastensis*, which has exserted bracts.

A. nobilis forms large forests along the slopes of the Cascade Mountains of Washington and Oregon, with a vertical range of 2,500–5,000 ft. It also occurs on the coast ranges of Washington and the Siskiyou Mountains of California. This tree was dis-

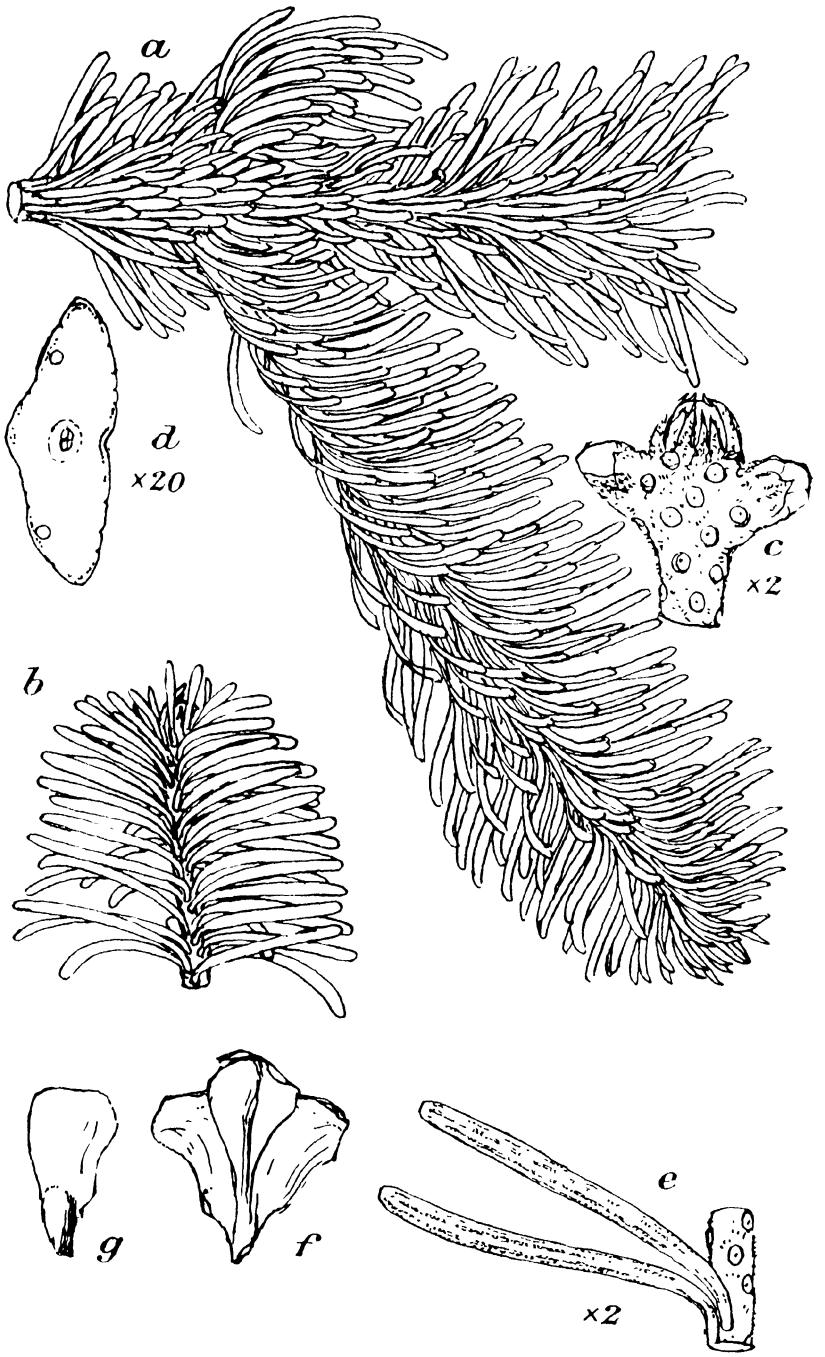

FIG. 21.—*ABIES NOBILIS.*

a, spray from above; *b*, from beneath; *c*, resinous winter buds; *d*, leaf in section, showing marginal resin canals; *e*, under-surface of leaves and shoot; *f*, cone-scale with long bract; *g*, seed.

covered by Douglas on the south side of the Columbia river in 1825 and was introduced by him in 1830.

The wood is light, moderately strong, hard, close-grained, light yellow or brownish, the sapwood rather lighter in colour than the heartwood. It is easy to work, finishes with a smooth, satiny surface and is one of the best of the American silver firs. Amongst other uses it is employed for the interior finish of houses, general carpentry and joinery, matchwood, and is a very excellent boxwood on account of its being free from odour. Planks and boards of large size free from blemishes are obtainable, and as the tree is plentiful, timber is available for export as well as for home use. Writing of this species, Hough [1] refers to a tree he measured as being 254 ft. high, the lowest branch 176 ft. from the ground; diameter of trunk 4 ft. from the ground, 63 in. The trunk was as clear and shapely as a mast, and from it eight logs 16 ft. long and one log 32 ft. long were cut. The upper end of the topmost log (160 ft. from the ground) was 35 in. in diameter and the nine logs were eventually cut into 18,142 board ft. of magnificent clear lumber.

A. nobilis has been extensively planted for ornamental purposes throughout the British Isles, and it has attained large dimensions in many gardens. It is not, however, a very satisfactory tree in the warmer parts of the country, for it is often badly injured by *Chermes picea*, var. *bouveri*, a conspicuous aphid that protects itself by a white wool-like excretion. This insect punctures young buds, causing the shoots to become seriously deformed by large gouty swellings which obliterate the terminal buds and eventually cause the death of the plant. In the early stages it is possible to check the disease by frequently spraying with a paraffin wash; but trees that have become seriously infected should be dug up and burnt. When not injured by this insect the tree is of a very attractive character, particularly when bearing its large, erect, purple cones. It gives the best results when planted in moist soil in mountain valleys, but it may also be expected to succeed elsewhere if it can be kept free from disease.

On the Ardverikie estate of Sir John Ramsden in Inverness-shire [2] *A. nobilis* is the most vigorous of the several kinds of conifers grown. It is free from disease and is likely to become one of the most useful forest trees of the neighbourhood. It has been planted extensively under forest conditions, and in 1910 we noted a large number of trees 20–40 ft. high growing at altitudes varying from 800–1,200 ft. The average annual rate of growth of trees growing at an elevation of 1,200 ft. for a period of thirty years was stated to have been 15 in. When purchasing trees care should be taken that they are free from insect pests.

[1] *American Woods*, ix, No. 225, pp. 52–54.

[2] *Kew Bull.* 1910, 243–246; Elwes and Henry, *loc. cit.* iv, 786 (1909); Clinton-Baker, *Illust. Conif.* ii, 19 (1909).

Photo by F. R. S. Balfour, Esq.

PLATE VII. *ABIES NOBILIS* AND *A. AMABILIS* AT FOOT OF NESQUALLY GLACIER, WASHINGTON.

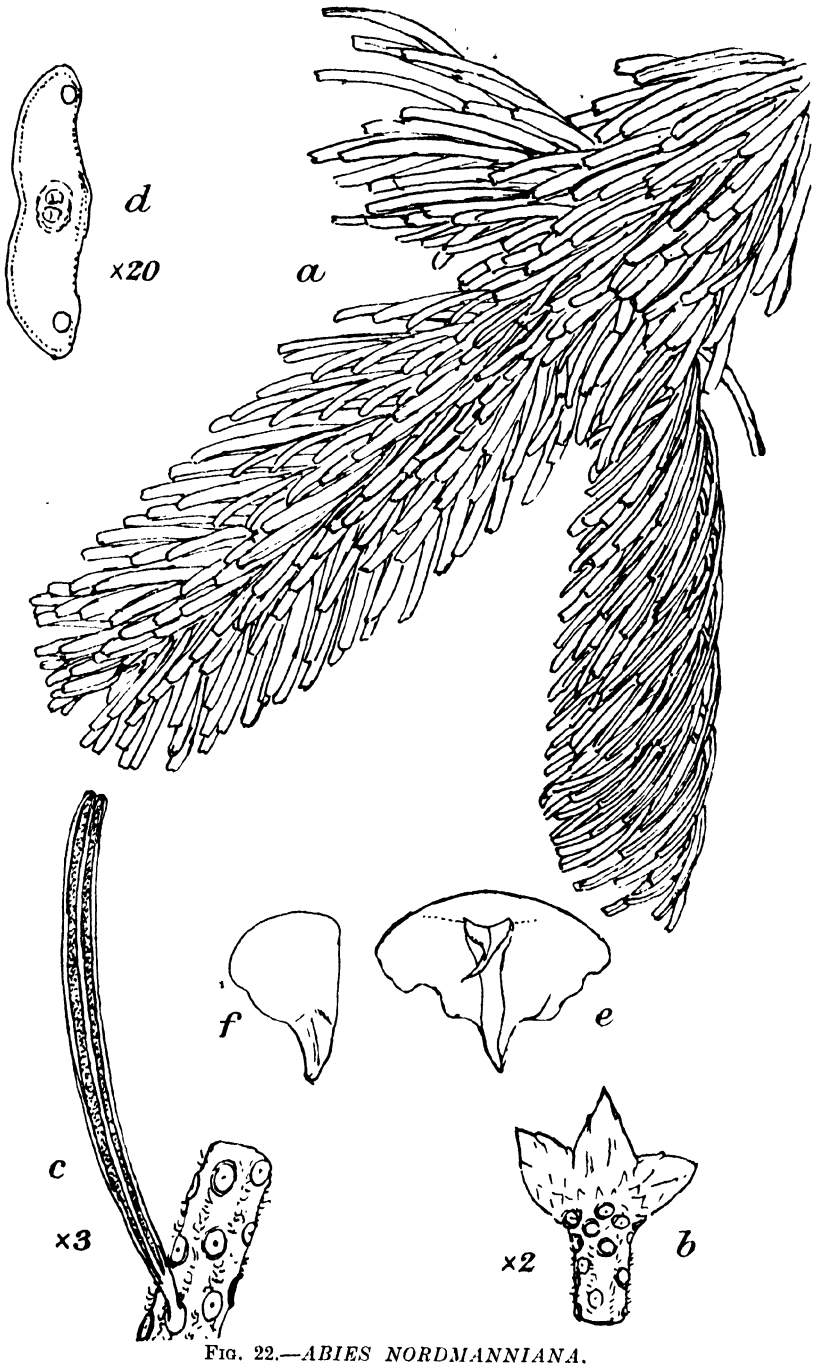

FIG. 22.—*ABIES NORDMANNIANA.*

a, spray from above; *b*, winter buds, not resinous; *c*, under surface of leaf and shoot; *d*, leaf in section showing marginal resin canals; *e*, cone-scale with bract; *f*, seed.

Abies Nordmanniana, Spach. (Fig. 22.)

CAUCASIAN FIR.

Picea Nordmanniana, Loudon; Pinus Abies, Parlatore; P. Nordmanniana, Steven. Crimean Fir; Nordmann's Fir.

A tree attaining a maximum height of 200 ft. and a girth of 15 ft. in its natural state. *Bark* of young trees smooth, thin, and greyish, on old trees rough and breaking up into scales like that of *A. pectinata*. *Young shoots* shining brown or grey-brown, with short, scattered hairs, denser on the lateral shoots. *Winter* buds non-resinous, ovoid, light brown, with ovate, acute, slightly keeled, closely pressed scales. *Leaves* on the lower side of the shoot in two lateral sets, horizontally arranged, spreading obliquely forward, those above shorter, directed forward, and densely covering the shoot; 1–1¼ in. long, $\frac{1}{12}$–$\frac{1}{16}$ in. wide, apex notched, upper surface bright shining-green, grooved; lower surface with two conspicuous white bands of stomata; resin canals marginal. *Cones* cylindrical, dark brown, about 6 in. long by 2 in. broad, covered with resin; *scales* broad, 1¼ in. wide by ¾ in. deep, bracts slightly protruding with the point reflexed. *Seed wing* about 1 in. long.

Var. equi-Trojani, Guinier and Maire.

Shoots reddish brown, without down, leaves short-pointed and only slightly notched. *Cones* with long protruding bracts which almost conceal the scales.

A. Nordmanniana is easy to distinguish from all the other firs except *A. amabilis*, which has duller green foliage emitting, when bruised, an odour like that of orange peel, and small resinous buds. It is a native of the mountains of the S. and S.E. shores of the Black Sea, and of the western spurs of the Caucasus, occurring at altitudes between 3,000–6,000 ft., sometimes forming pure forests. It appears to have been introduced into cultivation in 1848.

The timber resembles that of *A. pectinata* and can be used for similar purposes. It does not appear to be of more than local value.

A. Nordmanniana succeeds in the British Isles,[1] where it is commonly cultivated, but is very subject to attack by *Chermes nüsslinii*, and when once this pest becomes well established the tree quickly deteriorates, the leaves becoming flabby, yellowish, and falling prematurely. Affected plants should be sprayed several times with paraffin emulsion at intervals of a few days. This fir may be expected to give the best results when planted in cool, moist soil where the atmospheric conditions are on the moist side. The valleys of Wales and Scotland are more suitable

[1] A tree at Dawyck is over 100 ft. high, growing fast, and is free from *Chermes*.

than the warmer parts of England for this species. Propagation is by seeds. It has no value for forest planting in this country.

Elwes and Henry, *loc. cit.* iv, 746 (1909); *Bot. Mag.* t. 6992 (1888).

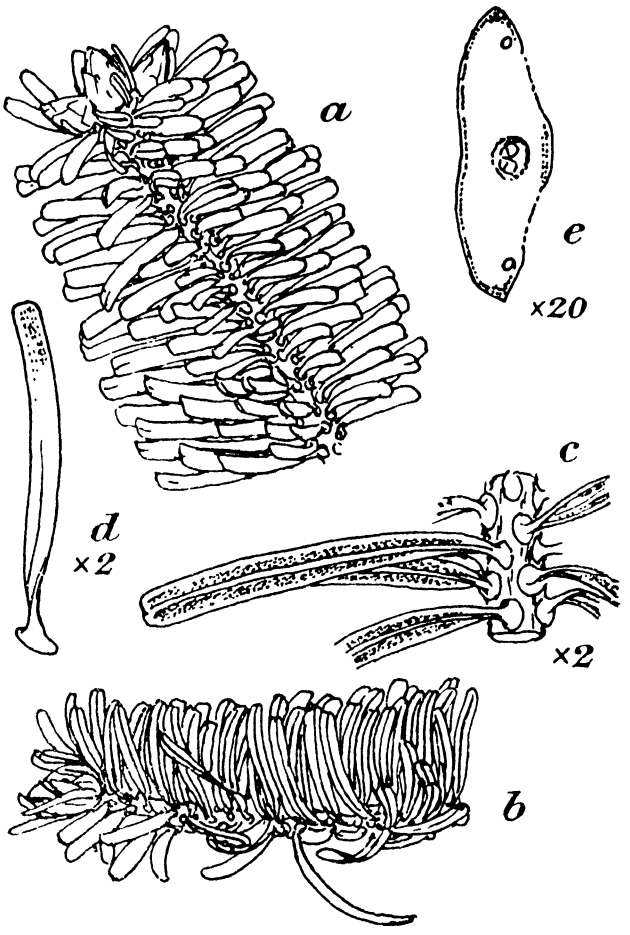

FIG. 23.—*ABIES NUMIDICA.*

a, upper side of spray, showing non-resinous winter-buds; *b*, side view of spray; *c*, under-surface of leaves and shoot; *d*, upper surface of leaf, showing stomata near the tip; *e*, leaf in section, showing marginal resin canals.

Abies numidica, De Lannoy.

ALGERIAN FIR. (Fig. 23.)

Abies Pinsapo, var. baborensis, Cosson; Picea numidica, R. Smith; Pinus Pinsapo, Parlatore [not Boissier].

A tree 70 ft. high and 8 ft. in girth. *Bark* grey and smooth on young trees, becoming scaly and fissured with age. *Young shoots* brown, without down. *Winter buds* large, ovoid, non-

resinous. *Leaves* on the lower side of the shoot horizontally arranged, spreading right and left, those above shorter, crowded, directed upwards, the middle leaves on strong shoots directed backwards and covering the upper side of the shoot; short and broad, ½–¾ in. long, by $_{1}^{1}$ in. broad, flattened, apex rounded, entire or notched, the upper surface dark, shining green with a few lines of stomata near the apex; the under-surface with two white bands of stomata; resin canals marginal. *Cones* cylindrical, brownish, about 5 in. long by 1½ in. broad; *scales* fan-shaped, 1¼ in. wide by ¾ in. high, or smaller in cultivated specimens; bracts concealed, one-quarter to one-half the length of the scales. *Seed-wing* about 1 in. long.

This fir may generally be recognized by its short, stout leaves, usually more or less vertically arranged on the upper side of the shoot, with broken lines of stomata on their upper surface. Forms of *A. brachyphylla* with non-pectinate leaves occasionally resemble it, but these may always be known by the absence of stomata on the upper side of the leaves, the median resin canals and resinous buds.

A. numidica occurs wild only in Algeria, where it occupies a small area towards the summit of Mount Babor in the Kabylie range, from 5,000–6,000 ft. altitude. It was discovered in 1861 by Captain de Guilleil and introduced into cultivation the following year.

The wood of this species is similar to that of *A. pectinata*, but it is of little commercial value outside its native country. The value of the tree in this country is purely for decorative purposes. It requires similar conditions to *A. Nordmanniana*, but is not so liable to insect injury as that species, although not immune.

Abies marocana, Trabut, described in *Bull. Soc. Bot. Fr.* liii, 154, t. 3 (1906), from a tree found by M. Joly in the mountains of Tetuan, Morocco, is said to be intermediate in foliage characters between *A. numidica* and *A. Pinsapo*, but we have seen no specimens.

Elwes and Henry, *loc. cit.* iv, 737 (1909).

Abies pectinata, De Candolle. (Fig 24.)

European Silver Fir.

Abies alba, Miller; A. argentea, De Chambray; A. candicans, Fischer; A. excelsa, Salisbury; A. metensis, Hor.; A. Picea, Lindley; A. taxifolia, Desfontaine; A. vulgaris, Poiret; Picea pectinata, Loudon; Pinus Abies, Duroi; P. pectinata, Lamarck; P. Picea, Linnæus.

Common Silver Fir; Silver Fir; Swiss Pine; White Deal in part.

A tree up to 150 ft. or more high and 20 ft. or more in girth. Trunk straight and tapering, often bare of branches for the greater part of its length, or, when isolated, heavy branches may be produced from all parts. *Bark* on young trees smooth,

greyish, ultimately breaking up into scales. *Young shoots* grey with scattered, short, erect hairs. *Winter buds* small, ovoid, non-resinous, composed of a few scales which are rounded at the apex. *Leaves* arranged in two opposite sets, the lower ones

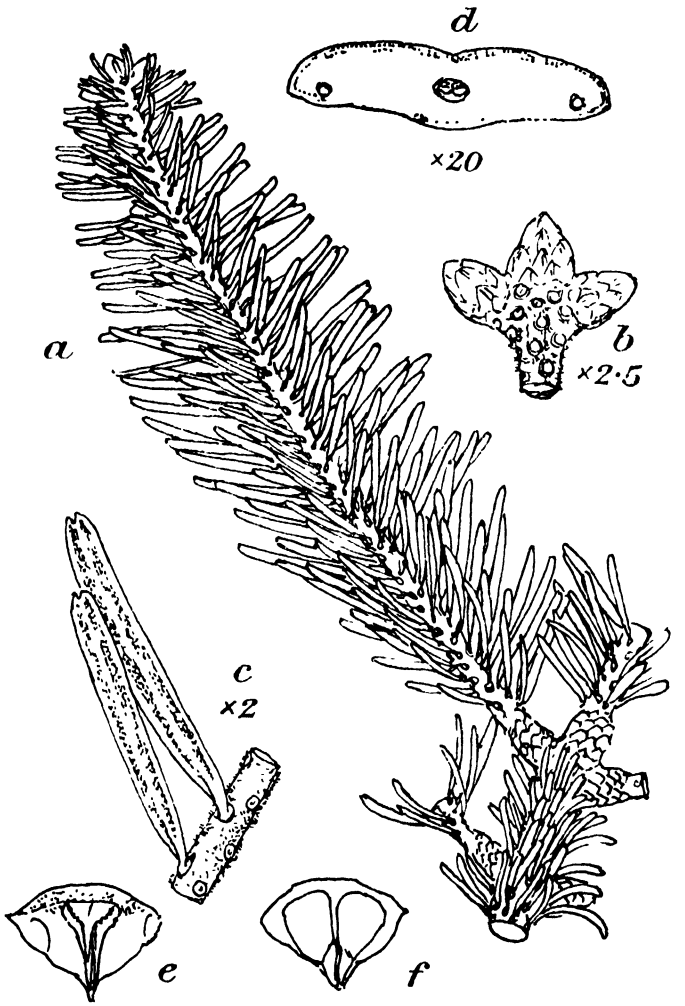

FIG. 24.—*ABIES PECTINATA*.

a, upper side of spray; *b*, non-resinous winter buds; *c*, under-surface of leaves and shoot; *d*, section of leaf, showing marginal resin canals; *e*, cone-scale with bract recurved at the tip; *f*, seed.

spreading horizontally, the upper ones often more or less erect on the branchlet and about half the length of the lower with a more or less distinct parting between them; $\frac{1}{2}$–1 in. long, $\frac{1}{12}$–$\frac{1}{10}$ in. broad, blunt and shallowly notched at the apex, dark shining green and grooved above with two white bands of stomata below; resin

canals marginal. *Leaves* on coning branches shorter, stiffer, and erect. *Cones* cylindrical, on short, stout stalks, slightly narrowed at each end, greenish when young, brown when mature; *scales* fan-shaped, bracts narrowly spoon-shaped, ending in a reflexed point. *Seed-wing* about 1 in. long.

The following varieties have been recorded:—

Var. **brevifolia.**

A dwarf form with short, broad leaves.

Var. **columnaris,** Carrière.

Very slender in habit, with numerous short branches all of equal length. Leaves shorter and broader than in the type.

Var **pendula,** Carrière.

Branches weeping. Recorded from the Vosges and East Friesland. There is a tree at Tregrehan, Cornwall.

Var. **pyramidalis,** Carrière.

Branches fastigiate, resembling those of a Lombardy poplar. France.

Var. **tortuosa.**

Dwarf in habit with twisted branches and bent, irregularly arranged leaves.

Var. **virgata.** Caspary.

Branches long, pendulous, giving off branchlets near their apices, densely clothed with leaves. Alsace and Bohemia.

The non-resinous buds and the comb-like arrangement of the leaves, showing a V-shaped depression between the two sets of leaves, usually suffices to distinguish the common silver fir. Occasionally it is difficult to separate from *A. Nordmanniana*, but if a sufficient number of branches are examined the characteristic leaf arrangement will generally be found.

A. pectinata is found wild in the mountains of Cent. and S. Europe, where it has an extensive but irregular distribution. In France, Germany, and Switzerland it often forms large forests, either pure or in which it is the dominant species. It extends South to Corsica and finds its maximum altitude at about 6,000 ft. in the Pyrenees. It appears to have been introduced to Britain about 1603.

The *wood* is light in weight, soft, not strong, white or yellowish white in colour, with the autumn wood well defined, making the annual rings very distinct. The timber of forest-grown trees is usually straight-grained, splits well, works easily, and finishes with a good surface. It lasts well indoors, but is not durable when

exposed to the weather or in contact with the soil. Amongst other purposes it is used for planks, boards, joists, etc., for the indoor finish of houses; for inferior kinds of joinery, sounding-boards for musical instruments, carving, wood wool, boxes, paper pulp, and, when treated with sulphate of copper or other preservatives, for telegraph and telephone poles. For special purposes slow-grown wood, by reason of its greater strength, is preferable to that of faster growth. The wood of the silver fir is employed to a far greater extent in Central Europe than in the British Isles. The timber produced by trees in open positions is very coarse and knotty. Strasburg turpentine, employed in varnishes, artists' colours, etc., is obtained from the bark-blisters and other parts of this tree. An essential oil of turpentine, obtained by distillation of the leaves and shoots, has been used in medical and veterinary practice for sprains and bruises.

The silver fir is an important forest tree in France, Switzerland, Germany, and Austria, whilst it is also used for forest planting in Britain. It attains its maximum size in the Jura Mountains, but there are excellent stands in many areas throughout its range. In some of the Swiss forests it attains a height of 120–140 ft., with a clean bole of 80–90 ft. of very equable girth. Good forests are carried to an elevation of 4,000 or more ft. in Switzerland. The rotation varies in different places from 90–140 years. For the British Isles a rotation of 90–100 years is likely to be satisfactory. The best timber trees are produced in dense stands that may be pure or mixed.

A. pectinata may be expected to endure a similar degree of cold to the common beech. It is spring-tender, for the young growths are liable to injury by late frosts. It should therefore be planted on north and east aspects rather than in warmer positions. A decided rest in winter is necessary, and for that reason it is not a good species for places where mild winters and cold springs are experienced. Moist climatic conditions are desirable and the best trees are grown in deep, moist, fertile soil. Loams and heavy loams which approach clay are more suitable than sandy loams and gravelly soils. Very dry soils and wet or sour peat are quite unsuitable. At Kew, where the soil is poor and dry, the atmospheric conditions on the dry side, and the air full of impurities, it is impossible to grow this tree, and young plants rarely survive for more than two or three years.

Natural regeneration is good in many parts of Cent. Europe, for the trees produce seed regularly every second or third year, from the time they are 65–70 years old. Although much of the seed is unfertile through imperfect fertilization or insect attacks, there is sufficient to ensure reproduction, and as the young trees endure dense shade few seedlings are lost. On account of its shade-bearing qualities it is frequently used for underplanting

thin woods of oak, Scots pine, spruce, and larch. Whether grown in pure or mixed woods it must be kept dense with an uninterrupted leaf canopy, otherwise large branches will develop low on the trunk and ruin the timber.

When seed is to be sown care must be taken that new seed is secured, for it does not retain its vitality from one year to the next. About 10,000 seeds are said to weigh one pound, and of this number about 40 per cent. are fertile.[1]

Numerous very fine specimens of *A. pectinata* are to be found in Britain, particularly on the Marquess of Bath's estate at Longleat. Some of these trees at 100 years of age were stated to be 130 ft. high and to contain from 300 to 400 cubic feet of timber. There are also several very large specimens at Alnwick Castle, at Roseneath, Dumbartonshire, and at Inveraray.

The silver fir is subject to attack by several fungus and insect pests. Schlich says the following fungi are harmful on the Continent: *Phytophthora omnivora*, *Pestalozzia Hartigii*, *Armillaria mellea*, and *Trametes radiciperda*. Of this number the two latter are sometimes harmful in the British Isles. A "cluster-cups" fungus (*Æcidium coruscans*) attacks the young shoots in some European countries. The shoots are turned a bright yellow colour by the fungus and in that state are eaten as a vegetable. A species of *Æcidium* causes abnormal growths in the form of "witches' brooms" to appear on the branches; they are sometimes followed by canker. In Switzerland and other Continental countries a mistletoe (*Loranthus europæus*, Linnæus), is parasitic on the silver fir, sometimes causing considerable injury to the trees.

The seeds are often attacked by the larvæ of a small fly, (*Megastigmus strobilobius*, Ratz), which ruin their vegetative properties. The worst insect pest in Britain, however, is *Chermes* (*Dreyfusia*) *nüsslinii*, Börn (see generic description). It kills thousands of plants annually. The timber is a favourite breeding-place of the wood wasps (*Sirex gigas*, Linnæus, and *S. juvenicus*, Linnæus), the larvæ of which tunnel into and seriously injure the timber.

Elwes and Henry, *loc. cit.* iv, 720 (1909); Woolsey, *Studies in French Forestry*, 83 (1920).

Abies Pindrow, Spach. (Fig. 25.)

West Himalayan Fir.

Abies Webbiana, var. Pindrow, Brandis; Picea Pindrow, Loudon; Pinus Pindrow, Royle. West Himalayan Low-level Silver Fir.

A tree attaining in the Himalaya a height of over 200 ft. and a girth of 26 ft. with a dense dark crown of foliage which often conceals the bole. *Bark* smooth and silvery, grey when young, deeply fissured when old. *Young shoots* smooth, grey,

[1] *Manual of Forestry*, ii, p. 355.

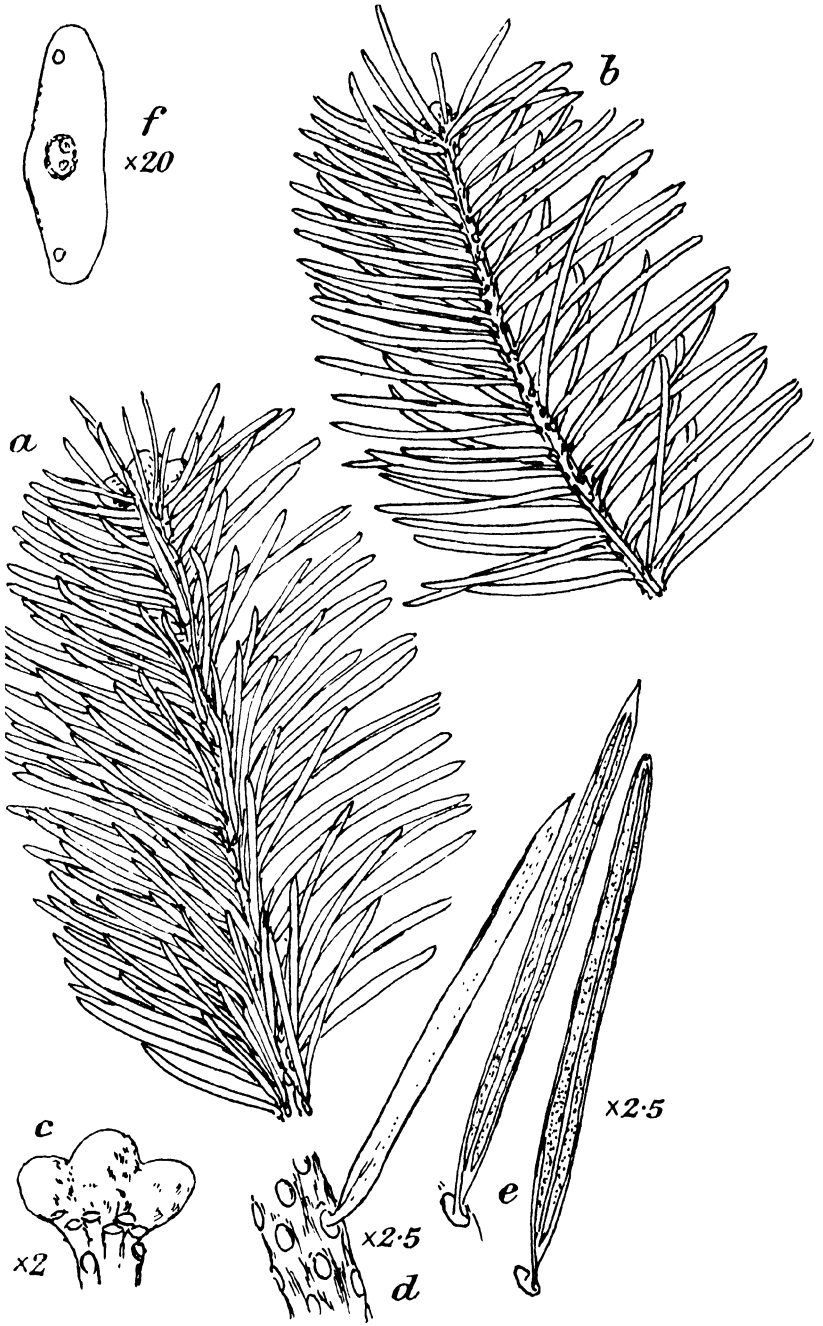

FIG. 25.—*ABIES PINDROW*, var. *BREVIFOLIA*. (A. Gambeli).

a, upper side of spray, *b*, under-side; *c*, resinous winter buds; *d*, shoot and leaf with stomata on upper surface; *e*, under-surface of two leaves, one with an acute, the other with a notched tip; *f*, section of leaf, showing marginal resin canals.

without down. *Leaves* on the lower side of the shoot arranged horizontally, spreading outwards and downwards, those of the upper side covering the shoot, the middle ones being much shorter and directed forwards and upwards; soft in texture, flattened, up to 2½ in. long, tapering to the apex, which ends in two horny points; upper surface dark shining green, grooved; lower surface pale green, with two greyish bands of stomata; resin canals marginal. Cones cylindrical, blunt, 4–7 in. long by 2–2½ in. wide, violet-purple, changing to dark brown when mature; *scales* fan-shaped, 1¼ in. wide by ¾ in. long; the bracts about one-third as long as the scales. *Seed-wing* about 1 in. long.

Var. **brevifolia**, (A. Gamblei). (Fig. 25.)
Leaves up to about 1½ in. long.

Var. **intermedia**, Henry.

This name has been given to a tree at Eastnor Castle which is apparently intermediate in character between *A. Pindrow* and *A. Webbiana*. It has shoots, buds, and bark like the former species, but the leaves are pectinate like those of *A. Webbiana* with median resin canals.

The large resinous buds and irregular arrangement of the bright green, shining foliage will suffice to identify this tree, which is also distinct in habit from *A. Webbiana*. *A. Pindrow* may also be known by its smooth bark and bright green leaves, which are not conspicuously white beneath.

A. Pindrow is widely distributed at elevations between 7,000–12,000 ft. throughout the western Himalaya from Afghanistan to Nepal. It is usually found at lower elevations than *A. Webbiana*, and is associated with *Picea Morinda* and other conifers, forming dense forests on all the great spurs of Kumaon. About 1837 cones were received by the Royal Horticultural Society from Dr. Royle, and from the seeds of these cones the first plants were raised in the British Isles.

Wood white, straight-grained, easy to work, not durable in contact with the soil, without odour. It is used for building purposes, general carpentry, box-making, shingles, matchwood, and is said to be suitable for paper pulp. Difficulties of extraction and the long distance from seaports preclude it from the export trade.

A. Pindrow is found at its best under natural conditions in cool, moist valleys and on gentle northerly slopes where the soil is deep and rich. In such places, and even where the conditions are less favourable, it forms dense stands and reproduces well. Young trees withstand shade well, but do not grow rapidly. In the Himalaya it is subjected to considerable cold, and in some

parts is surrounded by deep snow for several months of the year. Its moisture-loving nature may be appreciated from the fact that within its range the annual precipitation is from 45–100 in. The sylvicultural requirements of the species are well described by Troup.[1] It is not common in collections in the British Isles, and is usually seen at its best in the milder parts of England and Wales, where climatic and soil conditions are moist and soil of good quality.[2] Deep, rather light loam and the disintegrated granite of Cornwall suit it admirably.

Abies Pinsapo, Boissier. (Fig. 26.)

SPANISH FIR.

Abies hispanica, De Chambray; Picea Pinsapo, Loudon; Pinus Pinsapo, Antoine.

A tree up to 100 ft. high and 15 ft. in girth. *Bark* smooth at first, becoming rugged and fissured on old trees. *Young* shoots reddish brown, without down, furrowed. *Winter buds* ovoid, obtuse, resinous, with the scales projecting at the apex. *Leaves* spreading all round the shoot, straight or slightly curved, flattened and rigid, $\frac{1}{2}$–$\frac{3}{4}$ in. long, apex short-pointed or blunt, entire; upper surface convex, not furrowed, with numerous lines of stomata; lower surface with two distinct bands of stomata; resin canals median. *Cones* cylindrical, tapering to the apex, 4–5 in. long, up to $1\frac{3}{4}$ in. diameter in wild specimens, smaller on cultivated trees; *scales* triangular, cuneate; bracts concealed by the scales, ovate, pointed. *Seed-wing* up to $1\frac{1}{4}$ in. long.

Var. **glauca**, Beissner.

Foliage of a rich glaucous hue.

Var. **pendula**, Beissner.

Habit narrowly pyramidal, branches pendulous.

An easily recognized species distinguished from all the other firs except *A. cephalonica* by its short, blunt, rigid, widely spreading leaves. The latter species resembles it in leaf arrangement, but the leaves are longer, sharply pointed, and have marginal resin canals.

A. Pinsapo is indigenous only in the mountainous region round Ronda in S. Spain, where it is found in three main forests in localities at considerable distances apart. It was first found by Edmond Boissier and introduced into England in 1839 by Captain Widdrington.

The wood does not appear to possess any commercial value outside its native country. It is not plentiful enough for export and its inaccessibility makes it of little more than local use.

[1] Troup, *Silviculture of Indian Trees*, iii. 1133–1142 (1921).

[2] Mr. F. R. S. Balfour states that it is perfectly hardy at Dawyck and at most places in Scotland.

The Spanish fir grows well in the British Isles even on chalk, and there are many fine specimens, particularly in S.England. It succeeds in moist soil and retains its lower branches until late in life, when grown as an isolated specimen. The glaucous-leaved variety

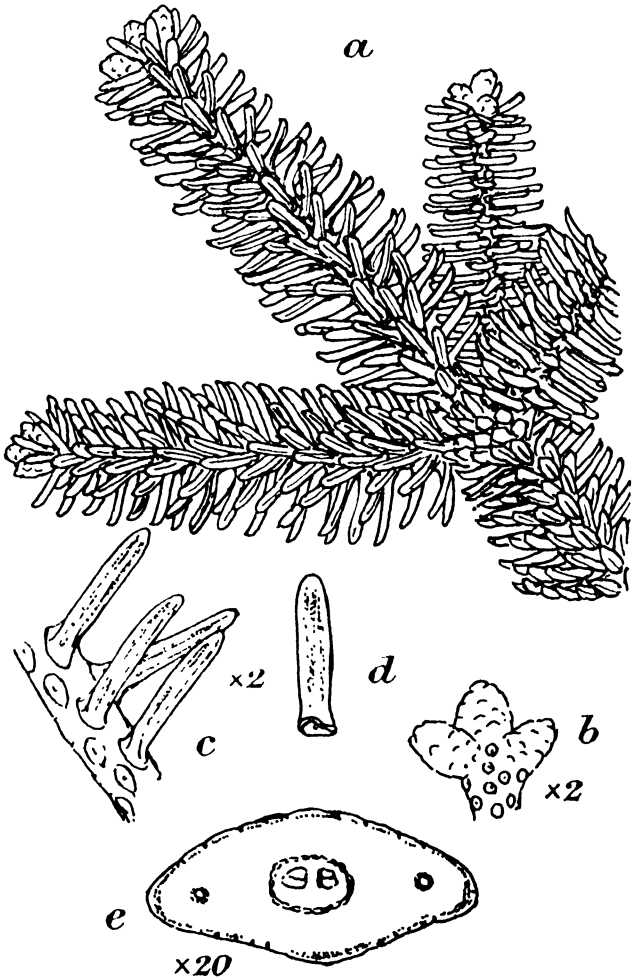

FIG. 26.—*ABIES PINSAPO.*

a, spray; *b*, resinous winter buds; *c*, leaves and shoot; *d*, anterior face of leaf; *e*, section of leaf, showing median resin canals.

forms a handsome lawn specimen. As it is found at high elevations in Spain it is much hardier than its southerly latitude suggests, and it succeeds in Denmark and in S. Norway and Sweden.[1] Badly developed plants in this country have frequently been due to grafting.

Elwes and Henry, *loc. cit.* iv, 732 (1909).

[1] *Pinetum Danicum* (*Journ. Roy. Hort. Soc.* xiv. 476 (1892)).

Abies recurvata, Masters.

A tree 60–120 ft. high in China, with a trunk 6–15 ft. in girth, pyramidal in habit, becoming flat-headed with age or in exposed places. *Bark* roughish, dark grey to reddish brown. *Young shoots* yellowish grey, without down, shining. *Winter buds* ovoid, resinous. *Leaves* strongly recurved, shining green on both sides or glaucous beneath, ½–1 in. long, sharp-pointed on young trees. *Cones* produced in clusters, oblong-ovoid, 2–3½ in. long, tapering abruptly below, smooth, with the bracts completely hidden, violet-purple before ripening, when they become grey-brown.

Native of W. Szechuen, where it is abundant on the mountains near the Min River, forming extensive forests.

Young plants in cultivation are easily recognized by their strongly recurved, sharply pointed leaves.

Journ. Linn. Soc. xxxvii, 423 (1906); *Pl. Wils.* ii, 44 (1914).

Abies religiosa, Lindley.

SACRED FIR.

Abies glauca, Roezl; A. glaucescens, Roezl; A. hirtella, Lindley; A. Lindleyana, Roezl; A. Tlapalcatuda, Roezl; Picea religiosa, Loudon; Pinus religiosa, Humboldt.

This is a Central American species attaining a height of 150 ft. and a girth of 15 ft. *Bark* greyish-white, rough, speedily becoming scaly like that of a spruce. *Young shoots* furrowed, brown on the upper side, olive-green on the lower side during the first year, brown all round later, covered with a minute down. *Winter buds* cylindrical, rounded at the apex, resinous. *Leaves* arranged as in *A. Nordmanniana* but rather thinly set and much fewer on the upper side than in that species, pointing forwards and upwards, longer on the lower side of the shoot and horizontally arranged; 1–1½ in. long, gradually narrowing to a blunt apex; upper surface dark shining green, lower surface with two greyish bands of stomata; resin canals marginal. *Cones* 4 in. long and 2 in. wide, conical, tapering from the base upwards; blue when young, changing to brown when mature; *scales* broadly fan-shaped, nearly 1¼ in. wide by ⅝ in. long; bracts chestnut-brown, exceeding the length of the scales, terminated by long reflexed scales.

A. religiosa occurs wild throughout the mountains of Central and S. Mexico and N. Guatemala at altitudes ranging from 4,000–10,000 ft. It was discovered by Humboldt in 1799 and was introduced by Hartweg in 1838.

The wood is scarcely known in Europe. Small sections cut from ornamental trees suggest that it may be classed with medium to good grades of silver fir. It is pale yellow in colour,

rather coarse-grained, and is easy to work. In Mexico and Guatemala it appears to be used for general carpentry. In Mexico the branches are used extensively for decorating places of worship at the times of religious festivals, hence the specific and common names.

It is a tender species and will only grow in the milder parts of the country. Very few well developed trees are known, one of the best being in Lord Falmouth's garden at Tregothnan near Truro. There is also a good tree at Fota, Ireland, which in March, 1922, was 90 ft. high and 7 ft. 3 in. in girth. This fir should only be planted in good damp soil in places where a mild temperature and moist climatic conditions prevail.

Elwes and Henry, *loc. cit.* iv, 808 (1909).

Abies sachalinensis, Masters.

Abies Akatodo, Miyabe ; A. Veitchii var. sachalinensis, Schmidt. Todomatsu.

A tree attaining a height of 100–130 ft. and a girth of 6–9 ft. *Bark* smooth, whitish, with numerous resin blisters. *Branches* short and slender. *Young shoots* grey or slate-coloured with prominent hairy furrows. *Leaves* arranged like those of *A. Veitchii*, but longer and narrower, $1\frac{3}{4}$ in. long by $\frac{1}{20}$ in. broad, apex rounded and slightly notched ; upper surface grass-green ; lower surface with two inconspicuous bands of stomata each of 7–8 lines ; resin canals median. *Cones* cylindrical, $3\frac{1}{2}$ in. long and $1\frac{1}{2}$ in. wide, with large reflexed bracts which nearly conceal the scales ; *scales* thin, fan-shaped, $\frac{1}{2}$–$\frac{5}{8}$ in. wide and about $\frac{1}{4}$ in. long. *Seed-wing* $\frac{3}{8}$ in. long.

Var. nemorensis, Mayr.

Abies nemorensis, Miyabe and Miyake.

Cones smaller, about $2\frac{1}{2}$ in. long, resembling those of *A. Veitchii*, with the bracts concealed.

Recorded from Hokkaido and the Kurile Islands. Seen in Saghalien by Wilson.

This species closely resembles *A. Veitchii* in the arrangement of the foliage, but the individual leaves are much more slender and the shoots are slate-coloured. The cones are also larger, with reflexed bracts. It is chiefly distinguished from *A. sibirica* by its furrowed shoots.

A. sachalinensis is found wild in the Kurile Islands and the Island of Saghalien, and is abundant in Hokkaido, the northern island of Japan, where it forms pure forests. Introduced by Maries in 1879, the Saghalien fir has not done well in cultivation, being too susceptible to spring frosts. It is probable that it requires a more decided rest in winter than is possible in Britain.

Photo. by E. J. Wallis.

PLATE VIII. WELLINGTONIA (*SEQUOIA GIGANTEA*) AT WOBURN.

The wood is used in its native country for lumber to some extent, but its principal use is for paper pulp.

As indicated above, it has little value in the British Isles as an ornamental tree; there is, however, a fine tree at Fota which in March, 1922, was 50 ft. high and 2 ft. 10 in. in girth.

Abies sibirica, Ledebour.

SIBERIAN FIR.

Abies heterophylla, C. Koch; A. Pichta, Forbes; A. Semenonii, Fedtschenko; Picea Pichta, Loudon; Pinus Pichta, Endlicher; Pinus sibirica, Turczaninow.

A tree rarely more than 100 ft. high, with a slender trunk. *Bark* smooth, grey, with numerous resin blisters. *Young shoots* silvery grey, with a scattered minute down. *Winter buds* small, globose, resinous, *Leaves* arranged like those of *A. Veitchii* but more irregular, those on the upper side of the shoot pointing forwards, those on the lower side of the shoot horizontal, and longer than those on the upper side; slender like those of *A. sachalinensis*, about $1\frac{1}{2}$ in. long, $\frac{1}{20}$ in. wide, apex rounded; upper surface grass-green, shining, grooved, occasionally with two or three short lines of stomata near the apex; lower surface with two narrow greyish bands of stomata each of 4–5 lines; resin canals median. *Cones* cylindrical, 2–3 in. long by $1\frac{1}{4}$ in. in diameter, bluish when growing, brown when mature, with the bracts concealed; *scales* fan-shaped, $\frac{5}{8}$–$\frac{3}{4}$ in. wide, $\frac{1}{2}$ in. long; *bracts* $\frac{1}{16}$ in. broad with a short point. *Seed-wing* about $\frac{5}{8}$ in. long.

A. sibirica forms vast forests in N. and E. Russia, Siberia, the Altai Mountains, and Turkestan, whilst a form was discovered by Purdom in Shensi. It is the most widely distributed of all the silver firs. According to Loudon it was introduced into cultivation in 1820, but it has never thriven and hardly any trees are recorded in Britain. It is more suitable for the colder than for the warmer parts of the country.

The best quality timber is suitable for the same purposes as the wood of *A. pectinata*, but it is probable that a great deal will be turned into pulp at a later period.

Elwes and Henry, *loc. cit.* iv, 758 (1909).

Abies squamata, Masters.

A tree 50–120 ft. high in China, with shaggy, purplish-brown bark which exfoliates in thin papery layers like that of a birch. *Young shoots* blackish, hairy. *Leaves* dense, relatively short and broad, $\frac{1}{2}$–1 in. long, curved, pointed or blunt at the apex; resin canals median. *Cones* oblong-ovoid, violet in colour, bracts exserted with recurved points which speedily break off.

Young plants in cultivation have stout, conspicuously bright

red, glabrous shoots, resinous buds, and crowded, stiff, widely spreading, sharply pointed leaves, with marginal resin canals.

It is an alpine tree attaining a higher altitude than any other fir and forming forests in W. Szechuen at 12,000–14,000 ft.

Gard. Chron. May 12, 1906, p. 299; *Pl. Wils.* ii, 48 (1914).

Abies sutchuenensis, Rehder and Wilson.[1]

Abies Fargesii, var. sutchuenensis, Franchet.[2]

A species based on a plant collected by Purdom on the banks of Tow River, Western Kansu, and said to be characterized by its shining red or purplish-brown glabrous branchlets, medium-sized, symmetrical, scarcely resinous, violet-black cones, with shortly cuspidate obovate-cuneate bracts and by its ascending, stout, relatively short and broad leaves with a distinct yellowish petiole and median resin canals. It is said to be distinguished from A. *Faxoniana* by its glabrous shoots and scarcely resinous cones with non-exserted bracts. We have not seen specimens. Young plants cultivated under this name at Messrs Hilliers' nursery, Winchester, and elsewhere, have the shoots dark purplish brown on the lower side. *Leaves* ascending, with a V-shaped parting, dark green and grooved above, with two conspicuous white bands on the lower surface, tapering to a bifid apex; resin canals marginal.

Franchet's variety *sutchuenensis*, based on a specimen from Chengkou Ting, is said to be distinguished from *A. Fargesi* by its leaves, which are obtuse, notched or acute on the same branch, and marked with white below.

Abies Veitchii, Lindley. (Fig 27.)

VEITCH'S SILVER FIR.

Abies Eichleri, Lauche; Picea Veitchii, Murray; Pinus selenolepis, Parlatore. Shirabe.

A fir 60–70 or more ft. high in the Japanese forests, where it is generally of narrow, tapering, pyramidal habit, with a slender trunk and short, slender branches. *Bark* smooth, pale grey or white with prominent resin blisters. *Young shoots* brown, more or less clothed with short down. *Winter buds* small, sub-globose, purplish, resinous. *Leaves* arranged very like those of *A. Nordmanniana*, but softer to the touch; those on the lower side of the shoot horizontal and spreading at right-angles to the shoot, those on the upper side shorter and pointing forwards but not pressed to the stem so much as in *A. Nordmanniana*; ½–1 in. long and about $\frac{1}{16}$ in. wide, flattened, gradually tapering to the base, apex truncate, notched; upper surface dark green, shining, grooved; lower surface with two conspicuously white broad bands of stomata; resin canals median. *Cones* cylindrical, 3 in. long,

[1] *Pl. Wils.* ii, 48 (1914). [2] *Journ. de Bot.* xiii, 256 (1899).

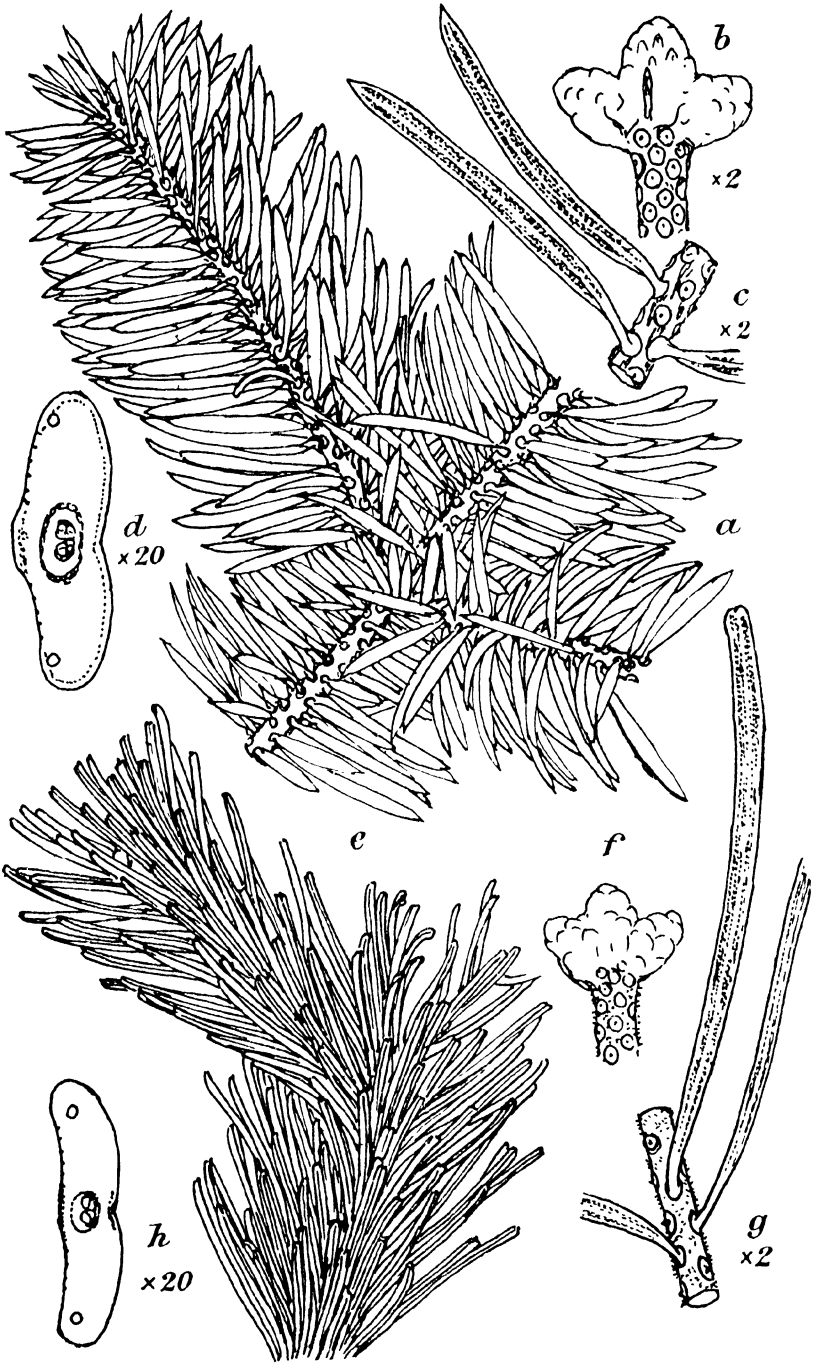

FIG. 27.—*ABIES CEPHALONICA AND A. VEITCHII.*

Abies cephalonica—*a*, shoot; *b*, winter bud; *c*, under-side of shoot and leaves; *d*, section of leaf, showing marginal resin canals. *A. Veitchii*.—*e*, shoot; *f*, winter buds; *g*, under-side of shoot and leaves; *h*, section of leaf, showing median resin canals.

bluish-purple when growing, brown when ripe; *scales* small, $\frac{5}{8}$ in. wide and $\frac{3}{8}$ in. long; *bracts* as long as the scales, slightly protruding and reflexed. *Seed* with a wing $\frac{5}{8}$ in. long.

Var. **nikkoensis**, Mayr.

This is said to differ from the type in its smaller cones (2 in. long) with the points of the bracts projecting only slightly between the scales.

Var. **olivacea**, Shirasawa.

Cones green when young, becoming grey-brown when mature. According to Wilson it grows with the typical form in Japan. Small plants are in cultivation at Kew.

A. Veitchii may be easily recognized by its small, resinous, purplish buds, truncate leaves very white beneath, and median resin canals. The characters by which it is known from *A. Mariesii* are mentioned under that species.

It is a native of the mountains of Central Japan, at elevations of 3,000–6,000 ft., and is the smallest of the Japanese firs. It was discovered on Mount Fuji-yama by John Gould Veitch in 1861, but was not, however, introduced into England until 1879, when Maries sent seeds to Messrs. Veitch.

The timber is not known in European markets and does not appear to be regarded as important in Japan, where the wood is largely used for pulp for the manufacture of paper.[1]

A. Veitchii thrives in the British Isles, where, in rich, moist soil in a pure atmosphere, it forms a slender, graceful, pyramidal tree with attractive foliage.

Abies Vilmorini, Masters.

Abies cephalonica x Pinsapo.

An artificial hybrid raised in 1868 at Verrières near Paris by M. de Vilmorin from a tree of *A. Pinsapo*, which he pollinated from a tree of *A. cephalonica*. Only one fertile seed was obtained, from which a seedling was raised and planted out the following year. In 1905 this had become a tree 50 ft. high by 5 ft. in girth and had three main stems, one of which was subsequently broken in a storm. The tree resembles *A. Pinsapo* in its foliage except that the leaves are longer and less rigid and bear stomata on their lower surface only. Their radial arrangement is imperfect. The cones, which are produced in abundance, have longer bracts than *A. Pinsapo*. The seeds, which resemble those of *A. cephalonica*, are fertile, and a number of seedlings have been raised. Young plants of *A. Vilmorini* from the original tree are occasionally met with in English collections.

Masters, *Journ. Royal Hort. Soc.* xxvi, 109 (1901); *Hortus Vilmorinianus*, 69, plate xii (1906).

[1] *Forestry of Japan*, 77 (1910), Bureau of Forestry, Tokyo, Japan.

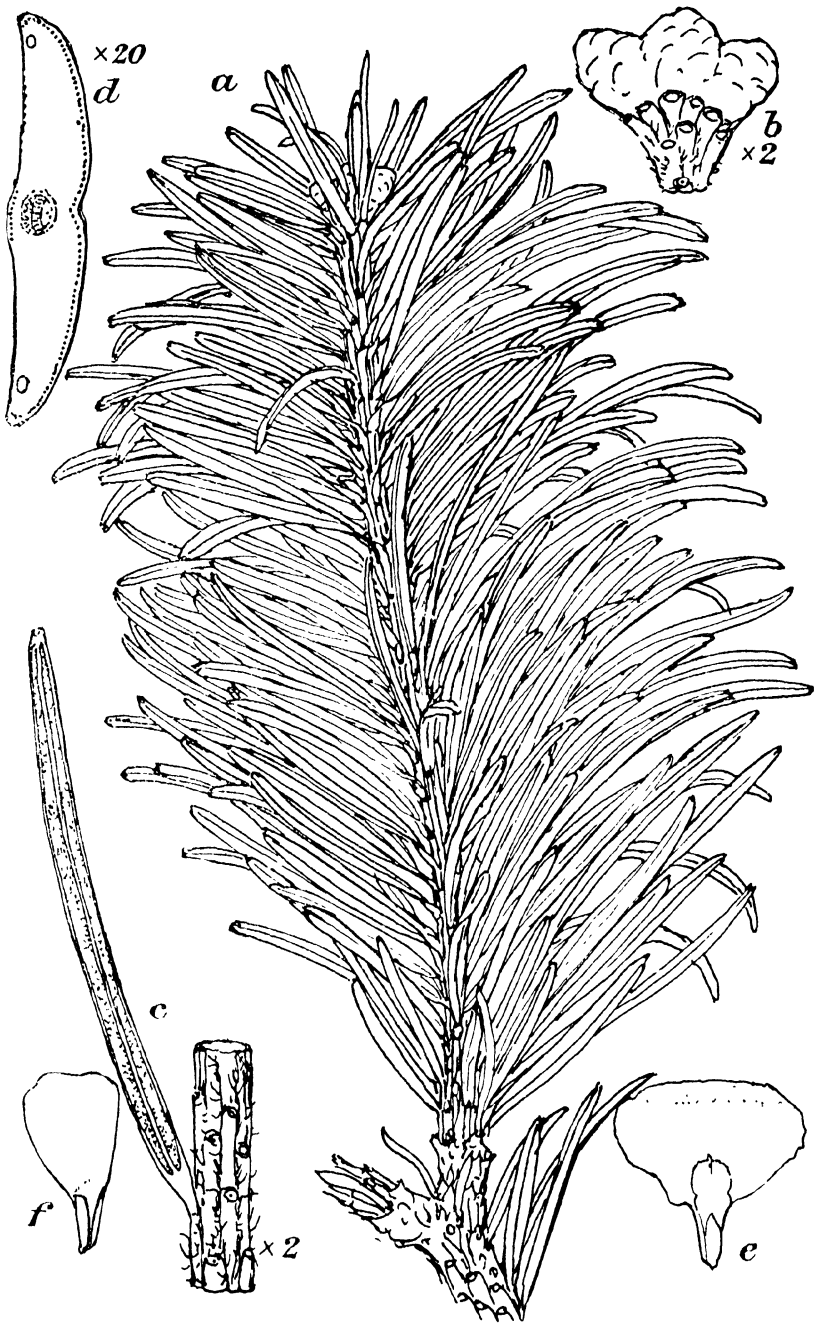

FIG. 28.—*ABIES WEBBIANA.*

a, spray ; *b*, resinous winter buds ; *c*, under-side of leaf and shoot ; *d*, section of leaf, showing marginal resin canals ; *e*, cone-scale with minute bract ; *f*, seed.

Abies Webbiana, Lindley. (Fig. 28.)

WEBB'S HIMALAYAN FIR.

Abies chiloensis, Hort.; A. chilrowensis, Hort.; A. densa, Griffiths; Picea Webbiana, Loudon; Pinus Webbiana, Wallich. East Himalayan Fir; West Himalayan High-level Silver Fir.

A tree attaining in the E. Himalaya a height of 150–200 ft. and a girth of 20–30 ft., but much smaller in the W. Himalaya, with thick, spreading branches forming a more or less flattened head. *Bark* greyish-brown, rough, fissured and scaling on old trees. *Young shoots* stout, reddish-brown, deeply grooved, hairy in the furrows. *Winter buds* large, rounded, covered with resin which conceals the scales. *Leaves* arranged in two lateral sets spreading right and left, each set of several ranks, the lower ranks with leaves spreading horizontally, the upper ranks with leaves becoming gradually shorter, directed outwards and upwards, forming a V-shaped depression with the branchlet visible between them, very variable in size, on the western trees often ½–1 in. long, on the eastern trees up to 2½ in. long and $\frac{1}{10}$ in. wide, flattened, rounded and notched at the apex; upper surface dark green, grooved; lower surface with two broad, conspicuous white bands of stomata; resin canals marginal. *Cones* resembling those of *A. Pindrow* in shape and colour, often 6–8 in. long on cultivated specimens but smaller on native trees; *scales* fan-shaped, suddenly contracted to a short claw; bracts broad above, narrow below, pointed, nearly as long as the scale. *Seed* with a wing one and a half times its length.

Var. **brevifolia**, Henry.

Abies spectabilis, var. brevifolia, Rehder.

Bark smooth, *young shoots* grey with less prominent furrows and shorter down. *Leaves* only about 1¼ in. long, greyish beneath, the stomatic bands inconspicuous. A very distinct variety, which probably represents the Western Himalayan form. Several trees which appear to be hardier than the type are in cultivation in England.

A. Webbiana occurs in the inner Himalaya from Afghanistan to Bhutan at elevations of 8,000–13,000 ft. It is found at higher altitudes than *A. Pindrow*, which in the N.W. Himalaya ceases to grow at 1,000–2,000 ft. below the line where *A. Webbiana* appears. Above 10,500 ft. elevation it often forms large pure forests, at lower elevations it is mixed with spruce and other trees. Seeds of this fir were received in England from India early in the nineteenth century, but no young trees appear to have been

raised until 1822. Unfortunately, this handsome fir is not quite hardy and only succeeds in the milder parts of the country.

The differences between this species and *A. Pindrow* are indicated under the latter species, which by some botanists is united with *A. Webbiana*, but the two trees are quite distinct.

The uses of the timber are identical with those of *P. Pindrow*, which see. In some parts the wood is used extensively for tea boxes, and in Museum No. 3, at Kew, there is a sample of cone scales which are stated to be used as a dye.

In the British Isles the tree is even more tender than *P. Pindrow*, although it is usually found at a higher elevation, and it is only successful in the warmer parts of the country. It is probable that seeds have only been received from trees growing at the lower elevations in the Himalaya, and that if they were obtained from trees growing at a high altitude we should have much hardier plants.

Troup, *Silviculture of Indian Trees*, iii, 1142 (1921).

ACTINOSTROBUS, Miquel.

Two species of evergreen shrubs, allied to *Callitris*, but differing in the shape of the cone-scales and by the cones being surrounded at the base by closely pressed bracts. *Leaves* alternately three-ranked, needle-like, and $\frac{1}{4}$–$\frac{1}{2}$ in. long on juvenile plants, scale-like, and about $\frac{1}{8}$ in. long on older plants. *Male and female* flowers on the same bush; the former oblong, with the stamens in whorls of 3–6 vertical columns. *Cones* globose or ovoid; *scales* 6, woody, equal in size, surrounding a central axis, each with 1–2 triangular, three-winged seeds at the base; the base of the cone surrounded by their closely pressed bracts.

Natives of W. Australia.

Neither species is of any economic value. Cultivation in Britain, except in the mildest parts, is restricted to greenhouses. Cuttings of young shoots may be rooted in sandy soil in a close frame, as in *Cupressus*.

Actinostrobus acuminatus, Parlatore.

A smaller shrub than *A. pyramidalis*, with finer branchlets and smaller leaves. The specific difference is based on the stamens, which have a dorsal ridge and acuminate point, and on the cone, which has the top contracted into a neck, each valve terminating in a short spreading point. Under cultivation the two plants show little difference.

Between Moore and Murchison Rivers.

Actinostrobus pyramidalis, Miquel.

Callitris Actinostrobus, F. v. Mueller.

A bush 4–8 ft. high, with erect, closely arranged branches divided into fine sprays. *Shoots* without down. *Leaves* scale-like, closely pressed at the base, free at the apex. *Cones* ovoid, about ½ in. in diameter at the base and the same in height; *scales* 6, triangular, pointed.

Found at King George's Sound, Baxter to Swan River, and Murchison River, often inhabiting salt, sandy plains.

Baker and Smith, *Pines of Austr.*, 291–298 (1910).

AGATHIS, Salisbury.

KAURI PINES.

Dammara, Rumphius.

Tall, evergreen, resinous trees with massive, columnar trunks, natives of New Zealand, Australia, New Caledonia, Fiji, Philippine Islands, and the Malay Peninsula. *Bark* thick, scaly, resinous, emitting a thick milky liquid when punctured which eventually solidifies and forms an incrustation on the bark or collects in masses beneath the trees. *Branches* horizontal, often in whorls on young trees, irregular on older trees, deciduous and leaving circular scars ½–¾ in. deep. *Winter buds* short, rounded, blunt, with a few closely pressed scales. *Leaves* spirally arranged on the main axis, opposite or alternate on lateral shoots; persisting many years, sometimes 15–20 years on the main stem; rose-coloured or reddish when young, dark green later, leathery, usually broad and flat with numerous fine parallel lines on the upper surface, varying in size and shape not only on the same tree but often on the same branch, narrowed at the base into a short, flat stalk, leaving after their fall rough, cushion-like scars as in *Picea* and *Larix*. *Male and female flowers* usually on the same trees. *Male flowers* in stiff, dense, cylindrical, solitary catkins from the leaf axils. *Female flowers* in round or broadly oblong cones. *Cones* globular or broadly oval, compact, symmetrical; *scales* fan-shaped, with a thickened margin overlapping a portion of the scales immediately above, falling as soon as the seeds are ripe. *Seed* solitary, with a well-developed wing on one side and a small process which occasionally develops into a second wing on the other.

The genus is closely allied to *Araucaria*, but may be distinguished by the larger leaves and by the seed being free from the scale, not combined as in *Araucaria*. About sixteen species have been described, but some of these are so much alike that they

appear to be geographical forms of one variable species with *A. loranthifolia* as the type.

The wood is of good quality, easily worked, and useful for all kinds of building purposes. Its microscopic features are given by Baker and Smith.[1]

All parts of the trees contain resin which exudes from wounds and accumulates on branches, trunks, and at the bases of trees. Large quantities of fossilized gum or resin from primæval trees are found buried in the ground, sometimes at depths of 6–10 ft. This fossil resin is regarded as superior to the fresh gum. Gum-resin, known as *Kauri gum*, is an important article of commerce, its chief use being in the manufacture of varnishes and linoleum.

The various species of *Agathis* are unsuitable for outdoor cultivation in Britain, but owing to the value of their timber they should be protected and their cultivation extended in their native countries. They are propagated by seeds, but sprouts sometimes appear from the bases of growing and felled trees, which may be used as cuttings. Erect shoots from trees that have had the leading shoot removed may also be utilized as cuttings.

Seward and Ford, "The Araucarieæ: Recent and Extinct" (*Phil. Trans. Royal Soc., Lond.*), cxcviii, 304–411 (1906).

Agathis australis, Salisbury. (Fig. 29.)

Kauri Pine.

Dammara australis, Lambert. Cowdie Pine; Kauri; Black Kauri; New Zealand Kauri; Red Kauri; White Kauri; Dammar.

A tree 80–120 ft. high, with a columnar trunk 8-12 ft. in diameter, or, occasionally, up to 150 ft. high with a diameter of 20–24 ft. *Bark* thick, smooth, greyish, very resinous. *Branches* whorled or irregular, horizontal. *Young shoots* without down, glaucous. *Winter buds* compact, rounded, with tightly pressed scales. *Leaves* variable; on young trees spreading, wide apart, 1–3 in. long, $\frac{1}{4}$–$\frac{1}{3}$ in. wide, glaucous-green, narrowly lance-shaped, thick, leathery, short-stalked, opposite or sub-opposite on lateral branchlets; on old trees shorter, oblong, green, close-set, sometimes without stalks. *Male and female flowers* often on the same tree. *Male catkins* 1–1$\frac{1}{2}$ in. long, $\frac{1}{4}$–$\frac{1}{3}$ in. wide. *Female flowers* from the points of short shoots. *Cone* woody, egg-shaped or rounded, 2$\frac{1}{2}$–3 in. in diameter; *scales* about $\frac{3}{4}$ in. across. *Seed* with a well-developed wing.

Distinguished from other species by its smaller and narrower leaves.

A native of the northern part of the North Island of New Zealand, where it is regarded as one of the most important forest trees. Introduced to Europe in 1823.

[1] *Pines of Australia*, 377 (1910).

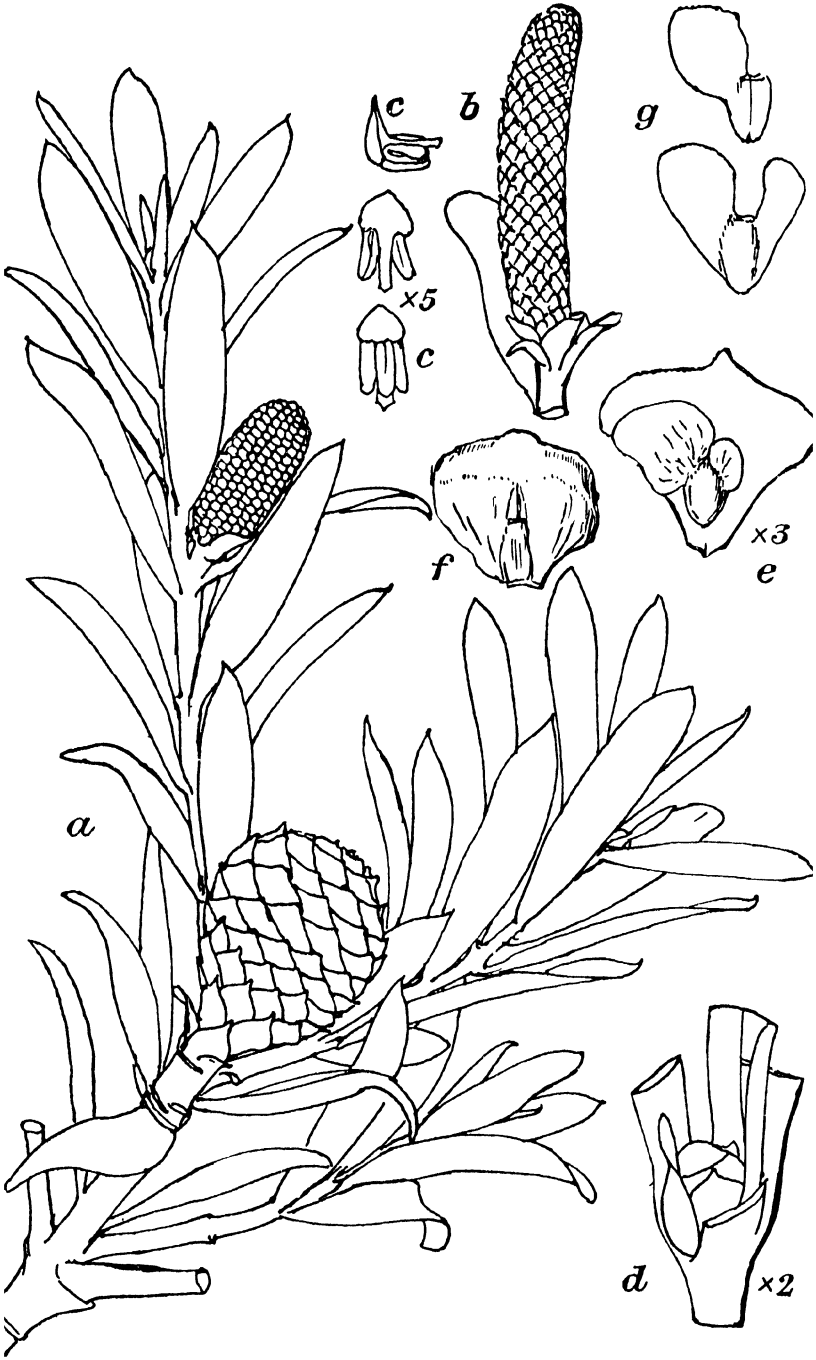

FIG. 29.—*AGATHIS [illegible]TRALIS.*

a, spray with young male and female cone; *b*, young male cone; *c*, stamen from three aspects; *d*, winter bud; *e*, cone-scale with young seed; *f*, mature cone-scale, showing scar to which the seed was attached; *g*, seeds with either one or two wings.

Wood yellowish-white to red and brown, sometimes mottled, resinous, straight-grained, of great strength, toughness, and durability, equal in quality to pitch pine. The following results of tests carried out on behalf of the Air Ministry are recorded in the *Catalogue of the Empire Timber Exhibition*, London, 1920, p. 113 :—

Sample.	*a.*	*b.*	*c.*	*d.*
Density—lb. per cu. ft.	32·6	30·6	30·5	30·5
Moisture, per cent.	15·6	15·7	15·2	13·7
Uniform Bending :				
Modulus of Elasticity/10^6	1·595	1·675	1·690	1·527
Elastic Limit	6,860	7,480	7,170	5,715
Modulus of Rupture	10,050	9,400	9,950	7,900
Tension :				
Modulus of Rupture in lb. per sq. in.	16,400	22,200	18,350	18,150 15,430
Compression :				
Modulus of Rupture in lb. per sq. in.	5,520	5,850	6,330	6,660
Moisture, per cent.	16·5	15·3	18·1	—
Obliquity of Grain :				
Radial Plane	—	—	—	1 in 17
Tangential Plane	—	—	—	Straight

Kirk [1] mentions four grades of timber :—(1) *Red Kauri*, which is regarded as the best general building timber and suitable for beams, joists, and heavy framework, but liable to cast and twist, shrinking longitudinally and transversely. (2) *White Kauri*, yellowish white, straight-grained, very tough, bears a greater strain than red but is less durable, neither warps nor shrinks longitudinally if fairly seasoned before working up. A splendid timber for mouldings and joiners' work, and largely used by boat-builders on account of its toughness and elasticity. (3) *Black Kauri*, deep brown in colour, very hard, dense, heavy, heavily charged with resin, difficult to work, has extreme durability. (4) *Soft Kauri*, pale dun colour, straight-grained, rather soft, light specific gravity, never casts or twists or shrinks longitudinally when exposed to weather, sometimes marked with longitudinal streaks or veins. Excellent for joiners' work and mouldings, but not for beams or heavy framing. In addition there are waved and mottled kinds of kauri in which the wood is beautifully figured. Such wood is used for panelling and furniture, and it takes a high polish. Kauri-wood is used for general building, flooring, all kinds of joinery and carpentry, bridges, wharves, mine-props, railway sleepers, shipbuilding, church

[1] Kirk, *Forest Flora of New Zealand*, p. 145 (1889).

furniture, cooperage, and many other purposes. The best timber is said to be obtained from trees felled during the dormant season.

Resin (copal) is obtained from all parts of the tree and large quantities of fossil resin (up to 15,000 tons) known as Kauri gum are obtained annually from the sites of ancient Kauri forests. Much of it is used in the manufacture of paint, varnish, and linoleum. From the refuse of the resin motor spirit and turpentine are obtained. In *Commerce Report*, December 2, 1920, p. 984, an account is given of the reclamation of fossil resin from the bogs of Auckland. It is stated that after the separation of the resin 40 to 50 gallons of Kauri gum oil can be obtained from every cubic yard of peat, which on distillation produces motor spirit and turpentine.

A. australis has been over-cut in New Zealand, and the New Zealand Government has taken steps to protect the remaining forests and to ensure regeneration. A tree of such general usefulness is worth all the attention that can be paid to it, and its cultivation should be greatly extended.

In England *A. australis* can only be grown out of doors in the mildest parts of the country. A small plant was growing, a few years ago, in the famous gardens at Tresco Abbey in the Scilly Islands, and the species has been tried near Falmouth. There is a specimen 35–40 ft. high in the Temperate House at Kew which bears male and female flowers and matures its cones frequently. Its introduction probably dates back to 1838, for, according to Smith, *Records of the Royal Botanic Gardens, Kew*, 72 (1880), this species was included in an importation of New Zealand plants brought about through the instrumentality of Sir William Symonds, then Surveyor to the Navy. He was desirous of obtaining New Zealand timbers for the Navy and despatched the ship *Buffalo* to bring home a cargo, giving instructions to the officers to introduce young plants of the principal trees. Three Wardian cases of plants were brought, and amongst the occupants were *Agathis australis*, *Dacrydium cupressinum*, *Podocarpus Totara*, and *Phyllocladus trichomanoides*. The original introduction into Europe appears to have been in 1823.

Cheeseman, *Ill. New Zealand Flora*, t. 184 (1914); *Gardener's Chronicle*, xx, 525 (1883); *Kauri Gum Industry in New Zeal.*, Bull. Imp. Inst., xx, No. 3, 331 (1922).

Agathis Beccarii, Warburg.

A tree of medium size with short, stout, bluntly angled branches, brownish in colour and sometimes slightly glaucous. *Buds* rounded and covered by two or three closely pressed scales. *Leaves* opposite or sub-opposite, lance-shaped, $2\frac{1}{2}$–$3\frac{1}{4}$ in. long, $\frac{1}{3}$–$\frac{3}{5}$ in. broad, leathery, dark green above, paler beneath, apex

a blunt point, the base flattened into a short stalk. Reproductive organs unknown.

The species was discovered in the State of Sarawak, Borneo, between the years 1865 and 1868. It is possibly merely a geographical form of *A. loranthifolia*, but we have only seen imperfect specimens.

Warburg, *Monsunia*, I, 184, t. viii, f. 7 (1900).

Agathis borneensis, Warburg.

A large tree with stout branches terminated by rounded buds covered by a few large, closely-pressed scales. *Leaves* usually opposite and arranged in one plane by a basal twist of their flattened stalks; elliptic or oval, narrowing to each end, apex rounded, the base flattened into a stalk ¼–½ in. long; the leaf-blade 1¾–3½ in. long, ⅞–1⅝ in. broad, leathery, dark green above, paler beneath, with well-marked longitudinal lines on each surface, margins recurved. *Male catkins* solitary in the leaf axils, on short stalks ⅛–¼ in. long. *Cones* not seen.

This plant was discovered by Dr. Beccari in Borneo between 1865 and 1868. It appears to be closely allied to *A. loranthifolia* and may be only a geographical variety of that species.

Warburg, *Monsunia*, I, 184, t. viii, f. D. (1900).

Agathis celebica, Warburg.[1]

A tree 120–160 ft. high, with a clean cylindrical trunk of half that height, indistinctly buttressed at the base. *Leaves* about 3 in. long by 1 in. broad. *Male catkins* 1½–2 in. long, ⅜–½ in. wide. *Cone*, 3–3½ in. long and about 2½ in. wide. *Seed* oblong with a broad, flat wing.

This species is a native of the Celebes, and as a good deal of fossil resin is said to be found in the Celebes it is presumably derived from past generations of this tree.

Agathis flavescens, Ridley.

A tree 40 or more ft. high with a trunk 3 ft. in girth at the base. *Young shoots* yellowish. *Leaves* elliptical or obtuse, narrowing to the base, thick, leathery, yellowish-green, 2–2½ in. long. about ½–1 in. wide. *Male catkins* about 1–1½ in. long, ½ in. wide. *Cones* globose, 2½ in. long, 1¾ in. wide; *scales*, 1¼ in. long, 1 in. wide. *Seeds* elliptical.

This species is closely allied to *A. regia*, from which it differs in its smaller male catkins. Ridley says that it is quite distinct from *A. loranthifolia*, Salisb.

Native of the Malay Peninsula and collected by Ridley on the Padang of Gunong Tahan, at an altitude of 5,000 ft. On

[1] *Monsunia*, 185 (1900).

the open rocky plain it is said to be remarkable for its yellowish colour. In woods the foliage is green and the tree taller than 40 ft.

Kew Bulletin, No. 9, 332 (1914).

Agathis lanceolata, Pancher.

Dammara lanceolata, Pancher.

A large tree with a clean bole, often rising to a height of 50 ft. before branching. *Crown* irregular, dense, of a rich shade of green, with straight ascending branches. *Bark* reddish-brown, smooth, scaling off in thin flakes. *Young shoots* compressed or quadrangular, terminated by buds $\frac{1}{6}$–$\frac{1}{3}$ in. in diameter, composed of numerous overlapping scales. *Leaves* large, opposite, ascending and overlapping, or spreading at right-angles, lance-shaped or narrowly oblong, with a short-pointed apex, and narrowing gradually at the base, $1\frac{3}{4}$–5 in. long, $\frac{1}{3}$–$\frac{2}{3}$ in. wide, leathery, the surface marked with close longitudinal nerves, dark glossy green above, paler and duller below, margins thickened and recurved. *Male catkins* inserted above the leaf-axils in opposite pairs, cylindrical, about 1 in. long and $\frac{1}{3}$ in. in diameter, on short, stout, woody stalks. *Mature cones* not known.

A. lanceolata is closely allied to *A. Moorei*, from which it is distinguished by its narrower, longer, and relatively thicker leaves. It is only found upon serpentine formations.

Sebert (*Notice sur les Bois de la Nouvelle Caledonie*, 169, 1874) records it as occurring in high forests from Yenguène to South Bay in New Caledonia, and states that one tree yielded 19 cubic metres of timber. Compton says that it is the characteristic tree of high forest on serpentine below 1,000 ft. altitude throughout the southern half of New Caledonia.

Wood apparently similar in quality to that of *A. robusta*. It is being exploited in various places, notably at the Baie des Pirogues.[1] The seeds are edible and the tree also produces an immense quantity of a yellowish, translucent, fragrant resin.

Agathis loranthifolia, Salisbury.

AMBOYNA PITCH TREE.

Agathis Dammara, Richard; Dammara alba, Rumphius.

A tree 120 ft. high and 18 or more ft. in girth, with a pyramidal crown of sub-pendent branches. *Bark* thick, resinous, reddish-grey. *Young shoots* light, dull green, angled. *Terminal buds* rounded, with a few closely pressed scales. *Leaves* persisting several years, dark green, leathery, $2\frac{1}{2}$–5 in. long $\frac{1}{2}$–2 in. wide, often smaller on coning branches; broadly lance-shaped, or

[1] Compton, *Journ. Linn. Soc.* XLV, 430 (1922).

ovate, marked with numerous longitudinal parallel lines, margins thickened and reflexed, apex usually blunt and rounded, occasionally short-pointed, stalks flattened, $\frac{1}{8}$–$\frac{1}{3}$ in. long. *Male flowers* in solitary catkins from the leaf axils, 2–3 in long, $\frac{3}{4}$–1 in. wide. *Female flowers* in short, stalked cones. Mature cone round, or rather longer than wide, about 4 in. in diameter; *scales* about 1 in. across, apex thickened and reflexed. *Seeds* $\frac{1}{2}$ in. long, $\frac{3}{8}$ in. wide, with a wing $\frac{1}{2}$ in. across.

This species, which is closely allied to *A. robusta*, is widely distributed in the Malayan and Polynesian region and may well be the type of several other trees which, although given specific rank, are merely geographical forms.

Wood not represented at Kew, but it appears from descriptions to be very similar to that of *A. robusta* and to be useful for the same purposes.

Dammar, copal, or resin, both fossil and recent, is obtained from the tree. Several samples of resin are to be seen in Museum 3 at Kew. They vary a good deal in colour and degree of transparency, and are named as follows :-

Damar Merah; light transparent brown, or dark brown, from ground lumps.

Damar Batu or *Puti*; very pale and clean.

Damar Poeteh; small lumps and fine resin collected from incisions made in the trunk.

There is also a specimen of Pink or Rose Dammar from an unnamed species collected in Borneo, which probably belongs to *A. loranthifolia*. The resin in this case is reddish in colour.

East Indian Dammar is obtained from Malacca, Borneo, Java, Sumatra, and the Moluccas.

Botanical Magazine, t. 5359 (1863).

Agathis macrophylla, Masters.

LARGE-LEAVED KAURI PINE.

A tree attaining a height of 100 ft., with wide-spreading branches *Young shoots* stout, often quadrangular towards the points. *Buds* rounded. *Leaves* ovate or lance-shaped, $3\frac{1}{2}$–7 in. long, $\frac{3}{4}$–2 in. wide, leathery, narrowing at the apex to a blunt point, and at the base to a short, flattened stalk, margin recurved, the surface dark green above, paler beneath, marked by numerous parallel lines. *Cones* erect, up to $3\frac{1}{2}$ in. long and $2\frac{3}{4}$–$3\frac{1}{3}$ in. wide.

This species is a native of the Solomon Islands and of La Perouse Island, Polynesia. It was originally discovered by Charles Moore the Australian botanist, and is allied to *A. loranthifolia* from which it differs in its larger leaves.

Agathis Moorei, Masters.

MOORE'S KAURI PINE.

Dammara Moorei, Lindley.

A tree 50–80 ft. high, of erect and graceful habit, with rather slender branches pendulous at the tips. *Young shoots* greenish. *Winter buds* short, rounded, covered by a few large, closely pressed scales. *Leaves* opposite or sub-opposite, lance-shaped to elliptical, up to 3½ in. long and 1 in. wide (sometimes larger on vigorous shoots), ending in a blunt point, leathery, dark glossy green above, paler beneath, the surface marked with numerous parallel lines. *Male catkins* solitary, cylindrical, erect, ⅗ in. long, $\frac{3}{16}$ in. wide, borne in the leaf axils. *Cones* erect globose or pear-shaped, up to 5 in. long and 4½ in. wide, symmetrical in outline.

A. Moorei is found on the schistose and gneissic rocks in the northern half of New Caledonia at altitudes of 1,000–2,000 ft., and may be distinguished from the other species of that country by its narrower leaves. Compton says that it is apparently absent from serpentine soils.

A specimen has been grown under this name for many years in the Temperate House at Kew.

Agathis ovata, Warburg.

Dammara ovata, C. Moore.

A tree seldom more than 30 ft. high. *Bark* rough, grey, deeply fissured. *Young shoots* alternate, opposite, or in whorls of 3–4, yellowish brown. *Winter buds* rounded, covered by four large, closely-pressed scales. *Leaves* spreading, opposite or sub-opposite, 3–4½ in. long, ¾–1¼ in. wide (rarely 1½ in. long and ½ in. wide), broadly lance-shaped or oblong-elliptical, thick, leathery, margins thickened and slightly recurved, apex rounded, the base contracted into a flattened stalk; dark green above, paler or glaucous beneath, marked on each surface by longitudinal, parallel lines. *Cones* elliptical, up to 4½ in. long and nearly 4 in. wide; *scales* flat, 1½ in. long, 1¼–1¾ in. broad, brown in colour, the outer margin slightly thickened.

A native of New Caledonia where, according to Compton,[1] it never enters into the composition of forests but is an inhabitant of the arid, exposed serpentine ridges and slopes in the south of the island, usually solitary, rarely forming a small local society, from sea-level to about 1,500 ft. altitude. The leaves on native trees are variable, more leathery than in the two woodland species (*A. lanceolata* and *A. Moorei*), glaucous below especially when young, oblong-elliptical, not acute. The female cones are elliptical and smaller than those of *A. lanceolata*.

[1] *Journ. Linn. Soc.* XLV, No. 304, 430 (1922).

This tree appears to have been confused with other species by Bennett, who collected in New Caledonia, for he has recorded it as surpassing *A. robusta* and *A. Moorei* both in size and in the value of the wood.

A. ovata was discovered in New Caledonia by Charles Moore, and it has also been recorded from the Isle of Pines.

Agathis Palmerstoni, Ferdinand von Mueller.[1]

NORTHERN KAURI PINE.

A tall tree with a fine columnar trunk free from branches for the greater part of its height. *Bark* ¾ in. or more thick, resinous. *Leaves* usually lance-shaped, 2–4 in. long and ½–¾ in. wide but sometimes ovate and rather larger, deep green, apex blunt, base narrowed into a flat stalk about ⅛ in. long. *Male catkins* solitary, cylindrical, about 1 in. long. *Cone* egg-shaped, up to 5½ in. long and 4 in. wide; *scales* numerous, closely overlapping, about 1 in. wide, thickened at the top.

Distinguished from *A. robusta* by its smaller and narrower leaves.

It is found in the Mount Bartle Frere, Christie Palmerston, and Mulgrave River districts of Queensland and its uses are similar to those of *A. robusta*, from which it is probably only geographically distinct.

Agathis philippinensis, Warburg.

PHILIPPINE ISLAND KAURI PINE.

A tree 150–200 ft. high and 6–9 ft. in girth. *Leaves* up to 3 in. long, ½–1 in. wide, oblong or slightly obovate, margins thickened and recurved, stalks about ⅛ in. long, apex abruptly pointed or rounded. *Male catkins* 1–1¼ in. long. *Cones* rounded, 3–4 in. across; *scales* fan-shaped, 1 in. wide. *Seeds* about ⅝ in. long, wing large, ⅝ in. across.

Found in the Island of Paragua and in the province of Bataan, Luzon, up to an altitude of 1,700 ft. It is a source of resin and a good timber.

Agathis regia, Warburg.[2]

A species allied to *A. loranthifolia*. *Leaves* broadly lance-shaped, 3–3½ in. long, 1⅛ in. wide, leathery, rounded at the apex, narrowed at the base into a flattened stalk, ⅛–$\frac{3}{10}$ in. long, $\frac{1}{10}$ in. wide. *Male catkins* ⅛ in. long, $\frac{3}{10}$ in. broad. *Cone-scales* about $1\frac{1}{10}$ in. long and 1⅛–1⅜ in. broad with a thickened apex.

This plant differs from *A. loranthifolia* by its smaller male catkins, but is doubtfully distinct.

[1] *Victorian Naturalist*, June, 1891, 45, 46.
[2] *Monsunia*, i, 183, t. viii, f. B. (1900).

It was discovered by Warburg on the small island Pulu dekat near Batjan, one of the Moluccas.

A. regia is said to yield the commercial *Dammar radja*, a hard resin or copal, that has long been exported from Batjan (Batchian).

Agathis robusta, Masters.

QUEENSLAND KAURI.

Dammara robusta, C. Moore. Australian Kauri; Dundathu Pine.

A tree 150 or more ft. high, with a long, straight, columnar trunk free from branches for the greater part of its height. *Bark* thick, brownish, resinous. *Winter buds* rounded, compact, with closely pressed scales. *Leaves* usually ovate, 4–6 in. long, 1–2 in. wide, dark green, striated with parallel veins, margins thickened and recurved, apex long or short-pointed, rounded or blunt, stalks flattened, about $\frac{1}{8}$ in. long. *Male catkins* dense, cylindrical, 1–2 in. long. *Cones* ovoid or rounded, 4–5 in. long, and usually less than 4 in. in diameter; *scales* about 1 in. across, closely overlapping, thickened at the apex. *Seeds* oblong, flattened, about $\frac{1}{2}$ in. long with a well developed wing on one side.

Native of Queensland and Fraser Island.

Wood brown or yellowish, short-grained, finishes well with a fine surface. Less useful for weight-bearing purposes than the New Zealand Kauri, but an excellent wood for joiners' work, indoor finish of houses, etc., as it takes paint and polish well. Queensland Kauri is an important timber, and the cultivation of the tree should be encouraged by every possible means in its native country. The timber is not plentiful enough for export.

Resin, both fresh and in a fossil state, is obtained from the tree. Specimens at Kew are of a clear, pale brown colour.

Some interesting particulars respecting this tree are given by Boyd in *The Queensland Agricultural Journal*, ii, pp. 67–68. Steps were apparently taken in 1879 to protect both this tree and the hoop pine (*Araucaria Cunninghamii*), and regulations were issued prohibiting the cutting of any pine tree having a less diameter than 3 ft. Subsequent amended regulations authorized the cutting of Kauri pine when 2 ft. in diameter and hoop pine at 21 in. diameter at 5 ft. from the ground. The Queensland Kauri pine is said to make little girth growth until the tree is above surrounding trees and a sapling 12 in. in diameter has usually completed its height growth. From this period yearly girth growth is rapid, usually 5–9 in. but sometimes as much as $12\frac{1}{2}$ in. After a diameter of 40–50 in. has been gained growth slackens off. Mr. Boyd maintains that it is disastrous to cut Queensland Kauri pine under 3 ft. in diameter, and gives the following table showing yield at different girths:—

Diameter in in.	Girth in in.		Side of sq. in.		Superficial ft.
20	60	=	15	Will yield	1,124
24	72	=	18	,, ,,	1,620
36	108	=	27	,, ,,	3,644
48	144	=	36	,, ,,	6,480
60	180	=	45	,, ,,	10,124
66	198	=	49·50	,, ,,	12,124

He adds: "It will thus be seen that a tree which at two feet diameter would yield 1,620 superficial feet of timber would, if allowed to grow five years longer, yield 3,644 feet, or, in other words, it would be worth double the money; and if allowed to grow for ten years, would yield exactly four times the amount of timber which a diameter of two feet would yield.

There are several specimens of this species in the Temperate House at Kew.

Baker and Smith, *Pines of Australia*, 376 (1910).

Agathis vitiensis, Bentham and Hooker.

FIJIAN KAURI PINE.

Dakua Wood; Dakua Tree.

A tree 50–60 or occasionally 100 ft. high, with a clean trunk 60 ft. high and a girth of 23 ft. *Bark* whitish externally, reddish within, the outer bark peeling off in strands. *Young shoots* greenish. *Terminal buds* small, brown, rounded, with tightly-pressed scales. *Leaves* very variable in size and shape, narrowly or broadly ovate, 2–5 in. long, $\frac{1}{3}$–$1\frac{1}{2}$ in. wide; leathery, dark glossy green above, paler and duller, or sometimes glaucous beneath, both surfaces marked by numerous parallel lines, narrowed at both ends, the apex blunt and rounded, the base ending in a flat stalk up to $\frac{1}{4}$ in. long. *Male catkins* cylindrical, 1–$1\frac{1}{4}$ in. long, $\frac{1}{3}$ in. wide, shortly stalked or sessile. *Cone* glaucous, ovoid or rounded, the apex tapering abruptly, 4–5 in. long, about 4 in. wide; *scales* fan-shaped, 1–$1\frac{1}{4}$ in. across, thickened at the top. *Seed* about $\frac{1}{2}$ in. long, wing $\frac{3}{4}$ in. long by $\frac{5}{8}$ in. wide.

Native of the Fiji Islands, where it is abundant in the islands of Vanua Levu and Viti Levu. Specimens were first collected in 1858 by Mr. Milne of H.M.S. *Herald*.

Interesting descriptions of this tree and its uses are given by Seemann in his *Flora Vitiensis* and by Mr. John Horn in *A Year in Fiji*, pp. 70 and 116. Horn describes a remarkable tree he saw in Viti Levu which was nearly 100 ft. high; its trunk, when measured at 6 ft. above the ground, was found to be 25 ft. in girth. At about 20 ft. from the ground the trunk had been broken, and had divided into a number of upright growing shoots, each with the dimensions of a tree of more than medium size.

The wood is said to be usually white, although sometimes

red wood exists. It is known as *Dakua wood* and is used for masts, booms, and spars, for flooring houses, and for most of the uses to which pine is put in the northern hemisphere. Resin, fossil and recent, is obtained, and it is used by the natives for glazing pots, etc. Recent resin is white, fossil resin being yellowish or light brown and transparent. The resin is exported for use in varnishes, etc., whilst, in addition to pottery glazing, the natives use it for burning as torches, and a dye obtained from the smoke is used for dyeing native cloth black. This smoke dye mixed with red earth is also said to make a brown pigment, which, amongst other uses, is employed for tattooing women.

A specimen of the tree may be seen in the Temperate House at Kew.

Botanical Magazine, t. 8512 (1913).

ARAUCARIA, Jussieu.

Evergreen trees confined to the southern hemisphere and occurring in S. America, Australia, New Guinea, New Caledonia, the New Hebrides, and Norfolk Island.

Young trees symmetrical, clothed with branches from base to summit; old trees with the trunks clear of branches for the greater part of their height, surmounted by flat, ragged heads. *Bark* resinous, thick on old trees, ridged with the bases of old leaves, or, in some species, rough and peeling off in papery scales. *Branches* horizontal, usually in whorls. *Young shoots* green, without down, some of the axillary shoots deciduous. *Buds* indistinct, enclosed by leaves. *Leaves* persisting for many years, spirally arranged, clasping the stem and overlapping, or thrown into two or more ranks by means of a basal twist; lance-shaped, flat, up to 2 in. long, leathery, sharp-pointed, or awl-shaped and four-angled or triangular, varying in size and shape on different parts of the same tree. *Male and female flowers* usually borne on different trees, but sometimes on different branches of the same tree. *Male catkins* dense, cylindrical, solitary or in clusters from the points of the branches, or from axillary buds, consisting of numerous spirally arranged stamens. *Cones* ripening in two or three years, globular or ovoid, with woody, closely overlapping scales which fall when the seeds are mature. *Seeds* one on each scale and adherent to it, winged on each edge in most species. *Cotyledons* usually two or four.

The genus is naturally marked out into two sections, characterized as follows:—

A. *Colymbea.*—*Leaves* flat, broad. *Cones* large. *Cotyledons* remain below ground in germination. Includes *A. imbricata*, *A. Bidwillii*, *A. brasiliana*.

B. *Eutassa.*—*Leaves* awl-shaped, curved. *Cones* relatively

small. *Cotyledons* pushed above ground in germination. Includes *A. Balansæ*, *A. Beccarii*, *A. Cunninghamii*, *A. Cookii*, *A. excelsa*, *A. Muelleri*, *A. Rulei*.

The genus *Araucaria* is closely allied to *Agathis*, but in the latter genus the seed has usually but one well-developed wing and is free from the scale. In *Araucaria* the seed is united to the scale, which is usually winged on the edges.

Wood resinous, yellowish white, straight-grained, easily worked, and useful for the indoor finish of houses, furniture, carving, box-boards, the commoner kinds of joinery and carpentry, and for paper pulp. It is probable that S. America has the largest supply of timber for export, that produced in Australia being insufficient even for home needs. The seeds are edible, and several species produce useful resin. Only one species, *A. imbricata*, is hardy and suitable for outdoor culture in Britain, but all the timber-producing species should be protected and their development encouraged in their native countries, for they produce the best soft-woods of their respective regions. The Araucarias are best propagated by seeds, although it is possible to increase them from cuttings. (See under *A. excelsa*.) They possess the power, to a remarkable degree, of renewing the leading shoot in case of injury. After a leading shoot has been broken or cut off a number of young, erect shoots appear from below the wound; such shoots will make very good cuttings.

"The Araucarieæ, Recent and Extinct." A. C. Seward, F.R.S., and Sibille O. Ford. *Philosophical Transactions of the Royal Society of London*, vol. cxcviii. 304–411 (1906).

Araucaria Balansæ, Brongniart and Gris.

A. elegans, Hort.

A tree 45–60 ft. high, with horizontal branches and long, slender, pendent branchlets. *Leaves* small, uniform in size, densely crowded on the branchlets and lasting many years; about $\frac{1}{8}$ in. long, almost as wide at the base, curving inwards and appearing to clasp the stem, stomata on the inner surface. *Male catkins* 2–3 in. long, $\frac{3}{4}$–1 in. wide. *Cones* oval, terminating short shoots, $2\frac{1}{2}$–3 in. long by 2–$2\frac{1}{2}$ in. wide, the scales ending in stiff, lance-shaped bristles $\frac{1}{3}$ in. long.

A species allied to *A. Cookii*, but distinguished by its smaller leaves and more slender growth.

Native of New Caledonia.

A. balansæ does not appear to be of any economic importance, but it is grown in greenhouses in Europe on account of its decorative character, and may be seen in the Temperate House at Kew.

L'Illustration Horticole, xxii, 26, t. 197.

Araucaria Beccarii, Warburg.[1]

Araucaria Cunninghamii, Beccari [not Aiton]; A. Cunninghamii, var. papuana, Laut.

A handsome tree, 70–80 ft. high in New Guinea, allied to *A. Cunninghamii* but differing in its less symmetrical branching and the absence of the candelabra-like habit peculiar to *A. Cunninghamii*. The *leaves* of mature trees are about $\frac{2}{5}$ in. long, and about $\frac{1}{16}$ in. wide at the base, the apex sharp-pointed and reflexed. The *cones* are said to be much larger than those of *A. Cunninghamii* and the cone-scales longer, with a narrower base and more pointed apex.

Found on the Arfak Mountains in N.W. Dutch New Guinea.

Araucaria Bidwillii, Hooker. (Fig, 30.)

BUNYA-BUNYA.

A tree up to 150 ft. high, with a trunk 3–4 ft. in diameter. *Young trees* pyramidal, symmetrical, and densely branched. *Lateral branchlets* long and pendent. *Bark* thick, resinous, outer bark scaling off in thin layers. *Young shoots* green. *Leaves* spirally arranged, overlapping, those of sterile shoots lance-shaped, up to 2 in. long and $\frac{3}{16}$–$\frac{7}{16}$ in. wide, dark green, stiff, margins entire, apex narrowing into a long, stiff point; on fertile shoots and on the higher branches shorter, stiffer, incurved, more closely arranged, often less than 1 in. long. In both cases stomata are present in regular lines on the under-surface and in irregular lines above. *Male and female flowers* are usually on different trees, occasionally on the same tree. *Male catkins* up to 6–7 in. long, and $\frac{1}{2}$ in. wide, produced near the points of the branches on the upper parts of the tree. *Cones* erect, borne on the higher branches, elliptical or globular, up to 12 in. long, 9 in. wide, and sometimes 10 lb. in weight, containing up to 150 seeds; *scales* numerous, 4 in. long, 3 in. wide, the apex drawn out into a long, recurved point. *Seed* large, pear-shaped, 2–2½ in. long, and over 1 in. wide in the widest part, maturing the third year, wings rudimentary.

A. Bidwillii more closely resembles the S. American species than the other species from Australasia. It differs from *A. imbricata* in its less rigid leaves and by the looser arrangement of the foliage on the sterile branches.

It is a native of the Coast District of Queensland and was brought to notice in 1838 by Mr. Andrew Petrie, Superintendent of Government Works at Moreton Bay. He gave specimens to Mr. J. S. Bidwill, who brought them to Kew, where they were described by Sir W. J. Hooker in 1843.

[1] *Monsunia*, i, 187 (1900); Gibbs, *Phytogeogr. and Fl. of the Arfak Mountains*, 83 (1917).

Wood creamy-white, easily worked, straight-grained, and suitable for the same purposes as the wood of *A. Cunninghamii*, which see. Owing to the food value of the seeds, the wood is not cut so extensively as it would otherwise be. The aborigines depend largely upon the nuts for food, and, when ripe, they travel long distances to the groves or forests for the purpose of collecting and feeding upon the nuts. To protect the trees for the natives, the Government has placed restrictions upon felling, and a tract of hilly country, eighty miles long and forty miles wide, where the trees are plentiful, has been reserved for the natives, who apportion the trees amongst themselves. Each tribe has its own trees, which are again divided amongst families, the trees being thus handed down from generation to generation. Ripe seeds are produced each year, but a full crop is only obtained every third year. The seeds are said to be very fattening.

As a cultivated tree in tropical and sub-tropical countries, *A. Bidwillii* has given excellent results, but it has been planted chiefly for decorative purposes. It should, however, be grown under forest conditions in countries where soft-woods are in demand and the true pines do not thrive, for it is of rapid growth and does not appear to be seriously injured by insect pests. Moist but well drained loamy soil suits it. In Australia there is reason for its extended cultivation. Two fine specimens, each 50 or more ft. high, from which the heads have been removed on several occasions, have been growing in the Temperate House at Kew for 60 or more years. One of them has occasionally produced cones since 1873, but the seeds are not fertile.

Baker and Smith, *The Pines of Australia*, pp. 360–370 (1910); W. J. Hooker, *Lond. Journ. Bot.*, t. xviii.

Araucaria brasiliana, Richard.

CANDELABRA TREE.

Araucaria brasiliensis, London. Parana Pine, Parana Wood.

A tree 100 or more ft. high with a tall, straight trunk terminated by a flat head of gaunt, horizontal branches with the branchlets in terminal tufts. *Branches* usually arranged in whorls of 4–8. *Leaves* green or glaucous, lance-shaped, on sterile branches 1¼–2¼ in. long and up to ¼ in. wide, sometimes appearing as if in pairs, on fertile branches shorter, more densely and spirally arranged, in each case long-pointed, stiff, leathery, with stomata well developed on the under-surface. *Male catkins* dense, 3–4 in. long, ½–¾ in. wide from the leaf axils of short shoots. *Cones* broader than long, 5 in. high and 6½ in. in diameter, narrowed from the middle upwards; *scales* terminated

by stiff, recurved appendages. *Seeds* bright brown, up to 2 in. long, ¾ in. wide and ⅓ in. thick.

Var. **Saviana,** Parlatore.

Differs from the type by its narrower, glaucous leaves.

A. brasiliana is allied to *A. imbricata*, but is readily known by its softer and more loosely arranged leaves.

It is a native of the mountains of Brazil and the Argentine.

The *wood* is yellowish, soft, straight-grained, and suitable for joinery and carpentry, particularly for the indoor finish of houses, box making, paper pulp, etc. The supply will probably not exceed the demand of S. America. *A. brasiliana* cannot be grown out of doors in the British Isles except in the mildest places, and even there it is not very successful. It would probably give good results in selected places in S. Africa.

Martius, *Flora Brasiliensis*, t. 110–111–112 (1863).

Araucaria Cookii, R. Brown.

Cook's Araucaria.

A tree up to 200 ft. high, with the peculiar habit of shedding its lower branches and replacing them by short shoots from adventitious buds, producing the effect of a dense green column which suddenly widens out within a short distance of the apex. *Branches* horizontal, lateral branchlets long, slender, whiplike. *Outer bark* shredding off in thin papery layers. *Leaves* on juvenile shoots triangular or lance-shaped, up to ½ in. long, pointed; on older shoots broadly ovate, $\frac{3}{16}$–¼ in. long, ⅛ in. wide, rigid, closely overlapping and curving inwards, the whole suggesting a neatly plaited cord. *Male catkins* 1–2½ in. long, ½–¾ in. wide, set in a cuplike arrangement of leaves. *Cone* elliptical, up to 6 in. long and 4½ in. wide, teasel-like when partly developed owing to the scale appendages; *scales* about 1¼ in. across, with a central seed margined by well-developed wings, each ½ in. wide; terminal spine about ⅓ in. long.

Var. **aurea.**

Foliage golden.

Var. **luxurians.**

More vigorous than the type, foliage more compact and even.

Var. **rigida.**

Leaves stiffer and more rigid than in the type.

A. Cookii is allied to *A. excelsa*, but differs in its more compact foliage and less plumose habit. It is a native of New Caledonia, Polynesia, and the Isle of Pines, and was discovered in the latter

island by Captain Cook during his second voyage in the Pacific. Travellers describe it as a conifer of most remarkable habit; the trees when seen at a distance are said to resemble columns of basalt.

The *wood* is similar in character to that of *A. Cunninghamii*, but of no commercial value outside its native country.

A. Cookii is sometimes grown for decorative purposes in warm temperate and sub-tropical countries, but it is not such a desirable tree for the purpose as *A. excelsa*.

Botanical Magazine, t. 4635; *Gardener's Chronicle*, 1877, pp. 86–87, with figures.

Araucaria Cunninghamii, Aiton.

MORETON BAY PINE.

Colonial Pine; Hoop Pine; Richmond River Pine; White Pine.

A tree 150 ft. or occasionally 200 ft. high, with a girth up to 12 ft. *Branches* long, with the branchlets concentrated in dense tufts near the point. *Bark* rough, in horizontal hoops or bands, peeling off in thin layers. *Leaves* of two kinds, those on young trees and lateral branches spirally arranged, usually lance-shaped or triangular, $\frac{1}{3}$–$\frac{3}{4}$ in. long, straight, spreading, sharp-pointed, margins entire, green or glaucous; on old trees and coning branches, shorter, crowded, overlapping, incurved, short-pointed; stomata on both surfaces in each case. *Male catkins* 2–3 in. long. *Cones* ovoid, symmetrical, about 4 in. long by 3 in. wide, teasel-like when young by reason of the protruding, stiff, recurved scale-points; *scales* broadly cuneate, with a long, awn-like, reflexed apex. *Seed* with a narrow membranous wing on each side.

Var. glauca.

This is distinguished by its silvery or glaucous foliage.

A. Cunninghamii is found in the North Coast District of New South Wales, the South Coast District of Queensland, and in the Arfak Mountains, Dutch N.W. New Guinea, and is distinguished from other species by its tufted branches and the hoop-like arrangement of the bark.

Wood white or cream-coloured, easily worked, straight-grained, and obtainable in large, clean planks. It is employed for the indoor finish of houses, furniture, general house-fittings, kitchen tables, for carving, boxwood, and sometimes for outside work. The supply does not appear to be equal to the home demand, for it is extensively sought after for boxes for dairy and other produce. Resin is obtained from the tree, but it does not appear to have any considerable commercial importance.

There are good reasons why its cultivation should be considerably extended in Australia, and also in S. Africa, where it

has met with a great measure of success. In Australia the best trees are said to be found along the watercourses, but the most serviceable timber is produced by trees on drier ridges. The wood of fallen trees is said to decay quickly, leaving the cylinder of bark intact. A tree over 50 ft. high may be seen in the Temperate House at Kew; the tufted habit of the branches has been more highly developed by necessary pruning.

Baker and Smith, *Pines of Australia*, 318 (1910).

Araucaria excelsa, R. Brown. (Fig. 30.)

NORFOLK ISLAND PINE.

A very beautiful tree, 150–200 ft. high, with a trunk 5–7 ft. in diameter. *Main branches* horizontal, in regular whorls, lateral branchlets horizontal or pendent. *Outer bark* peeling off in thin flakes. *Leaves* of two kinds, those on juvenile or lateral branchlets soft, awl-like, incurved, bright green, up to $\frac{1}{2}$ in. long; those of older and fertile shoots dense, overlapping, broadly ovate, up to $\frac{1}{4}$ in. long and $\frac{3}{16}$–$\frac{1}{4}$ in. wide at the base, with an incurved horny point, the whole leaf system coarser than in *A. Cookii*. *Cones* often broader than long, 3–4 in. by $3\frac{1}{2}$–$4\frac{1}{2}$ in. *Seeds* 1–$1\frac{1}{8}$ in. long and $\frac{1}{2}$ in. wide, exclusive of well developed wings, the apex of each scale being a soft, flat, triangular spine $\frac{3}{8}$–$\frac{1}{2}$ in. long and less than $\frac{1}{4}$ in. wide at the base.

Several forms have been given varietal names, but they do not appear to be very distinct.

Var. **albo-spica.**

Leaves and shoots silver-variegated.

Var. **gracilis.**

More compact than the type; a cultivated variety often utilized as a pot plant.

Var. **Leopoldii.**

Foliage compact glaucous-green.

Var. **Muelleri.**

A free-growing, vigorous plant.

Var. **Silver Star.**

Tips of shoots silvery.

Var. **virgata.**

Shoots long and whip-like.

A. excelsa is most nearly allied to *A. Cookii*, from which it differs in its more plumose habit and coarser foliage.

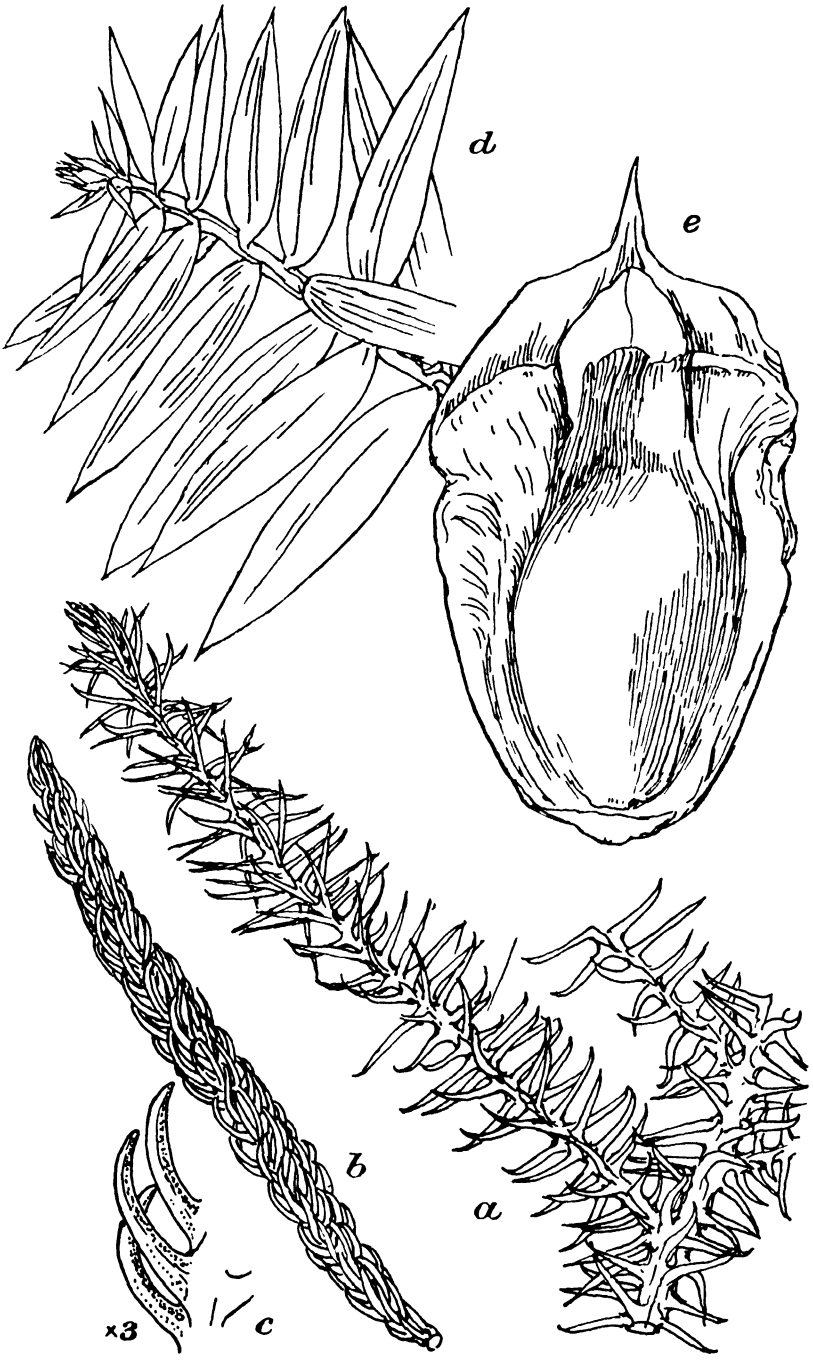

FIG. 30. *ARAUCARIA EXCELSA, A. BIDWILLII.*

Araucaria excelsa.—branchlet with spreading juvenile foliage ; *b*, branchlet with close mature foliage ; *c*, leaves of mature foliage. *A. Bidwillii.*—*d*, end of branchlet ; *e*, seed united to cone-scale.

It is confined to Norfolk Island, where it is perhaps the most characteristic tree.

Owing to the limited supply, very little value is attached to the timber. The wood is, however, equal in quality to that of other Araucarias and the tree has been planted rather extensively in S. Africa and other sub-tropical countries, where it may become of some importance as a timber-producer. It is very popular as an ornamental tree in the Mediterranean region, the Azores and other countries with a similar climate. It is not hardy in Britain but is used extensively as a pot plant for greenhouse and room decoration. The plant or its varieties is also grown in large numbers in Belgium and other European countries. For pot culture it is usually increased by cuttings made from erect shoots from cut-back plants. Little artificial heat is required, but plants should not be exposed to frosts. Trees are occasionally seen out of doors in Cornish gardens. *A. excelsa* was introduced to England in 1793.

Flore des Serres, 2304–5 (1877).

Araucaria imbricata, Pav.

CHILE PINE.

Monkey Puzzle.

A tree 50–150 ft. high, with a trunk 3–5 ft. in diameter, showing little taper. *Branches* horizontal, usually in distinct whorls, lateral branchlets horizontal or pendulous, deciduous after several years. *Bark* about ¾ in. thick, resinous. *Leaves* of one kind, spirally arranged, green for 10–15 years, but often remaining for many years longer after turning brown, crowded, overlapping, leathery, dark green, glossy, margins thickened, apex a sharp prickle, the surfaces marked with longitudinal lines, stomata on both surfaces. *Male and female flowers* usually on different trees, occasionally on the same tree. *Male catkins*, axillary, solitary or in clusters, erect, 3–5 in. long, about 2 in. wide, outline irregular with the long, sharp-pointed, and recurved appendages of the scales, often persisting for several years after shedding their pollen. *Cones* globular, brown when ripe, 4–7 in. long, 3–5 in. in diameter, taking 2–3 years to mature, falling to pieces as soon as the seeds are ripe. *Seeds* 1–1½ in. long, about ½ in. thick, bright brown, wingless, or with ridges on the edges suggesting rudimentary wings, each one bearing a long, triangular, stiff, recurved appendage at the apex.

Var. aurea.

Leaves golden in colour.

The Chile pine may be identified by its stiff, rigid, spirally arranged leaves.

It is found in Chile, Tierra del Fuego, and N. Patagonia.

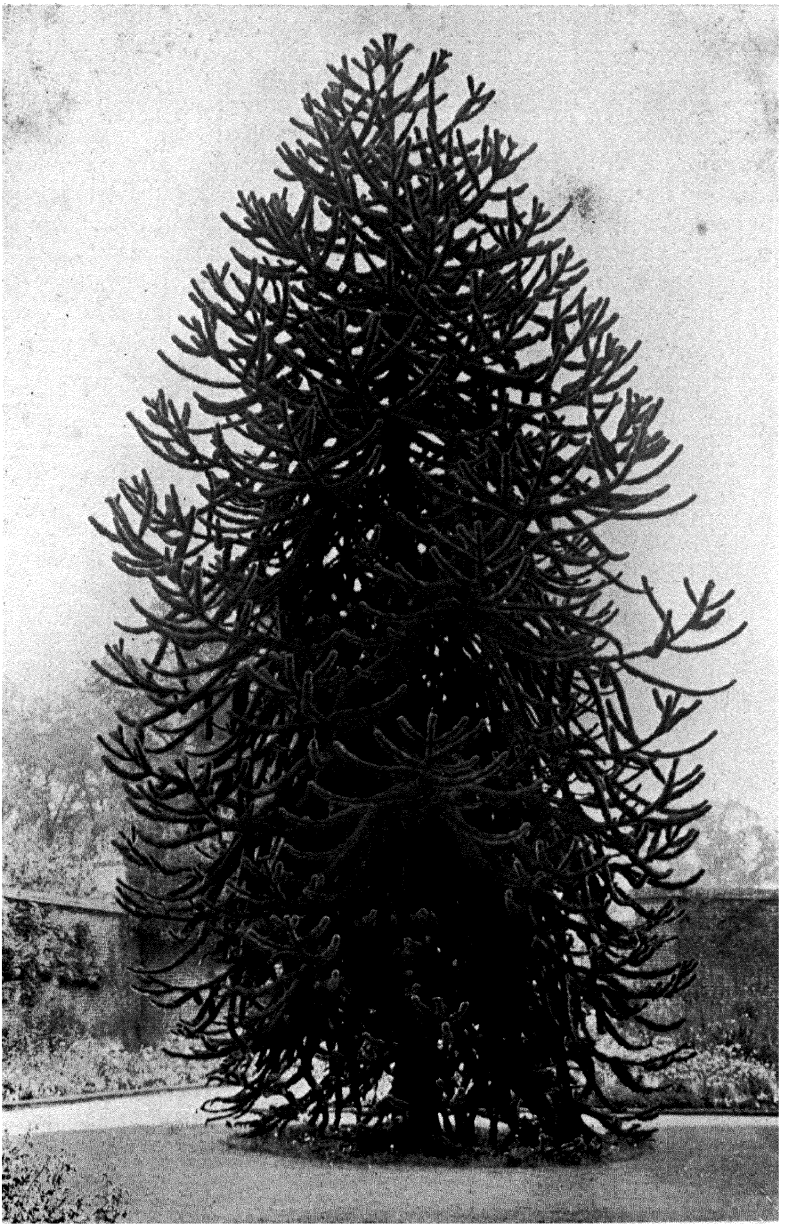

Photo. by E. J. Wallis.

PLATE IX. CHILE PINE (*ARAUCARIA IMBRICATA*).

In the Botany Reports of the Princetown University Expeditions, 1896–1899, it is referred to as follows: "*Araucaria imbricata* forests are met with within the coast Cordillera up to a height of about 1,500 m. and in the Cordillera up to 1,800 m. In S. Chile to the south of 30° 30′ lat.; N. Patagonia to 45° 30′ lat. principally on the eastern slopes of the Cordillera, also along the uppermost rivers forming gallery forest. It is also distributed on the west side of the Cordillera, viz. in the uppermost section of the evergreen forest." It was discovered about 1780 and was introduced fifteen years later by Archibald Menzies, who visited the coast of Chile at that time with Captain Vancouver. Menzies brought home living plants which he had raised on board ship, and one of them was sent to Kew, where it was eventually planted on a lawn near the present Cactus House. For a number of years it was carefully covered during winter to protect it from cold. Eventually it died, in 1892, at the age of nearly 100 years.

This Araucaria did not become common in cultivation until William Lobb sent home in 1844 a good supply of seeds, which produced most of the finest trees now in England.

The wood is yellowish, straight-grained, and easily worked. Knots, when present, are dark brown firmly fixed and afford a striking contrast to the rest of the wood. It is used for building purposes, masts, the indoor finish of houses, boxes, paper pulp, and most of the purposes for which pine is employed in the northern hemisphere. Timber produced in this country is of moderately good quality, although usually knotty. If obtainable in quantity it would doubtless realize about the same price as Scots pine. In S. America the wood is of considerable commercial importance, although it is scarcely known on the European market. The seeds are an important article of food in Chile.

Araucaria imbricata is one of the most remarkable trees that has been introduced to Britain, for besides being the only hardy *Araucaria*, it is one of the few S. American trees hardy in Britain. For many years after its introduction it attracted a good deal of attention and small trees were sold for as much as ten guineas each. It was one of the most treasured occupants of our gardens, and became so popular that it was overplanted and placed amongst most incongruous surroundings. Not many years ago a few trees were growing on the summit of Leith Hill in Surrey, where, amidst purely British vegetation, they struck a most discordant note. It was also planted in small gardens in front of villa residences, where it looked equally out of place. It is essentially a garden tree, but if planted in parks it should be grouped and not mixed indiscriminately with British types.

The Chile pine grows best where both soil and climatic con-

ditions are on the moist side. When planted in loamy soil that never becomes water-logged, it grows freely and retains its branches from the ground-line for fifty or more years. On dry, thin soils, however, and in a smoke-laden atmosphere, it loses its lower branches early in life and becomes ragged and unkempt. If branches are sawn off about half an inch from the base before they are quite dead, young shoots are sometimes formed from the stumps. Although it is usual to propagate the tree from seeds, cuttings of erect shoots from headed-back trees can be rooted. Cultivated plants vary a good deal in habit, the lateral branches of some being very stiff and ridged, whereas those of others are slender, pendulous, and bear much smaller leaves. This difference in habit has been suggested as a guide to sex, but the suggestion is without foundation. *A. imbricata* is used as an isolated specimen, in groups and for avenues. Good crops of seed are frequently ripened in England. It is probable that it would succeed as a timber tree in the S. of England.

The common name of *Monkey Puzzle* is said to have originated in Cornwall and not to be of S. American origin. On one occasion when the owner of a plant was exhibiting it to friends a remark was passed to the effect that "it would puzzle a monkey to climb that tree," and the owner forthwith adopted the name, "monkey puzzle," which still remains.

Elwes and Henry, *Trees of Great Britain and Ireland*, i, 44 (1906).

Araucaria Muelleri, Brongniart and Gris.

MUELLER'S ARAUCARIA.

A rare tree, which appears to form a connecting link between the two groups, for it has some of the characters of each. *Leaves* thick, leathery, 1–1¼ in. long, ½–⅝ in. wide, ovate, closely overlapping as in *A. imbricata*, sharp-pointed, with stomata on each surface. *Male catkins* terminal, up to 10 in. long and 1½ in. wide. *Cone* ovoid, 4½–6 in. long and 3½–4 in. wide, resembling a small cone of *A. imbricata*, the base closely clasped with leaves. *Seeds* about 1 in. long and ⅓ in. wide, with narrow, flimsy wings.

A. Muelleri appears to be most closely related to *A. Rulei*, from which it may be distinguished by larger and coarser leaves. From *A. imbricata* it is separated by shorter leaves and longer male catkins.

It is a native of New Caledonia and has no economic importance.

L'Illustration Horticole, xxix, 449.

Araucaria Rulei, Ferdinand von Mueller.

A. Niepratschki, Hort.; A. Van Gaertii, Hort.

A tree 50 ft. high, clothed with branches spreading on all sides of the trunk to a distance of 15 ft. *Branchlets* pendulous,

tail-like, up to 1¼ in. in diameter. *Leaves* dark green, glossy, incurved, closely overlapping and clasping the stem ; stiff, hard, leathery, very variable in length, on different plants, often ½–1 in. long, ¼–⅓ in. wide at the base, short-pointed at the apex, stomata very minute, on the upper surface only. *Male catkins* terminal, 2 in. long, 1 in. wide. *Cones* similar to those of *A. Cookii* ; apex of scale terminated by a spine-like growth ¾ in. long. *Seeds* about ⅓ in. long and $\frac{3}{16}$ in. wide, wings narrow.

Var. **Goldieana,** Mast.

This differs from the type by its smaller leaves and neater habit.

Var. **intermedia.**

Intermediate in foliage between *A. Rulei* and *A. Cookii.*

A. Rulei is closely allied to *A. Cookii* but is easily distinguished by its larger and stiffer leaves. The varieties *Goldieana* and *intermedia* appear to connect the two. The species is very variable, and whilst it has affinities with *A. Cookii* and *A. Balansæ* at one extreme, it bears a likeness to *A. imbricata* at the other. In Museum 3 at Kew is a branch specimen collected in New Caledonia which very strongly resembles *A. imbricata.* The leaves are thick, leathery, 1¼ in. long and ½ in. wide ; the margins are, however, more incurved than those of the S. American tree.

This species was discovered by Mr. W. Duncan, botanical collector to Mr. John Rule of Melbourne, near the summit of a lofty volcano on an island near New Caledonia where it is exposed to the violent hurricanes which sweep over that country. It grows in rocky debris which becomes very dry and hard in summer and is deluged with rain in winter. So inhospitable is the land that not a blade of grass or other sign of vegetation exists for hundreds of feet below. The whole group of trees in the locality is limited to a radius of half a mile. There is a small specimen in the Temperate House at Kew. It is probable that the plant may be hardy in Cornwall, but it is so scarce in cultivation that few, if any, experiments in outdoor culture appear to have been made.

The Agricultural Gazette of New South Wales, xviii, 905 (1907).

ATHROTAXIS, Don.

TASMANIAN CEDARS.

Evergreen trees, natives of Tasmania, belonging to the group *Taxodineæ* of *Pinaceæ. Bark* slightly furrowed, fibrous. *Branches* small, rather dense, irregularly disposed. *Branchlets* spreading, the ultimate divisions deciduous as in *Cryptomeria.*

The leaves of fallen trees are said to remain green for eighteen months.[1] *Buds* hidden by leaves. *Leaves small*, spirally arranged, crowded and overlapping, uniform in size and shape. *Male and female flowers* stalkless, borne on the same tree. *Male* flowers solitary and catkin-like from the points of the shoots with spirally arranged, crowded stamens. *Female flowers* solitary and terminal, with 12–25 spirally arranged scales, each bearing 3–6 pendulous ovules. *Cones* maturing the first season, resembling those of *Cryptomeria japonica*; *scales* woody, wedge-shaped at the base, spreading horizontally, with a triangular, spine-like process near the apex. *Seeds* small, thin, oblong, with two narrow wings, rather similar to those of *Sequoia*.

Wood pale red when newly cut, becoming lighter on exposure; open and straight-grained, light in weight, easily worked, and in good repute in Tasmania for cabinet-work, coach-building, and the internal finish of houses.

The trees are prominent figures amongst the scrub vegetation of the mountains and thrive on rocky ground. In a young state they are regular in outline, but old trees are gaunt with ill-shapen heads. They succeed out of doors in light, loamy soil, moderately free from lime in the moister and milder parts of Britain, and a specimen of *A. laxifolia* 8 ft. high has been noted as far north as Durris near Aberdeen. Propagation is usually by seeds or cuttings, but they have also been grafted upon stocks of *Cryptomeria japonica*. Cuttings should be inserted in sandy soil in a close, slightly warm frame, during late spring or early summer.

Athrotaxis cupressoides, Don.[2] (Fig. 31.)

Cunninghamia cupressoides, Zuccarini; Athrotaxis imbricata, Maule.

A tree 20–40 ft. high, with a girth of 3–5 ft. *Leaves* very small, scarcely $\frac{1}{8}$ in. long, pressed close to the stem and closely overlapping, thick in texture, apex blunt. *Cones* spherical, $\frac{1}{3}$–$\frac{1}{2}$ in. in diameter; scales woody, base wedge-shaped, apex rounded with a short, spine-like process on the outer side.

Recognized by its small, closely pressed leaves.

Found in the Western Ranges and Lake St. Clair district, Tasmania.

Athrotaxis laxifolia, Hooker. (Fig. 31.)

A tree 25–30 ft. high, intermediate in habit between the other species. *Leaves* larger and less closely pressed to the branch than in *A. cupressoides*, $\frac{1}{6}$–$\frac{1}{3}$ in. long and broad, thick in texture, with a pointed apex. *Cones* slightly larger than in the preceding species.

Summits of the Western Mountains, Tasmania.

[1] Baker and Smith, *Pines of Australia*, 306 (1910).
[2] *Trans. Linn. Soc.* xviii, 173, t. 13, f. 2 (1841).

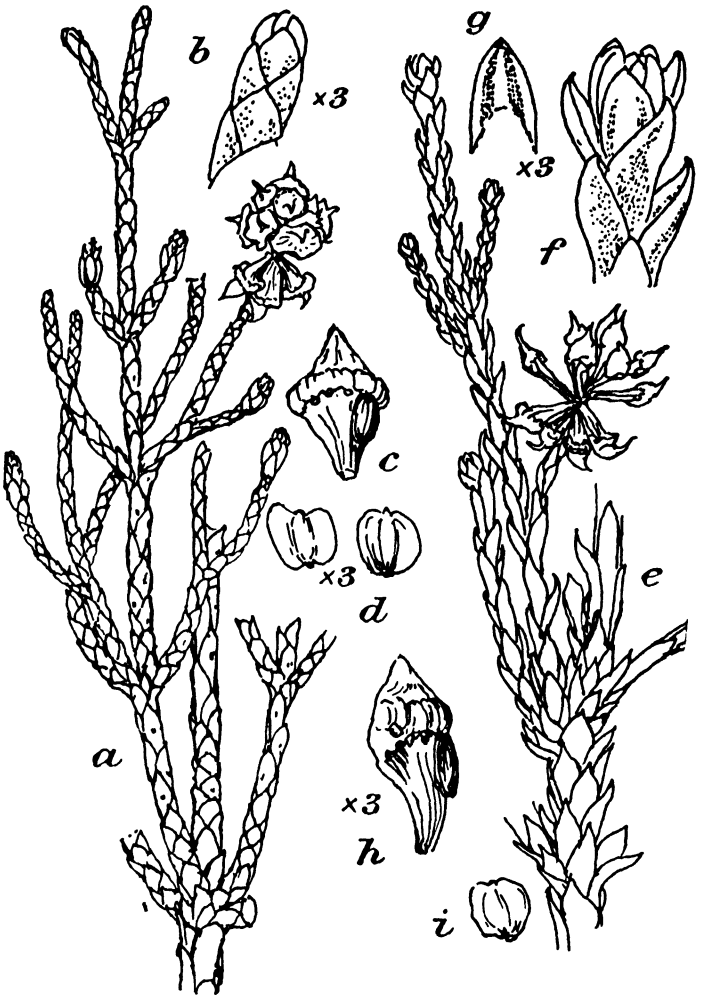

FIG. 31.—*ATHROTAXIS CUPRESSOIDES, A. LAXIFOLIA.*

Athrotaxis cupressoides.—*a*, spray with an expanded female cone and four male cones; *b*, end of branchlet; *c*, cone-scale with one seed attached; *d*, seeds. *A. laxifolia.*—*e*, spray with expanded female cone; *f*, end of branchlet, showing bands of stomata on leaves; *g*, inner face of leaf; *h*, cone-scale with a seed attached; *i*, seed.

Athrotaxis selaginoides, Don. (Fig. 32.)

KING WILLIAM PINE.

Cunninghamia selaginoides, Zuccarini; Athrotaxis alpina, van Houtte.

A tall, gaunt tree 100 ft. high and up to 9 ft. in girth. *Leaves* longer, broader, and more loosely arranged than in the other species; $\frac{1}{4}$–$\frac{1}{3}$ in. long, lance-shaped, leathery, sharp-pointed, keeled on the outer surface, curving inwards and loosely over-

lapping; stomata on each surface. *Cones* the largest in the genus, $\frac{1}{2}$–$\frac{3}{4}$ in. long and wide; scales woody, ending in a spine-like process.

Native of the Western Mountains of Tasmania at an altitude

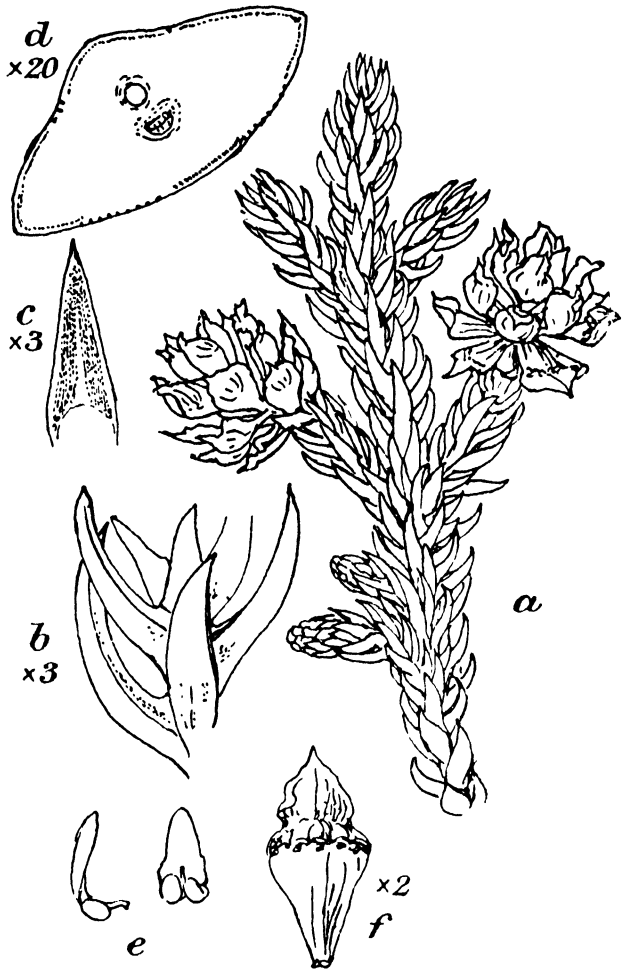

FIG. 32.—*ATHROTAXIS SELAGINOIDES.*

a, spray with two female cones, and two male cones; *b*, foliage showing stomata; *c*, inner side of leaf, showing stomatal buds; *d*, section of leaf; *e*, stamens; *f*, cone-scale with scars from which five seeds have fallen.

of 3,000–4,000 ft. Introduced about 1857 by Mr. W. Archer of Cheshunt.

Except that it is larger in all its parts it is very like the other species; in fact, they might well be regarded as gradations of one species. It appears to be much rarer in cultivation than the others.

CALLITRIS, Ventenat.

Cypress Pines.

Frenela, Mirbel; Fresnelia, Steudel; Leichhardtia, Sheph.; Pachylepis, Brongniart; Octoclinis, F. Mueller; Parolinia, Endlicher.

Evergreen trees and bushes natives of Australia and Tasmania. *Bark* hard, furrowed, or fibrous. *Branches* short, erect, divided into slender branchlets which are ridged by the closely pressed, sheath-like leaf bases. *Buds* hidden by leaves. *Leaves* in whorls of three, those of the adult stage closely clasping the shoot except at the triangular scale-like tip, which is sometimes slightly thickened and incurved; leaves of juvenile plants narrow, pointed, $\frac{1}{4}$–$\frac{1}{2}$ in. long. *Male and female flowers* on the same plant. *Male flowers* solitary, or 2–3 together at the ends of the shoots, cylindrical or oblong, the stamens in whorls of 3–4. *Female flowers* solitary or in clusters composed of 6–8 scales, bearing numerous ovules. *Cones* globular, ovoid or pyramidal, persisting for several years after shedding the seed; *scales* 6–8 arranged in one whorl, alternate ones shorter and narrower than the others, broad at the base, pointed at the apex, thick and woody, smooth or warty on the outer surface, not enclosed by bracts. *Seeds* oblong, 2–9 on each scale, with 2–3 broad wings.

Callitris is allied to *Tetraclinis* and *Widdringtonia*. From them it is distinguished by the larger number of cone-scales (normally four in each of the other genera). From *Tetraclinis* it also differs in its leaves being in whorls of three (in Tetraclinis they are in fours and the shoots have a distinctly jointed character), whilst *Widdringtonia* has the leaves in alternately opposite pairs.

Wood variable; dark, or light-coloured, with distinct heartwood and sapwood; hard, close-grained, fragrant, sometimes beautifully figured, finishes with a smooth surface, polishes well, and said to be proof against white ants, owing to the presence of a phenol and other chemical bodies. The timber is valuable for building purposes, furniture, panelling, pedestals, etc. Other economic products are tannin from the bark; fragrant oils by distillation of shoots, leaves, and cones; and resin, similar to sandarac of commerce, from wounds in the bark.

The species of *Callitris* are peculiarly adapted for dry, arid regions and are amongst the most useful Australian conifers, for, apart from their value in arid places, the resistance of the wood to the attacks of white ants makes it specially valuable.

Their culture in Europe is restricted to gardens and scientific collections. They thrive in the S. of France and may be grown out of doors in the warmer parts of Britain. Several species are cultivated in the Temperate House at Kew.

The following account of the species is based on the elaborate

research carried out by R. T. Baker and H. G. Smith [1] at the Technological Museum, Sydney, with the aid of herbarium and living specimens at Kew.

Callitris arenosa, A. Cunningham.

CYPRESS PINE.

Frenela arenosa, A. Cunningham; F. columellaris, F. v. Mueller; F. robusta, var. microcarpa, Bentham. White Pine.

A tree 40–60 ft. high, with a dense, shapely head of branches. *Bark* dark brown, rough. *Branchlets* divided into very fine spray. *Leaves* very small, glaucous, the free portion short-pointed, incurved. *Cones* solitary or in clusters, globose, ⅓–½ in. in diameter at the base; *scales* 6, alternately large and small, wrinkled but not warted externally, each with a small point or claw near the apex. *Seed* small, two-winged, dark brown.

Found in the Richmond River and Clarence River areas of New South Wales and on the S. Coast of Queensland.

Wood reddish brown, very fragrant, straight-grained, easily worked, takes a good polish and chiefly used for cabinet work and furniture; sometimes for building purposes and telegraph poles. Root wood is often beautifully marked and is valued for turnery and veneers. Bark moderately rich in tannin.

Callitris calcarata, R. Brown.

BLACK CYPRESS PINE.

Callitris fruticosa, R. Brown; C. sphæroidalis, Slotsky; Frenela australis, Endlicher; F. calcarata, A. Cunningham; F. Endlicheri, Parlatore; F. ericoides, Hort.; F. fruticosa, Endlicher; F. pyramidalis, A. Cunningham; Cupressus australis, Persoon; Juniperus ericoides, Noisette. Black Pine; Mountain Pine; Murray Pine; Red Pine; Scrub Pine.

An erect pyramidal tree 60–80 ft. high and 3–4½ ft. in girth. *Bark* hard, compact, dark brown or black, deeply grooved. *Branches* compact, branchlets divided into small spray. *Leaves* scale-like, the free tips sharp or blunt. *Cones* on stalks ¼–½ in. long, solitary or in clusters, about ½ in. long and ⅓ in. wide; *scales* 6, smooth or slightly roughened, each with a claw near the apex. *Seeds* small, black, wings much larger than the seeds.

Native of the E. States of New South Wales and also found in Queensland, where it usually occupies hills and ridges.

Wood dark brown, often finely figured and valued for the indoor finish of buildings, furniture, panelling for rooms, steamships and railway carriages; very durable as fencing. The bark is rich in tannin and a good resin is obtained from the tree.

C. calcarata is recommended for planting on dry and poor stony ground, for the bark of trees not attaining timber size can be used for tanning.

[1] *A Research on the Pines of Australia*, 13–289 (1910).

Callitris Drummondii, Bentham and Hooker fil.

DRUMMOND'S CYPRESS PINE.

Frenela Drummondii, Parlatore.

A shrub or a tree up to 50 ft. high. *Bark* hard, furrowed. *Branchlets* angular, longer, and more robust than in most species. *Leaves* larger than in most species, but pressed close to the branch except at the blunt tip. *Cones* solitary or in clusters, on stout stalks, globose, somewhat glaucous, about ½ in. long and wide; *scales* thick, woody, brown, surface roughened, the point near the apex very small; alternate scales only slightly smaller than the others.

Native of the coast of Western Australia, where it appears to be of little economic importance.

Callitris glauca, R. Brown.

MURRAY RIVER PINE.

Callitris Huegelii, Knight; C. Preissii, Miquel; Frenela canescens, Parlatore; F. crassivalvis, Miquel; F. Gulielmi, Parlatore. White Pine; White Cypress Pine.

A tree up to 100 ft. high and 6–9 ft. in girth, but sometimes little more than a bush; pyramidal when young, ultimately developing a spreading head. *Bark* hard, brown, furrowed. *Branchlets* divided into fine spray. *Leaves* very short, glaucous-green, pointed. *Cones* solitary or in clusters, globular, rounded at the apex, ½–¾ in. in diameter, on stalks ¼–⅓ in. long; *scales* 6, the smaller ones about three-quarters the size of the larger, woody but thin, roughened on the outside, the claw near the apex indistinct. *Seeds* 2–3-winged.

C. glauca is the most widely distributed species of the genus. It is a native of Australia, is usually found inland, and was described in 1825.

The timber is more extensively used than that of any other *Callitris*. It has brown heartwood and yellowish sapwood, is sometimes handsomely figured, is straight-grained, easily worked, polishes well, and is suitable for building purposes, panelling, cabinet-work, pedestals, columns, and fencing.

C. glauca has been recommended for sylvicultural work in the interior of Australia, as it withstands drought better than many trees.

Callitris gracilis, R. T. Baker.

MOUNTAIN CYPRESS PINE.

A tree 50–60 ft. high and 3–6 ft. in girth. *Bark* dark grey, hard, compact, furrowed. *Branchlets* slender, drooping, divided into small spray. *Leaves* small, short-pointed, bright green.

Cones large, solitary, round, flattened above and below, up to 1⅓ in. in diameter, on short stout stalks; *scales* 6, very thick and woody, the smaller ones about half the size of the larger, the surface smooth or slightly roughened, the claw indistinct. *Seeds* dark brown; wings very variable in size and shape.

A very local species, found only on Tal Tal Mountain and Gowie Range, Bylong, Rylstone, New South Wales. Originally discovered by Mr. J. Dawson in 1893.

The timber is described as straight-grained with a pleasing figure, and suitable for indoor carpentry and panelling.

Growing naturally on rocky ridges, it is recommended for afforesting barren places in Australia.

Callitris intratropica, Bentham and Hooker fil.

Frenela intratropica, F. v. Mueller; F. robusta, var. microcarpa, Bentham.

A tree up to 60 ft. high, somewhat resembling *C. arenosa*, but the internodes not ridged. *Leaves* glaucous, the free part spreading and shortly pointed. *Cones* spherical, wrinkled, under ½ in. in diameter; scales alternately large and small, comparatively thin, the point near the apex fairly prominent. *Seeds* 1, 2, and 3-winged.

Found in the northern part of the Northern Territory and the N.W. coast of W. Australia.

Wood dark coloured, heartwood reddish brown; uses as in *C. glauca*. Owing to the presence of a large percentage of oil and phenol it is one of the best white-ant-resisting species. The wood has been suggested for railway sleepers and is in great request in the Port Darwin district.

Callitris Macleayana, Bentham and Hooker fil.

PORT MACQUARIE PINE.

Callitris Parlatorei, F. v. Mueller; Frenela Macleayana, Parlatore; Leichhardtia Macleayana, Sheph.; Octoclinis Macleayana, F. v. Mueller. Stringybark.

A tall, pyramidal tree sometimes 150 ft. high and 9–12 ft. in girth, but usually much smaller. *Bark* red, fibrous, stringy. *Branchlets* prominently three-angled owing to the arrangement of the leaves. *Leaves* of two kinds, bright green, needle-like, often in whorls of 4, ¼–⅓ in. long, usually occurring on the lower branches; or reduced to minute scales on the higher shoots. *Cones* solitary, large, ovoid or pyramidal, 1 in. long and 1 in. wide at the base, narrowing to a pointed apex, on stalks 1 in. long; *scales* 6–8, thick, woody, pointed, almost equal in size, grooved on the back with a reflexed point near the apex. *Seeds* with a well-developed wing.

C. Macleayana is confined to the coast region of New South Wales north of Newcastle to Queensland.

Wood pale brown in colour, straight-grained, without figure, slightly fragrant, easily worked. It is suitable for cabinet-work, indoor finish of houses, fencing and panelling.

The tree is suitable for forests as well as for ornamental purposes.

Callitris Morrisoni, R. T. Baker.

MORRISON'S CYPRESS PINE.

A small tree 20–30 ft. high. *Branchlets* erect, divided into very fine spray, internodes short. *Leaves* small, scale-like, glaucous, blunt. *Cones* solitary or in clusters, globular, $\frac{1}{3}$–$\frac{1}{2}$ in. in diameter, smooth, grey in colour, on short, sturdy stalks ; *scales* 6, alternate ones much smaller and more regularly triangular than the others. *Seeds* two-winged.

Native of S.W. Australia, where it grows in rocky places. Originally brought to notice in 1903 by Dr. A. Morrison, Government Botanist of Western Australia, although specimens had been collected much earlier and confused with other species.

Callitris Muelleri, Bentham and Hooker fil.

ILLAWARRA PINE.

Frenela fruticosa, A. Cunningham ; F. Muelleri, Parlatore.

A tree of close, columnar, or fastigiate habit, up to 50 ft. high, with a dense crown of foliage. *Bark* hard, close, black. *Branches* rising at an acute angle with the trunk, branchlets dense with long internodes, appearing angled from the clasping leaf bases. *Leaves* somewhat spreading, olive-green, longer than in most species, the free ends rather blunt. *Cones* solitary or several together, rounded with a flattened apex, $\frac{3}{4}$–$1\frac{1}{4}$ in. wide ; *scales* 6, woody, the larger ones oblong and blunt, the smaller ones triangular and pointed. *Seeds* 2, rarely three-winged.

A rare species confined to a few localities in New South Wales. Timber not available in sufficient quantity to be of any commercial value.

Callitris oblonga, Richard. (Fig. 33.)

TASMANIAN CYPRESS PINE.

Callitris Gunnii, Hooker fil ; Frenela australis, R. Brown ; F. Gunnii, Endlicher ; F. variabilis, Carrière ; F. macrostachya, Gordon. Native Cypress.

An erect bush or small tree of symmetrical outline, up to 25 ft. high, with numerous branchlets divided into a dense mass of fine spray. *Leaves* very small, the free upper portion triangular acute, the lower closely pressed and forming angled internodes *Cones* solitary or in clusters, conical, the apex much narrowed

shortly stalked or sessile; scales 6, woody, the larger ones blunt, ¾–1 in. long, the others about half that length, the claw near the apex prominent. *Seeds* broadly oval, wings variable in size and shape.

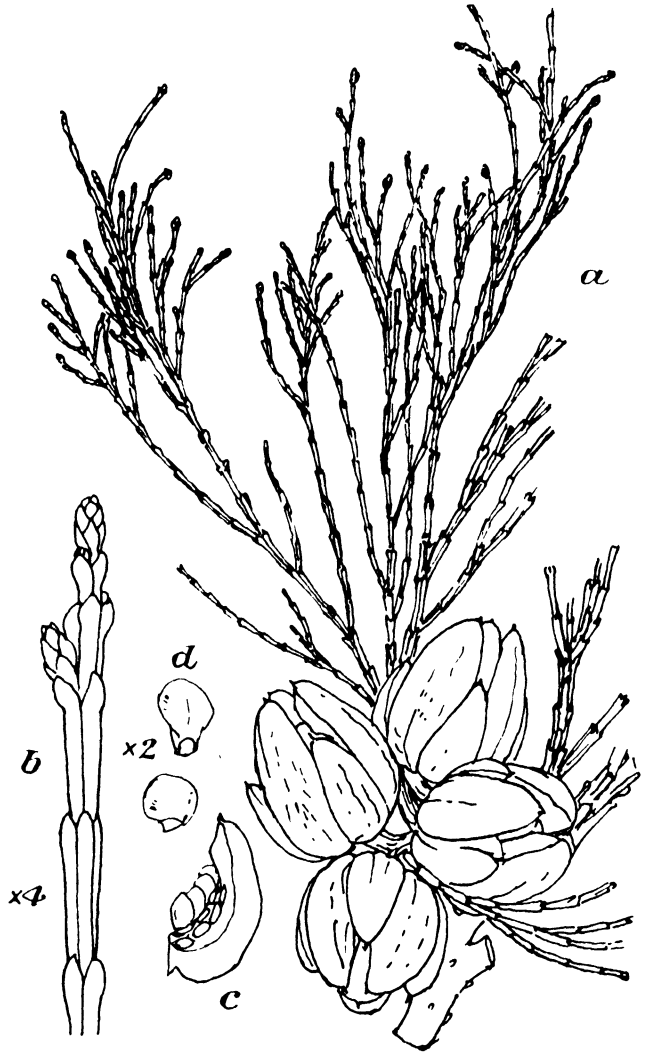

FIG. 33.—*CALLITRIS OBLONGA.*
a, spray with four expanded cones; *b*, end of branchlet; *c*, cone-scale with four seeds attached and four scars whence seeds have fallen; *d*, seeds.

C. oblonga is a native of Tasmania, where it is fairly common on the banks of the S. Esk and St. Anne's Rivers.

A plant now (1923) about 10 ft. high has been in cultivation at Rostrevor, Ireland, since 1893.

Gard. Chron. July 7, 1917, p. 3.

Callitris propinqua, R. Brown.

Frenela Moorei, Parlatore.

A rare tree up to 60 ft. high with a dense branch system divided into fine, compact sprays bearing very small, bright green leaves. *Cones* egg-shaped, smooth or roughened, glaucous, 1–1⅛ in. long; *scales* 6, the smaller ones narrower, but only slightly shorter than the large ones; claw well developed. *Seeds* dark-coloured, two-winged.

Native of Kangaroo Island, S. Australia, and S.E. New South Wales. It is too rare to be of any economic value.

Callitris rhomboidea, R. Brown.

ILLAWARRA MOUNTAIN PINE.

Callitris cupressiformis, Ventenat; Frenela attenuata, A. Cunningham; F. rhomboidea, Endlicher; F. triquetra, Spach; Cupressus australis, Desfontaine; Thuja australis, Poiret; T. articulata, Tenore. Cypress Pine.

A small tree 30–50 ft. high and 3–4½ ft. in girth of trunk, with a narrow, dense head of branches divided into a mass of small, slender spray. *Leaves* bright green, very small, closely pressed to the branches throughout their length, terminating in a short point. *Cones* globular, ⅓–½ in. across, grey brown, on short, stout stalks; *scales* 6, thick, rhomboidal, smooth with a prominent, pointed, central boss, the smaller ones about half the size of the larger. *Seeds* brown, rounded, small, with two very narrow wings.

Found in restricted areas in Queensland and New South Wales in the neighbourhood of Sydney.

Timber used locally for buildings and poles, but not plentiful enough to be of economic importance.

Callitris robusta, R. Brown.

COMMON CYPRESS PINE.

Callitris Preissii, Miquel; C. Suissii, Preiss; Frenela robusta, A. Cunningham; Widdringtonia equisetiformis, Masters; Black Pine; Dark Pine; Lachlan Pine; Light Pine; White Pine.

A very useful tree up to 100 ft. high. *Bark* hard, dark brown, furrowed. *Branches* erect, divided into numerous branchlets and small spray. *Leaves* light green, very small, the tips blunt and pressed close to the shoot. *Cones* in clusters, sessile or very shortly stalked, over 1 in. in diameter at the base, narrowing to the apex, 2 in. wide when expanded; scales thick, woody, tapering to a blunt apex, covered externally with oil or resin tubercles, the smaller scales about one-third shorter than the larger.

The species is widely distributed in Western Australia, where it is an important timber tree, the wood being light to dark brown, moderately hard, straight-grained, and easily worked.

It is suitable for building purposes, railway sleepers, posts and rails, furniture, etc. The cones are rich in oil.

Callitris Roei, Endlicher.

Frenela subcordata, Parlatore.

A shrub or small tree with stout, erect branches and angular branchlets. The attached parts of the leaves ridged, the points blunt and pressed close to the shoot. *Cones* globular, $\frac{1}{2}$–$\frac{3}{4}$ in. in diameter, on short, stout stalks ; *scales* 6, very thick, the smaller ones triangular and pointed, the larger ones blunt, smooth, prominently angled when closed.

A rare tree, apparently limited to a few localities in Western Australia.

Callitris sulcata, Schlechter.

Frenela sulcata, Parlatore ; F. balansæ, Brongniart and Gris.

A symmetrical tree 40 ft. high, with an erect, smooth trunk and a conical outline. The young shoots bear free leaves in whorls of 3–4, the leaves being narrow, clasping the stems, and about $\frac{1}{4}$ in. long and $\frac{1}{20}$ in. wide, gradually diminishing in length on older branches and passing into the mature, almost completely adnate type of leaf.

Wood camphor-scented, very hard and durable. Abundant in the Comboui Valley, New Caledonia, and locally known as "Sapin de Comboui." It is a lowland tree found up to 1,000 ft. altitude.

Var. **alpina**, Compton.[1]

An alpine form of the above found up to 3,000 ft. altitude.

Callitris tasmanica, Baker and Smith.

Oyster Bay Pine.

Frenela rhomboidea, var. tasmanica, Bentham.

A bush or small tree up to 40 ft. high, with horizontal or drooping branches divided into fine spray. *Leaves* larger and coarser than in *C. rhomboidea*, to which it is closely allied. *Cones* solitary or clustered, $\frac{1}{2}$–$\frac{5}{8}$ in. wide, similar to those of *C. rhomboidea*.

Recorded from Victoria, New South Wales, and Tasmania.

Callitris tuberculata, R. Brown.

Little is known of this species. Baker and Smith [2] say that the decurrent leaves are glaucous like those of *C. glauca*, which it also resembles in the terete branchlets formed by the decurrent

[1] "Syst. Acc. Plants of New Caledonia" : *Journ. Linn. Soc.* XLV, No. 304, p. 432 (1922).

[2] *Loc. cit.* 99.

leaves, but the cones are somewhat like those of *C. robusta*, except in being smaller and more depressed.

Reported from Middle Island, York Island Bay.

This rare species was originally discovered and named by Robert Brown, who in 1802 collected specimens in the above localities, but was afterwards placed by Bentham as a synonym of *C. robusta*.

Callitris verrucosa, R. Brown.

TURPENTINE PINE.

Frenela verrucosa, A. Cunningham. Camphor Wood; Rock Pine.

A shrub or small tree up to 30 ft. high. *Bark* thick, dark brown. *Branches* short, erect; branchlets compact, divided into fine spray. Internodes very short. *Leaves* bright green, very small, the free ends short-pointed and pressed close to the branchlets. *Cones* solitary or in clusters, globular, 1 in. in diameter; *scales* 6, thick, woody, covered externally with wart-like oil tubercles, the larger ones twice the size of the smaller. *Seeds* two-winged.

C. verrucosa is found in the drier parts of New South Wales; also in W. Australia.

Wood pale brown, close-grained, easy to work and useful for constructive purposes, telegraph poles, and for railway sleepers.

CALLITROPSIS, Compton.[1]

A recently described genus closely allied to *Callitris* but distinct in the Araucaria-like foliage and in the structure of the cone.

Callitropsis araucarioides, Compton.

A tree of conical habit 30–35 ft. high, with an erect trunk and greyish bark resinous in all its parts. *Branches* horizontal. *Branchlets* cylindrical, fastigiate, forked, resembling those of an *Araucaria*. *Leaves* regularly arranged in 8 vertical rows, stiff, incurved, about $\frac{1}{4}$ in. long, $\frac{1}{5}$ in. wide, short-pointed, strongly keeled on the back, margin minutely toothed. *Male flowers* terminating the long branchlets, consisting of sessile pollen sacs borne on the bracts, which are arranged in about eight rows, like the leaves. *Cones* terminating short, lateral branches, consisting of 8 scales in 2 whorls of 4 each, separating at maturity and forming a cup-like involucre from which the ripe seeds are scattered. *Seeds* angular, scarcely winged. *Cotyledons*, two.

A native of New Caledonia, where it was found in 1914 in a single locality on serpentine rocks at an altitude of about 800 ft.

[1] *Journ. Linn. Soc.* XLV, 433, pl. 27 (1922).

CEDRUS, Lawson.

CEDARS (true).

Larix, Miller; Pinus, Linnæus; Pinus, section Cedrus, Parlatore; Abies, Poiret.

Evergreen trees belonging to the *Laricineæ* group of *Pinaceæ* found in the Syrian Mountains, the Himalaya, Atlas Mountains, and Cyprus; pyramidal in outline when young, often developing massive trunks and large table-like branches when old, the foliage borne in tufted masses except on terminal shoots. *Bark* of young trees greyish, thin and smooth, at length becoming brown, thick, deeply furrowed and broken into small irregular plates. *Branchlets* of two kinds: long terminal shoots, bearing scattered leaves, and short, spur-like shoots which bear tufts of leaves in false whorls. *Young shoots* clothed with greyish down. *Winter buds* minute, ovoid, with brown scales which remain on the shoots after the appearance of young leaves. *Leaves* needle-like, persistent, lasting 3–6 years, usually three-sided, with stomata on each surface and two marginal resin canals on the inner surface. *Male* and *female flowers* on the same or on separate trees, solitary and erect on the short shoots, appearing during late July and August, fully developed during late September and early October. *Male flowers* forming stiff, erect, cylindrical catkins up to 2½ in. long and ⅓–½ in. wide, consisting of numerous densely crowded anthers which open longitudinally; pollen grains golden, wingless. *Female* flowers in small, greenish cones, about ½ in. long and ¼ in. in diameter at the time of pollination; *scales* numerous, closely overlapping, rounded above, narrowed to a claw-like process at the base. *Ovules* two to each scale. *Cones* large, erect, barrel-shaped, resinous, on short, stout stalks; bracts very small (or absent); *scales* woody, closely overlapping, fan-shaped with a basal stalk-like claw. *Seeds*, two to each scale, each with a broad membranous apical wing several times larger than the seed. *Cotyledons* 9–10. Pollination takes place in October, but the cones only begin to grow the following spring and do not attain their full development until about two years after the first appearance of the flowers. They are fully matured about two years after pollination, and break up irregularly between that time and the following spring, leaving the central axis on the tree as in *Abies*. The break-up of the cones appears to be hastened by wet weather.

Cedrus is distinguished from *Larix* by its evergreen leaves and large cones with deciduous scales.

Wood oily, sweet-scented, normally without resin ducts; sapwood yellowish white, heartwood brownish, becoming darker on exposure, very durable, and an important timber in the Himalaya and N. Africa. The wood, however, must not be confused with

the " cedar " of most timber merchants, which usually refers to a species of *Cedrela* or some other genus, almost certainly not *Cedrus*. About seventy different kinds of wood are known under the trade term of " cedar " with one or another prefix.[1]

Oil is obtained by distillation of the wood.[2]

The cedars are hardy in many parts of the British Isles and grow into noble trees, especially when allowed ample space for development. In small gardens or amidst cramped surroundings they are quite out of place. The best results are obtained by planting in moist but well-drained loamy soil, although good specimens can be grown on drained peat.

Propagation is by seeds which must be sown as soon as possible after they are ripe. They give the best results when sown in pots or boxes or in beds under glass, a cold frame being perfectly suitable. Young plants, if moved biennially whilst in the nursery, may be safely transplanted up to a height of 10 or 12 ft. The varieties are increased by grafting upon stocks of the type.

The distinctions between the so-called species of *Cedrus* are of a trivial character and seem to depend for the most part upon habit. As individual trees vary considerably in this respect, it seems reasonable to suppose that they are geographical forms of one species. From the horticultural standpoint, however, it is more convenient to regard them as species.

Cedrus atlantica, Manetti. (Fig. 34.)

ATLAS CEDAR.

Cedrus africana, Knight; C. Libani, Mathieu; Pinus atlantica, Endlicher; P. Cedrus, Linnæus; Abies atlantica, Lindley and Gordon. Algerian Cedar.

A tree up to 120 ft. high, pyramidal when young, with an erect leading shoot, ultimately assuming a similar habit to old trees of *C. Libani*. *Young shoots and leaves* identical with those of *C. Libani*. *Cones* usually smaller and more cylindrical than *C. Libani*, up to 3 in. long and 2 in. wide; *scales* about 1½ in. wide. *Seed* about ½ in. long, seed and wing together 1–1⅛ in. long, wing wedge-shaped.

Found on the Atlas Mountains in both Algeria and Morocco. Introduced about 1845 by seeds taken from cones collected by Lord Somers[3] at Téniet-el Hâad.

Clinton-Baker, *Illust. Conif.* i, 69 (1909).

Var. **aurea**, Hort.

Leaves golden. An effective plant when well grown, but not easy to cultivate.

[1] Dallimore, *Kew Bull.*, 1913, 207–224.

[2] Kremers (Gildermeister and Hoffmann), *The Volatile Oils*, ii, 134 (1916).

[3] One of the original plants raised from Lord Somers' seed is now a magnificent tree, 93 ft. high by 11 ft. 8 in. in girth (at Westonbirt, Gloucestershire). It was planted in 1847 by the late Mr. R. S. Holford.

Var. **fastigiata**, Carrière.

Of stiff, erect habit with short, sturdy branches.

Var. **glauca**, Carrière.

Leaves of a beautiful blue or glaucous hue. One of the most effective and widely grown conifers.

Var. **pendula**, Carrière.

Branchlets pendulous.

The timber of trees grown for decorative purposes is knotty, but of good quality, and trees grown without side-branches will probably furnish useful timber.

The Atlas cedar is an excellent avenue tree provided it is given ample space for development, and appears to be better suited for towns than either the deodar or Lebanon cedar.

Cedrus brevifolia, Henry fil.

CYPRUS CEDAR.

Cedrus Libani, var. brevifolia, Hooker.

This differs from *C. Libanii* and *C. atlantica* (of one of which it may be a depauperate form) by its more or less stunted habit, short leaves (up to ½ in. long), and small cones. The cedar forests in Cyprus composed of this tree are said to cover about 500 acres on the principal watershed of the southern range at about 4,500 ft. altitude. The largest tree is stated to be 60 ft. high and 11 ft. 6 in. in girth at 5 ft. above the ground, but there are many trees 40 ft. high. It was introduced by Sir Samuel Baker in 1879, but is rare in cultivation. There are small stunted examples at Kew, but they have no decorative value.

Beissner, *Nadelh.* 329 (ed. 2, 1909); *Trees of Great Brit. and Ireland*, iii, p. 467 (1908).

Cedrus Deodara, Loudon. (Fig. 34.)

THE DEODAR.

Cedrus indica, Chambers; C. Libani var. Deodara, Hooker; Abies Deodara, Lindley; Larix Deodara, C. Koch; Pinus Deodara, Roxburgh.

A tree exceeding 200 ft. in height and 35 ft. in girth in the Himalaya. *Bark* greyish brown, divided into irregular, oblong scales. *Leading shoots* of young trees and branches pendulous. *Leaves* 1–1½ in. (occasionally 2 in.) long, dark green, glaucous or silvery, sharply pointed. *Male and female flowers* often on separate trees, but sometimes on the same tree, in which case they are on separate branches.[1] *Cones* barrel-shaped, 3–5 in. long, 2–3½ in. in diameter (proportionately the largest in the

[1] Troup, *Silv. of Ind. Trees*, 1,101 (1921).

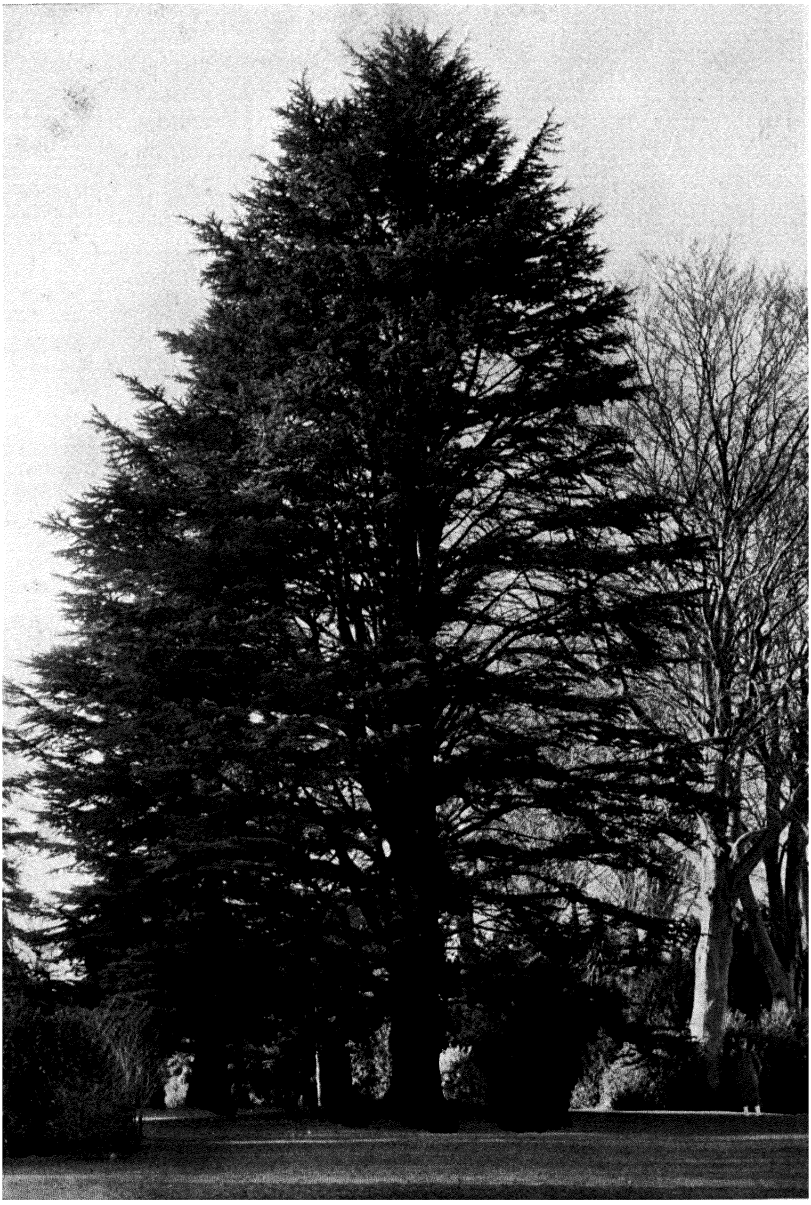

Photo by R. A. Malby

PLATE X. ATLAS CEDAR (*CEDRUS ATLANTICA*) AT WESTONBIRT, GLOUCESTER. 93FT. × 11FT. 8IN. PLANTED IN 1847.

genus); *scales* numerous, fan-shaped, 1¼–1½ in. across. *Seeds* triangular with a broad wing, the seed and wing 1–1¼ in. long.

Var. **albo-spica.**

Tips of young shoots white.

Var. **crassifolia**, Hort.

A stiff-habited tree of stunted appearance with thicker and shorter leaves than the type. Suggestive of a high-altitude plant.

Var. **erecta.**

Narrower and less pendent than the type.

Var. **pendula**, Beissner.

Leading shoot and branches very pendent. In order to induce vertical growth the leading shoot must be staked.

Var. **robusta**, Hort.

Leaves longer and stouter than is usual in the type (usually about 2 in. long).

Var. **viridis**, Knight.

White or silvery leaves occur amongst others of normal colour.

Var. **viridis.**

Leaves grass-green.

The deodar is distinguished from other species by its longer leaves and pendulous leader.

C. Deodara is widely distributed through the W. Himalaya from Afghanistan to Garhwal, at 4,000–10,000 ft. elevation, where it is the most important conifer. The best forests are found [1] where the rainfall varies from 40–70 in., but trees of timber size occur where the annual rainfall is below 30 in. provided the soil is deep and good. According to Ravenscroft it was introduced to Britain in 1831, the Hon. Leslie Melville sending seeds to Scotland, Dropmore, and elsewhere. There are many fine trees in gardens in the south and west of England, though none have reached maturity. One of the original trees was planted at Kew, but it was removed in 1888. A fine tree (probably one of the oldest in cultivation) is growing on the lawn at Westonbirt. It was planted by the late Mr. R. S. Holford about 1832, and is now over 90 ft. high by 9 ft. 10 in. in girth. Disappointment has been caused by some of the older trees becoming thin and rapidly losing branches when 30–40 years old. In some cases this has been traced to the fact that many of the earlier trees were increased by grafting upon stocks of larch (*Larix europœus*).

[1] Troup, *loc. cit.* 1098 (1921).

Wood moderately hard, oily, strongly scented and very durable, both when used in roofs and in contact with the soil. Amongst other purposes it is extensively used for buildings, railway sleepers, general carpentry, and furniture. A fragrant oil is distilled from the wood.

The deodar is being tried under sylvicultural conditions in some parts of the British Isles, but there are no plantations old enough to enable us to judge of its value for this purpose. In the milder parts of the country, however, growth is satisfactory. Prof. Troup [1] gives an excellent account of its requirements under natural conditions, with numerous illustrations of old and young trees.

Cedrus Libani, Loudon. (Fig. 34.)

CEDAR OF LEBANON.

Cedrus patula, Koch; Pinus Cedrus, Linnæus; Larix Cedrus, Miller; L. patula, Salisbury; Abies Cedrus, Poiret.

A majestic tree 70–100 ft. high, with a massive trunk 16–25 ft. or more in girth. Branches of young trees often erect or ascending, the leading shoot usually drooping or bent at the tip. Trunks of old trees often dividing into several stout, erect branches, side-branches horizontal, sometimes extending for a considerable distance from the trunk. Branchlets numerous and spreading so as to form a wide, table-like surface. *Leaves* $\frac{3}{4}$–$1\frac{1}{4}$ in. long, green or glaucous, needle-like. *Cones* barrel-shaped, 3–$4\frac{1}{2}$ in. long, $1\frac{3}{4}$–$2\frac{1}{2}$ in. wide (usually a little smaller than those of the deodar); *scales* up to 2 in. wide. Seeds as in *C. atlantica*.

Var. **argentea,** Antoine.

Leaves glaucous. Common in the Cilician Taurus.

Var. **aurea.**

Leaves golden.

Var. **decidua,** Carrière.

Leaves falling before the end of winter, especially after severe weather. There are trees of this variety at Kew.

Var. **nana,** Loudon.

A tree of low, stunted habit.

Var. **pendula,** Knight.

Branches weeping.

Var. **stricta,** Carrière.

Branches stiff and erect.

[1] *Loc. cit.*

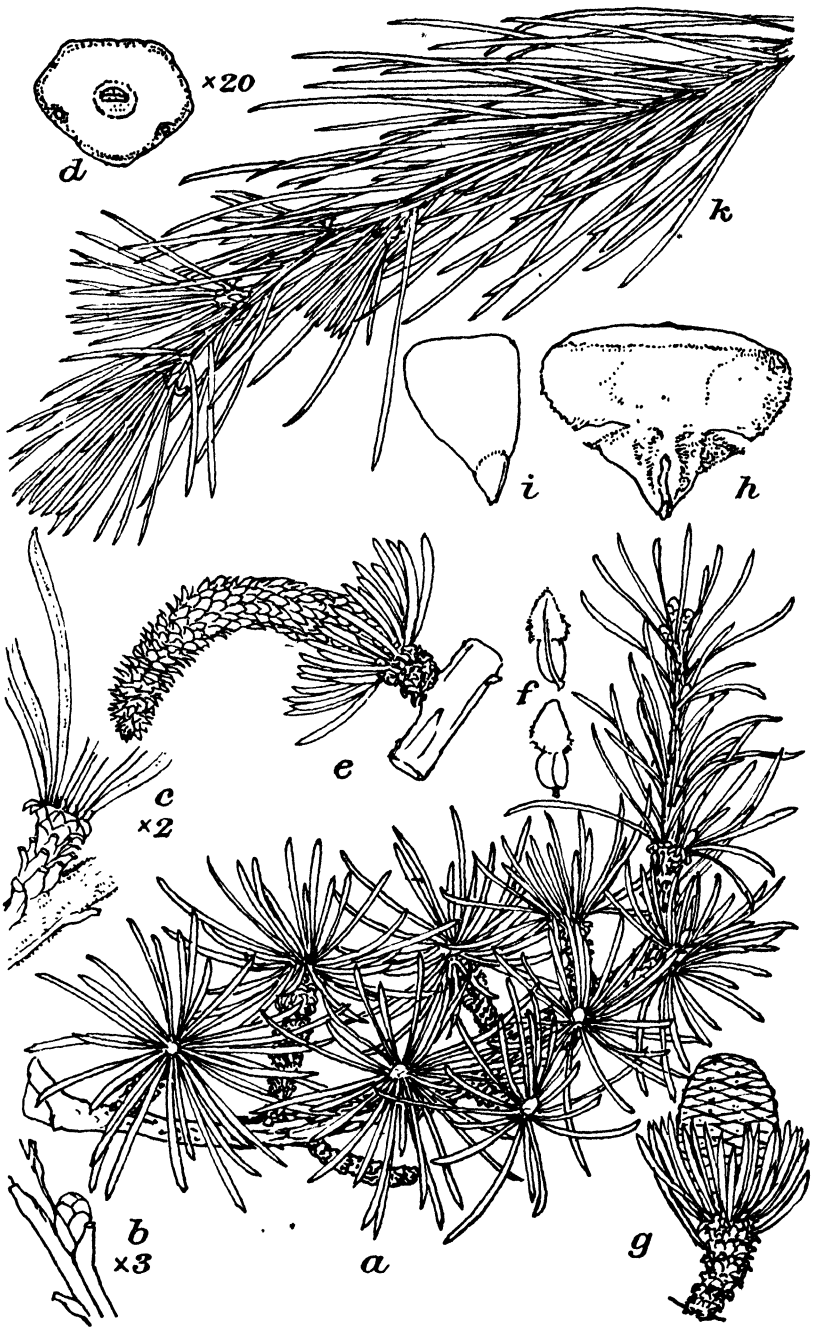

FIG. 34. *CEDRUS LIBANI, C. ATLANTICA.*

Cedrus Libani.—*a*, spray with many short shoots and one long shoot; *b*, winter bud; *c*, leaf and leaf bases on short shoot; *d*, section of leaf, showing two resin canals. *C. atlantica.*—*e*, short shoot bearing male cone; *f*, stamens; *g*, young female cone; *h*, cone-scale with a small slender bract; *i*, seed. *C. Deodara.*—*k*, spray.

Var. tortuosa.

A rare form with contorted branches.

C. Libani is distinguished from *C. Deodara* by its less pendent branchlets and shorter leaves, and from *C. atlantica* by the more or less drooping leader and by the general habit. Leaf specimens of *C. Libani* and *C. atlantica* are often difficult to identify.

This species is now rare in the Lebanon Mountains but is still plentiful in the Cilician Taurus. The best historical account of the Lebanon cedars is given by the late Sir J. D. Hooker.[1] The species appears to have been introduced to England between 1670 and 1680. though it may have been introduced as early as 1638.

Timber of home-grown trees is sometimes offered for sale, but it rarely realizes a satisfactory price. Although usually coarse and brittle it is very durable, and that sawn up on private estates has been used with good results for rough carpentry, rafters, wall-plates, beams, floor-boards, cattle-troughs, washing-tubs, fencing, greenhouse doors, and other purposes. It has also been employed for furniture and panelling, but lacks "figure." Drawers and chests made of this wood are usually avoided by insects. The wood is esteemed for firewood on account of its fragrant odour, but it is a pity to use clean wood for that purpose which might be put to more important uses.

Old specimens of Lebanon cedar are among our most picturesque evergreens, the massive trunks and symmetrical heads of widely spreading branches lending an aspect of dignity and beauty to our parks and gardens. *C. Libani* is quite hardy and thrives under a wide range of conditions. Planted in deep, light, loamy soil, growth is very rapid, and a space of $\frac{1}{4}$–$\frac{1}{2}$ in. between the wood rings is common. There are many fine specimens at Goodwood, Claremont, Bayfordbury, Pain's Hill, Cobham, Longleat, and elsewhere. Elwes measured a tree at Pain's Hill in 1904 which was 115–120 ft. high and 25½ ft. in girth.

Elwes and Henry, *Trees of Great Brit. and Ireland*, iii, 453 (1908); Clinton-Baker, *Illust. Conif.* i, 71 (1909).

CRYPTOMERIA, Don.

Cryptomeria japonica, Don.

JAPANESE CEDAR.

Cryptomeria Fortunei, Otto e Dietrich; Cupressus japonica, Linnæus f.; Taxodium japonicum, Brongniart. Goddess of Mercy Fir; Peacock Pine; Sugi.

This, the only representative of a genus belonging to the tribe Taxodieæ of Pinaceæ, is a very variable evergreen tree,

[1] *Nat. Hist. Rev.* vol. ii, 11 (1862).

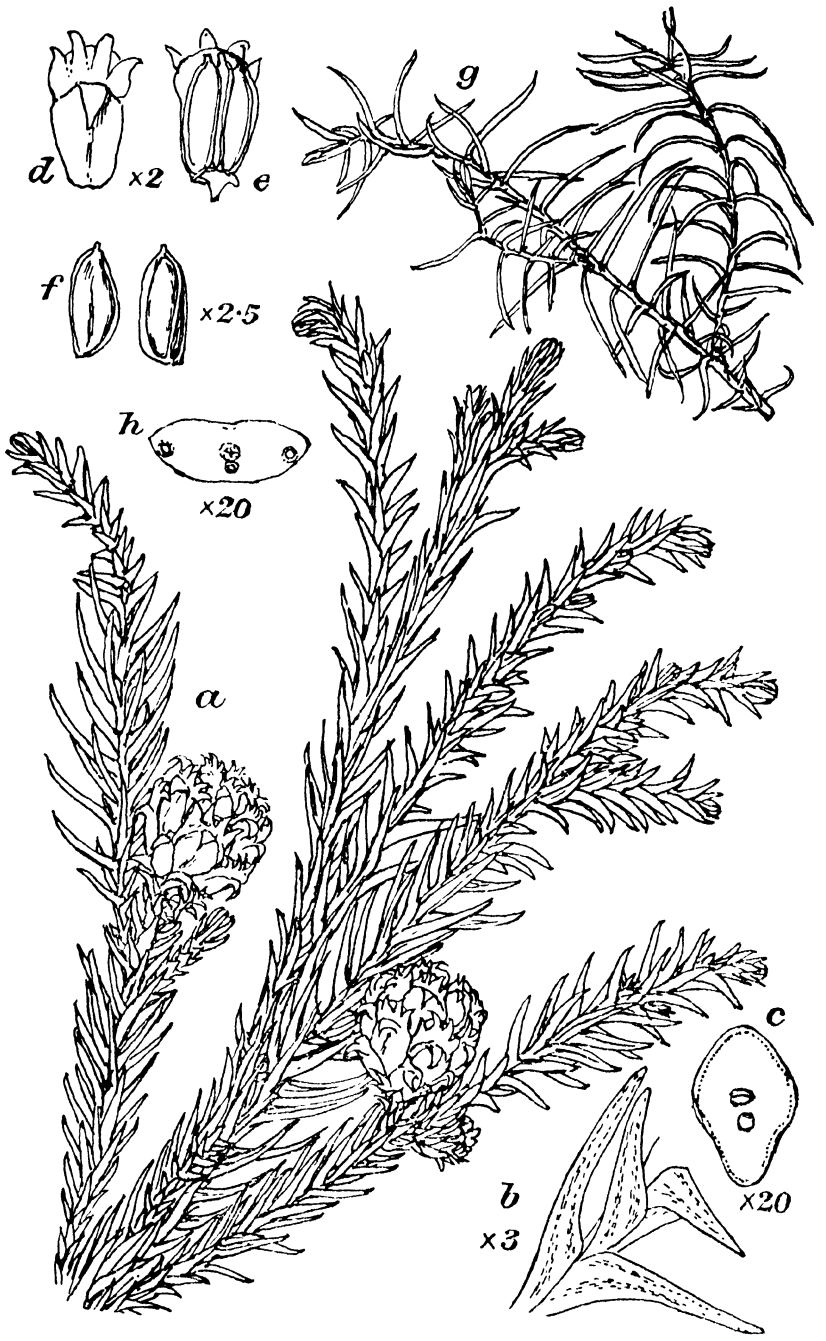

FIG. 35.—*CRYPTOMERIA JAPONICA and Var. ELEGANS.*

a, spray with three cones; *b*, leaves showing bands of stomata; *c*, section of leaf; *d*, cone-scale with its bract united below to the toothed seed-bearing scale; *e*, inner side of cone-scale, showing three seeds; *f*, seeds; *g*, spray of var. *elegans*; *h*, section of leaf.

attaining a height of 120–150 or more ft., and a girth of 15–25 ft., with a clean, tapering trunk rising above well-defined buttresses. *Bark* reddish-brown, fibrous, becoming detached in long shreds. *Branches* usually in whorls, horizontal or drooping. *Branchlets* spreading or drooping, eventually deciduous. *Young shoots* green, without down. *Winter buds* small, hidden by small awl-shaped, immature leaves. *Leaves* spirally arranged, persisting 4–5 years, awl-shaped, $\frac{1}{4}$–$\frac{1}{2}$ in. long, the first leaves of the year shorter than later ones, curving inwards, sometimes slightly twisted, pointing forwards, keeled on both surfaces, margins entire, apex tapering to a blunt point, base spreading and clasping the shoot, stomata on each surface. *Male and female flowers* on different parts of the same branch. *Male catkins* sub-terminal, in clusters of 20 or more from the leaf-axils, $\frac{1}{4}$–$\frac{1}{3}$ in. long, produced in autumn, expanding and shedding their pollen in March; orange or reddish when opening. *Female flowers* formed in autumn at the points of short branchlets, appearing in winter as small green rosettes of leaves. *Cones* brownish, globular, solitary, $\frac{1}{2}$–$\frac{3}{4}$ in. long and wide, ripening the first year and remaining on the trees for many months after shedding the seeds; *scales* 20–30, centrally attached to the axis; stalked, with 2–3 straight or curved, spine-like processes at the apex; the bract combined with the scale for the greater part of its length and showing as a recurved point on its outer surface. *Seeds* dark brown, irregularly triangular, up to $\frac{1}{4}$ in. long and $\frac{1}{8}$ in. wide, each edge narrowed into a rudimentary wing. A peculiarity of the species is that the growing shoot is sometimes prolonged from the apex of the cone.

Numerous forms have been given varietal names. Some of them are geographically distinct, others are of garden origin.

The following are geographical forms:—

Var. **Fortunei**, Otto and Dietrich.

C. japonica, var. sinensis, Siebold.

A variety with more slender and more drooping branchlets than the last two, with fewer scales to the cone, rarely more than 20, and usually two seeds to each scale. Native of China.

Var. **Lobbii**, Carrière.

C. Lobbiana, Billain.

A Japanese tree of denser and more compact habit than the var. typica, with longer leaves which are light green in colour. *Cones* with the processes and tips of the bracts longer and more slender than in the typical form. It is regarded as the hardiest form and was originally introduced from the Botanic Garden, Buitenzorg, Java, about 1853, by Thomas Lobb.

Var. typica.

This is the typical form occurring wild in Japan. It forms a tall, pyramidal tree with spreading branches and rather small, dark green leaves. *Bracts* of the cones long-pointed; *seeds* usually 5 to each fertile scale.

The garden forms include the following:—

Var. araucarioides, Henk. and Hochst.

Branchlets long, slender, and wide apart. *Leaves* dark green, short, stout, stiff, curving inwards.

Var. dacrydioides, Carrière.

Habit compact; branchlets rather short, slender. *Leaves* small, ¼ in. long, closely set, stiff, dark green. Elwes and Henry suggest that it may be a depauperate form.

Var. elegans, Masters. (Fig. 35.)

C. gracilis, Hort.; C. elegans, Veitch.

A well-marked variety of bushy habit in which the juvenile type of foliage is retained. *Branch system* dense, main branches short, branchlets numerous. *Leaves* spreading outwards and downwards, flattened, narrow, soft to the touch, ½–1 in. long, bright green in summer, changing to a reddish-bronze colour in autumn and winter, and back again to green in spring. *Cones*, rarely produced, smaller and smoother than those of the type. Introduced from Japan in 1861 by John Gould Veitch.

Var. elegans nana.

A dwarf plant of dense habit with crowded leaves, bearing the juvenile type of foliage.

Var. fasciata.

A stunted plant with many of the branches fasciated.

Var. Lobbii nana.

Of dwarf habit.

Var. nana, Fortune.

Var. pygmæa, Knight.

A low bush, usually below 3 ft. high, of compact habit with twisted or erect leaves.

Var. pendula, Leroy.

Lateral branchlets long, slender, pendent.

Var. pungens, Carrière.

Leaves straighter, stiffer, more spreading and sharper-pointed than in the type.

Var. **selaginoides.**

Branches long, slender, with short-tufted branchlets near apex.

Var. **spiralis,** Siebold.

Var. spiraltier falcata.

A curious variety with slender branches. *Leaves* closely pressed and twisted, giving a screw-like character to the branch.

Var. **albo-variegata.**

Shoots with white leaves occurring here and there amongst leaves of normal colour.

Var. **variegata.**

Leaves variegated with yellow.

The following varieties are grown under Japanese names :—

Var. **Kusari Sugi.**

A dwarf plant with clustered branches.

Var. **Ha-o-Sugi.**

Branchlets long, slender, and curving. *Leaves* thick, pointed, incurved.

Var. **Husari-Sugi.**

Branches curiously bent.

Var. **Sekkwia-Sugi.**

An erect tree of free growth with the point of every shoot fasciated.

Var. **Yenko-Sugi.**

A form with long, slender branches bearing few branchlets.

Cryptomeria is allied to *Araucaria* and *Sequoia*. It resembles *Araucaria Cunninghamii* in its spirally arranged foliage, but the leaves of the latter end in bristle-like points, whereas in *Cryptomeria* they are merely bluntly pointed. *Sequoia gigantea* differs in having its subulate leaves closely pressed against the branchlet and arranged in three ranks. In *Cryptomeria* the leaves are free in their upper half, and are arranged in five ranks.

It is a native of China and Japan, and was originally discovered in the former country in 1701 by J. Cunningham, and in Japan by Kaempfer in 1692. It, however, remained for Captain Everard Hume to introduce the tree to England, for he sent seeds to Kew in 1842. Two years later Fortune sent seeds to the Royal Horticultural Society.

Wood coarse-grained and fragrant, heartwood red, sapwood yellow or whitish. It is strong, durable, easy to work, very variable in grain, sometimes handsomely figured, and is one of

the most widely used timbers of Japan. Its uses include all kinds of building construction, panelling, furniture, joinery, boxes, etc., and it is not readily attacked by insects. The bark is also of importance, for it is carefully stripped from trees when they are cut down, and used for roofing houses and other buildings.[1]

Professor Sargent says[2] that Japan owes much of the beauty of its groves and gardens to the *Cryptomeria*. The tall, shaft-like stems tapering abruptly from a wide base, covered by the bright, reddish bark, and surmounted by regular conical dark green heads, are very impressive and are only rivalled by the Sequoias of California. They occur in natural and planted forests over extensive areas south of Hakodate and are particularly plentiful in Hondo. With the exception of *Pinus densiflora*, *Cryptomeria* is the most commonly grown conifer in Japan, thriving in open positions in a variety of soils. It has been planted in Japan from very early times. Under forest conditions it grows very fast and in State forests is treated on a 80–100 years' rotation ; the rotation in the Imperial forests being 60–120 years. *Cryptomeria* is stated to form 30 per cent.[3] of the total area of Japanese forests, but it is also widely planted in gardens and about temples. Sargent[4] gives an account of the impressive groups of this tree which surround the temples and the tomb of Ieyasu at Nikko and of the avenue which leads up to the tomb, along which the descendants of Ieyasu travelled from the capital of the Shoguns to do honour to the burial-place of the founder of the Tokagawa dynasty. This avenue, he says, " has not its equal in stately grandeur." The story of the creation of the avenue is as follows: " When the body of Ieyasu was laid to rest on the Nikko Hills, his successor in the Shogunate called upon the Daimyos of the empire to send each a stone or a bronze lantern to decorate the grounds about the mortuary temples. All complied but one man who was too poor to send a lantern but offered to plant trees along the road that future visitors to the tomb might be protected from the heat of the sun." His offer was accepted and has proved one of the most magnificent of all monuments. The avenue is kept intact, trees blown or cut down being replaced. This famous avenue was formed at the beginning of the seventeenth century.

Wilson[5] states that the most impressive *Cryptomeria* avenue he saw was the one on Koya-san on the borders of Yamato and Kii provinces, said to have been planted by a priest, Ogo Shonin, about 650 years ago. It is more than a mile long and consists of trees of surpassing grandeur, 120 to 180 ft. high and up to 25 ft. in girth.

[1] Sargent, *Forest Flora of Japan*, p. 74 (1894.).
[2] Sargent, *loc. cit.*
[3] *Forestry of Japan*, 93 (1910).
[4] *Loc. cit.*
[5] *Conifers of Japan*, 69 (1916).

The type and its varieties thrive in all except the coldest parts of the British Isles, where good moist soil is found. It is not a suitable tree for dry hard soils or for exposed situations. Recommendations have been made to the effect that it might be profitably planted for the production of pit props, but judging from its growth as a decorative tree there does not appear to be any reason to suppose that it can compete with pine, spruce, and larch. Trees 50–60 ft. high have been recorded in several parts of the country, but really well developed specimens are uncommon.

Elwes and Henry, *The Trees of Great Britain and Ireland*, i, p. 127 (1906).

CUNNINGHAMIA.

A genus of evergreen trees forming a connecting link between the *Araucarieæ* and the *Taxodineæ*. The foliage closely resembles that of some Araucarias in shape, but differs in having three seeds instead of one on each scale.

Cunninghamia sinensis, R. Brown.

CHINESE FIR.

Cunninghamia lanceolata, Hooker; Belis jaculiflora, Salisbury; Pinus lanceolata, Lambert.

An evergreen tree up to 150 ft. high, and 18 ft. in girth. *Bark* of old trees brown, shed in long irregular strips, showing the young reddish bark beneath. *Branches* of young trees more or less whorled, of old trees irregular. Lateral branchlets deciduous. *Young shoots* without down, densely clothed with leaves. *Winter buds* round, flattened, and covered by leafy scales, the flower-buds larger than the others. *Leaves* spirally arranged, those on the main axis standing out from all sides of the stem, those on the under-side of the branches turning upwards by a basal twist so that all appear to spring from the sides and surface of the shoot; persisting alive for five or more years and remaining dry and dead on the branches for several years more; lance-shaped, curving backwards, 1–2¾ in. long, $\frac{1}{16}$–$\frac{1}{8}$ in. wide at the base, green or glaucous-green, margins finely toothed, apex a long, slender point; stomata in a broad band on each side of the midrib on the under-surface. *Male flowers* sub-terminal in short catkins, about twelve of which form a dense cluster at the end of the shoot. They are formed in autumn and open in April. *Female flowers* sub-terminal, formed in autumn near the points of the shoots, enclosed in leafy scales, opening in April. *Cones* ovoid or rounded, 1¼–1½ in. long and wide, solitary or several together; *scales* brown, stiff, margins toothed, apex narrowed abruptly into a long spine. *Seeds* 3 to each scale, thin, about $\frac{3}{16}$ in. long and ⅛ in. wide, surrounded by a thin membraneous wing like that of *Sequoia*.

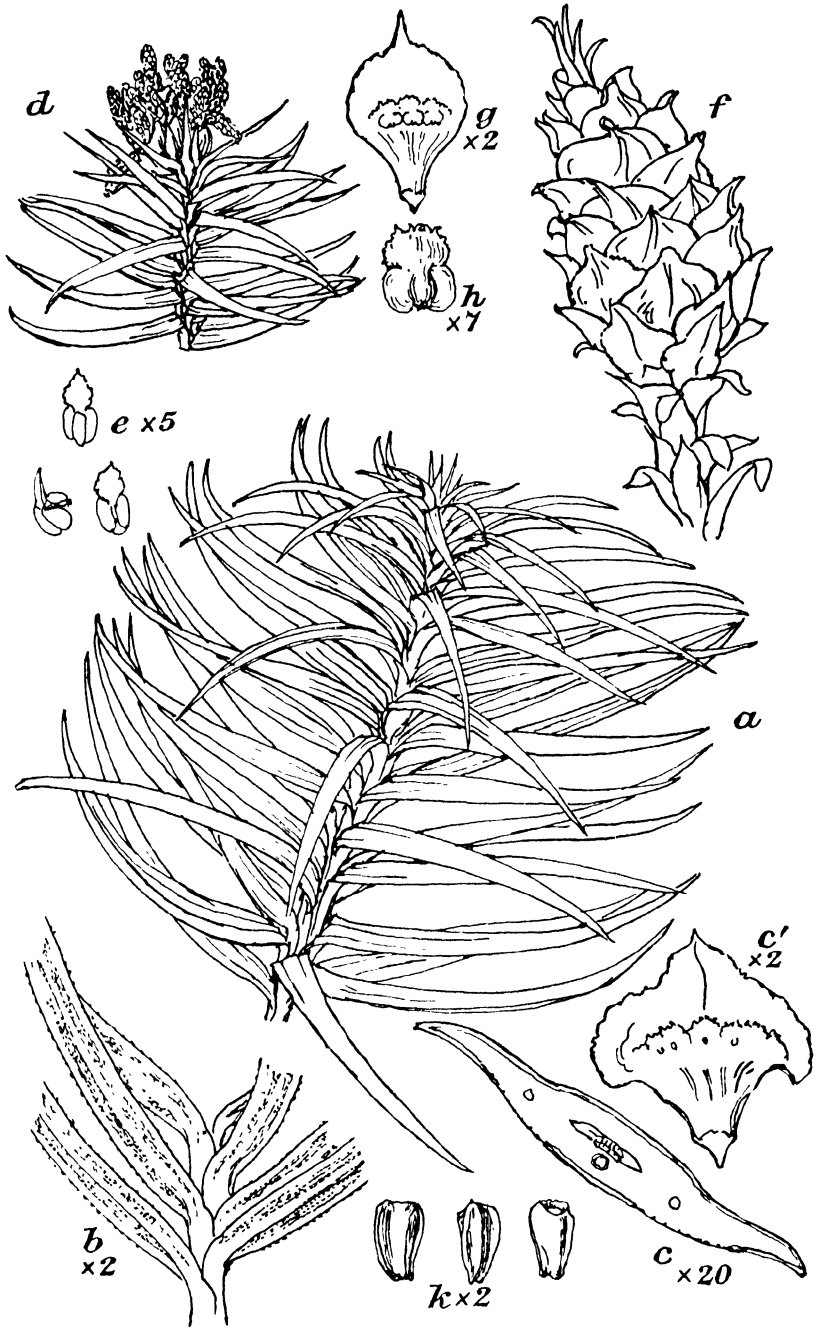

FIG. 36.—*CUNNINGHAMIA SINENSIS.*

a, branchlet; *b*, under-side of shoot, showing bands of stomata on leaves; *c*, section of leaf, showing three resin canals; *d*, cluster of male cones; *e*, stamens; *f*, female cone; *g*, cone-scale with three ovules attached below a toothed ridge; *h*, pendulous ovule; *i*, cone-scale, showing scars whence seeds have fallen; *k*, seeds with narrow wings.

Var. glauca.

Leaves glaucous or blue-green in colour.

The Chinese fir is widely distributed in the mountain valleys of Central and S. China, and was originally discovered in the Island of Chusan in 1701. It was introduced by William Kerr to Kew in 1804. Mr. E. H. Wilson found the tree in large forests at altitudes of 2,500–4,000 ft. in Omei Shan, and it is also plentiful in Ichang and W. Szechuen.

Wilson[1] gives a good deal of information about this species. He describes the timber as the most useful, next to bamboo, for all round work in China. The wood is light, soft, fragrant, pale yellow or almost white, easily worked, durable, and used for housebuilding, indoor carpentry, masts, planking for native craft, box-making, and largely for coffins. In some parts of China, trees buried by land-slides many years ago are dug out in an excellent state of preservation, but the wood is often much darker coloured than the ordinary timber. It is considered to be superior to newly felled timber, and the best boards are in request for coffins. Wilson states that the wood for a coffin may realize from 400–1,000 ounces of silver, and that selected thick planks are worth from £12 to £60 each. Wood produced by ornamental trees in Britain is clean, light, and fragrant.

In the *Kew Report* for 1878, p. 30, a list of Chinese coffin woods, compiled by Mr. Cecil C. Smith, who at one period was Colonial Secretary at Hong Kong, is given. Unfortunately the names of the trees producing the wood are not given, although from the accompanying descriptions several appear to be *Cunninghamia sinensis*. They are as follows :-

1. Pine from the upper four districts of Ting-chow, in Fokkien. Price £10 to £150 each.
2. Pine from the Tsing-lan (River), in Ting-chow, in Fokkien. Price £6 to £100.
3. Pine from Lan-chow, in Kwang-si. Price from £4 to £60.
4. Pine from Fu-chuen, in Kwang-si. Price from £4 to £40.
5. Pine from Foo-chow, in Fokkien. Price £4 to £40.
6. Pak-heung or Fragrant Cedar from Kwang-si. Price £34.
7. Yan-sha from Szechuen. Price £80.
8. Wai-muk (or Mast End) from Kwang-si. Price £2.
9. Pine from Tung-kong (Eastern River), in Wai-chow, in Kwangtung. Price £1.
10. Pine (common kind), named Sz-ni-luk, from Sz-ni, in Kwangtung. Price £15.

The value of all these woods, in the estimation of the Chinese,

[1] *A Naturalist in Western China* (1913.)

appears to depend upon their scent. Some of them are said to be of very dark colour, and they would appear to be the dark wood from buried trees described by Wilson.

The bark is durable and is often utilized in China for roofing houses.

In its natural state, when growing under forest conditions, it develops with a long, straight, mast-like trunk, 80–150 ft. high, clear of branches for half its height. In the open the branches are retained much lower on the trunk. Cut-over trees produce sprouts which form a means of renewing the forests. *C. sinensis* thrives in the warmer parts of Britain, and there are specimens 40–50 ft. high in Devonshire and Cornwall which bear cones freely. It succeeds at Kew; but during the severe winter of 1894–95 every plant was killed to the ground. The following summer young shoots were produced which are now 20–24 ft. high and up to 2 ft. in girth. They flowered in 1922. It is hoped that plants raised from seeds collected by Wilson at a high elevation will prove hardier than the plants of previous introduction.

The Chinese fir thrives in light, warm, loamy soil, and gives the best results in a warm, sunny position. In China it is said to be specially partial to red sandstone. Propagation is effected by seeds, sprouts, and cuttings. Its value in Britain is purely decorative.

Elwes and Henry, *loc. cit.* iii, 494 (1908).

Cunninghamia Konishii, Hayata.

A tree of moderate size. *Bark* reddish-brown, odorous. *Young shoots* without down. *Leaves* spirally arranged, crowded on the branches, not curved, persisting about eight years, narrowly triangular, without stalks, $\frac{3}{4}$–$1\frac{1}{3}$ in. long, $\frac{1}{10}$–$\frac{1}{8}$ in. wide, curving upwards, stiff, leathery, margins finely toothed, apex a long fine point, stomata on both surfaces but most conspicuous beneath.

Cones ovate or rounded, $\frac{3}{4}$–$\frac{7}{8}$ in. long, about $\frac{1}{2}$ in. broad; *scales* rounded with a distinct short claw at the base. *Seeds* 3 to each scale, ovate or elliptical, hard, surrounded by a narrow wing.

This species differs from *C. sinensis* by its smaller and more persistent leaves with stomata on both surfaces, the spiral arrangement of the leaves, and small ones.

C. Konishii was first collected by Mr. N. Konishi on Mt. Randai in the Island of Formosa. In habit it is said to be intermediate between *Cunninghamia sinensis* and *Taiwania cryptomerioides*.

Small plants are in cultivation at Kew, but they are not old enough to allow a correct judgment to be formed of their hardiness or decorative value.

Hayata, *Gardeners' Chronicle*, xliii, p. 194 (1908).

CUPRESSUS, Linnæus.

CYPRESSES.

Evergreen trees or rarely shrubs widely distributed throughout the warm temperate regions of the northern hemisphere. About 15 species, occurring in the Levant, N. America, the Himalaya, China and Japan, are recognized. *Branches* spreading or ascending, terminating in branchlet systems or sprays of foliage which are pinnately divided and clothed with closely pressed, scale-like leaves, overlapping in four ranks on the ultimate divisions, or awl-shaped on the main axes. *Male and female flowers* appear on the same tree. *Male catkins* cylindrical, terminal on the ultimate divisions of the branchlets, bearing numerous stamens, each composed of 2–6 globose anther cells. *Female flowers* consisting of peltate scales with the ovules in several rows at the base. *Fruit* a globose or ellipsoid cone formed of 4–14 woody, shield-like scales fitting closely together by their margins while growing, but separating when mature, each with a central boss or triangular process on the outer surface. *Seeds* 1–20 on each scale, winged.

The species are divided into two groups, (1) *Eu-Cupressus*, (2) *Chamæcyparis*, which are referred to in the accompanying key.

Plants with awl-shaped leaves like those of seedling plants or intermediate in character between juvenile and adult foliage were formerly separated as a distinct genus *Retinispora*, often spelled *Retinospora*, and this name is still used in gardens.

Wood light yellow to brownish, early and late wood not always strongly defined, heartwood and sapwood distinct in some species, not in others ; without resin ducts ; medullary rays very fine, but visible with a lens ; light, easily worked, finishing with a smooth surface ; odorous with a spicy-resinous, sometimes rather unpleasant, odour ; very durable and useful for building purposes, furniture, telegraph and telephone poles, fencing, general joinery and carpentry, and other purposes. Furniture made from the wood repels insects, but the odour is objectionable for some kinds of packing-case work, particularly where grocery and dairy produce are concerned.

Although several of the cypresses are important timber trees in their native countries, their principal use in Britain is for decorative purposes ; three species, *C. Lawsoniana*, *C. nootkatensis*, and *C. macrocarpa* are sometimes successfully planted under forest conditions. The *Chamæcyparis* group are hardier than the species included in *Eu-Cupressus*, otherwise they thrive under similar conditions. They succeed in a great

Photo by R. A. Malby

PLATE XI. LAWSON CYPRESS (*CUPRESSUS LAWSONIANA*) AT WESTONBIRT, GLOUCESTER.

variety of soils and are found flourishing in light and heavy loams, peat, and in almost pure sand, provided it is moist. Like other conifers, they require pure atmospheric conditions, but are less exacting in this respect than the firs and spruces. Moist atmospheric and soil conditions are essential to success. *Propagation* of the species should be by seeds which may be sown in spring in frames, in beds or boxes, or the hardier kinds may be sown in well-prepared outdoor beds with a very shallow soil covering. The varieties are increased by cuttings or by grafting upon stocks of their respective types. Cuttings are made of short shoots during July and August and are firmly inserted in sandy soil in a close cold or warm frame. If planted in a cold frame they must remain undisturbed until the following spring. Those placed in a warm frame are removed to a cooler place when rooted. Grafting is practised indoors from February to mid-April, the stocks having previously been established in pots. The stocks should be about the thickness of a lead pencil and the method of union known as side-grafting used. Plants, whether raised from cuttings or grafts, will probably require occasional pruning to correct too rapid lateral development. Permanent planting should take place when the plants do not exceed 3 ft. in. height, although it is possible to successfully transplant much larger specimens of the *Chamæcyparis* group, provided they have been carefully prepared by biennial transplanting while in the nursery. The *Eu-Cupressus* group are, however, difficult to re-establish, and it is usual to place *C. macrocarpa* in permanent places when 12–18 in. high or to keep young plants in pots until they can be utilized. Several species, including *C. macrocarpa* and *C. Lawsoniana*, can be used with effect for hedges, but they should be kept in shape and within bounds by the use of a knife or secateurs, as shears give a disfiguring effect. Pruning may be carried out during summer.

The species are divided into two sections, characterized as follows :—

Section I. *Eu-Cupressus.*

Leaves fringed with a narrow transparent border,[1] either uniform in four ranks or with boat-shaped lateral pairs and flattened facial pairs. Branchlet systems either flattened or arising at varying angles. Cones large, usually ½ in. or more, in diameter, ripening in the second year. Seeds usually 6 to 20 on each scale. Cotyledons 2 to 5. *C. torulosa*, *C. funebris*,[2] *C. lusitanica*, *C. cashmeriana*, *C. Duclouxiana*, *C. Macnabiana*,

[1] This can only be seen with a lens of considerable magnifying power.

[2] *C. funebris*, with its small cones and few seeds to each scale, forms a connecting link between the two sections.

C. arizonica, *C. sempervirens*, *C. macrocarpa*, *C. Goveniana*, *C. lusitanica*.

Section II. *Chamæcyparis*.

Leaves entire in margin, the lateral pair boat shaped, the facial pair flattened. Branchlet systems usually flattened. Cones small, not more than ⅓ in. in diameter, usually ripening in one year. Seeds 1 to 5 on each scale. Cotyledons always 2.

C. obtusa, *C. Lawsoniana*, *C. pisifera*, *C. nootkatensis*, *C. thyoides*, *C. formosensis*.

Key to Cupressus.

Branchlet systems flattened, pinnæ in one plane.
- Seeds more than 5 on each scale, cones ⅓–½ in. in diameter.
  - Leaf-tip appressed.
    - Branchlets equal-sided, leaves obtuse, cone scales without prominent processes.—*C. torulosa*.
    - Branchlets compressed, leaves acute, cone scales with prominent processes.—*C. lusitanica*, var. *Benthami*.
  - Leaf-tip spreading.
    - Branchlets, compressed, pendulous, foliage glaucous.—*C. cashmiriana*.
- Seeds 1 to 5 on each scale, cones ¼–⅓ in. in diameter.
  - Lateral leaves on branchlets larger than dorsi-ventral leaves.
    - Leaves obtuse, non-glandular, foliage with conspicuous Y-shaped white markings below.—*C. obtusa*.
    - Leaves acute, furrowed on back, foliage grey green, without white markings.—*C. funebris*.
    - Leaves acute, usually glandular, foliage green on under-side or with ill-defined white markings.—*C. Lawsoniana*.
  - Lateral and dorsi-ventral leaves on branchlets nearly equal.
    - Foliage with white markings on lower surface.
      - Leaves sharply pointed, cones globose, ¼ in. in diameter.—*C. pisifera*.
    - Foliage without white markings on lower surface
      - Leaves acute, foliage pale green, often tinged with bronze, cones egg-shaped ellipsoid.—*C. formosensis*.
      - Leaves acute or sub-acute without glands, foliage dull green, rank-scented, cones globose, ⅓ in. in diameter, scales 4, each with a prominent central point.—*C. nootkatensis*.
      - Leaves acute, glandular on the back, cones ¼ in. in diameter, glaucous.—*C. thyoides*.

Branchlet systems arising at different angles, pinnæ not in one plane.

Leaves with a conspicuous resin gland on back.

Branchlets compressed, foliage bright green, leaves obtuse. —*C. Macnabiana.*

Branchlets four-sided, foliage glaucous, leaves acute. —*C. arizonica.*

Leaves not conspicuously glandular.

Cones 1–1¼ in. long.

Leaves $\frac{1}{25}$ in. long, closely appressed, not swollen at tips, cones dull glossy brown or grey.— *C. sempervirens.*

Leaves $\frac{1}{16}$ in. long, appressed, swollen at the tips, cones shining reddish brown.— *C. macrocarpa.*

Cones ½–¾ in. long.

Leaves $\frac{1}{25}$–$\frac{1}{20}$ in. long, very fragrant. Cones obtuse, shining brown. —*C. Goveniana.*

Leaves $\frac{1}{16}$ in. long, acuminate, not noticeably fragrant. Cones glaucous.— *C. lusitanica.*

Cupressus arizonica, Greene.

ARIZONA CYPRESS.

C. guadalupensis, Sargent (not S. Watson). Red-barked Cypress; Arizona Red-barked Cypress.

A tree attaining in Arizona a height of 70 ft., with a girth of 12 ft. *Bark* reddish brown, separating into long, persistent flakes. *Branches* smooth, purplish brown, often glaucous. *Branchlets* irregularly disposed, bipinnate, the ultimate divisions quadrangular. *Leaves* with a disagreeable odour, grey or glaucous, in 4 ranks, closely pressed, ovate, short-pointed, $\frac{1}{20}$–$\frac{1}{12}$ in. long, marked on the back with a glandular resinous pit. *Cones* globose, shortly stalked, ½–¾ in. in diameter; scales 6–8 with prominent processes. *Seeds* 8–10 on each scale with a few inconspicuous resin tubercles.

This species is probably a northern form of *C. lusitanica*, but is readily distinguished by its greyish foliage and the glandular pits on the leaves exuding a whitish resin.

It occurs wild in the mountains of Arizona and in N. Mexico and was discovered in 1880 by Greene near Clifton in E. Arizona, forming pure forests of considerable extent at 5,000–6,000 ft. altitude. It was introduced into England in 1882 from the Arnold Arboretum, and only small trees are known in this country.

According to Sudworth a second species of *Cupressus*, which has been described as *C. glabra*, occurs in Cent. Arizona. It is said to differ from *C. arizonica* in its smooth, purplish bark and in the absence of the strong pole-cat-like odour which characterizes the leaves of that species. The leaves have large resin glands, those of true *C. arizonica*, according to Sudworth, being without resin glands. Most of our cultivated plants have conspicuously glandular leaves and therefore belong to *C. glabra* as defined by Sudworth.

The wood of *C. arizonica* is soft, close-grained, greyish with yellow streaks, and is used locally for general carpentry and for fuel.

It is only suitable for the warmest parts of England and Ireland.

Cupressus cashmeriana, Royle.

KASHMIR CYPRESS.

Cupressus funebris, var. glauca, Masters.

A small tree, apparently unknown in the wild state, although stated by Carrière to be a native of Tibet. In cultivation it is a tree of narrowly pyramidal habit with ascending branches and remarkably pendulous branchlets which are often several feet long, the older ones reddish brown and bare of leaves in the third or fourth year. *Branchlet systems* long and pendulous, conspicuously flattened, two- or three-pinnate, the ultimate divisions compressed. *Leaves* glaucous or of an iridescent tinge, $\frac{1}{16}$–$\frac{1}{2}$ in. long, with lance-like, spreading tips. *Cones* greenish yellow with a glaucous tinge when young, dark brown when mature, about $\frac{1}{2}$ in. in diameter, globose; *scales* 10, each with a central depression and an acute, triangular, reflexed process. *Seeds* numerous, about 10 to each scale, winged.

This, the most beautiful and elegant of all the cypresses, appears to be a juvenile form of *C. torulosa* which it closely resembles in its cones. It was formerly considered to be a well-marked variety of *C. funebris*, but differs from that species in the larger number of cone scales and in having about 10 seeds on each scale.

The well-known specimen in the Temperate House at Kew was cut down a few years ago owing to its having become too large for its position; there are, however, smaller ones in the same building. The most famous tree in Europe is that on the Isola Madre at Lake Maggiore. It is a specimen over 60 ft. high, of remarkable beauty. *C. cashmeriana* can be grown out of doors in the mildest parts of England and Ireland.

Cupressus Duclouxiana, Hickel.[1]

Cupressus sempervirens, Franchet (not Linnæus).

An elegant species closely allied to *C. sempervirens*, var. *horizontalis*, but differs from it in its slenderer, glaucous branchlets (about $\frac{1}{40}$–$\frac{1}{30}$ in. in diameter), with very small, obscurely glandular leaves about $\frac{1}{20}$ in. long. *Cones* globose, $\frac{3}{4}$–1 in. in diameter; *scales* usually 8, rather flat; *seeds* $\frac{1}{7}$ in. long, narrowly winged, with tubercles on the surface.

Native of Yunnan, China, and formerly confused with *C. sempervirens*. Young trees raised from Chinese seed are in cultivation in Normandy, Orleans, and in Cornwall.

Cupressus formosensis, Henry. (Fig. 37.)

FORMOSAN CYPRESS.

Chamæcyparis formosensis, Matsumura. Beniki.

A species attaining an enormous size in Formosa, where trees up to 195 ft. high and 72 ft. in girth have been recorded.[2] It has the flattened branchlet systems characteristic of the section *Chamæcyparis*, with the ultimate divisions flattened. *Leaves* dull green tinged with brown, often whitish on the lower surface; closely pressed but free at the incurved and shortly mucronate apex, the lateral ones boat-shaped, as long as the facial ones, which are ovate and $\frac{1}{16}$ in. long, either keeled or with a glandular pit. *Cones* ripening in the first year, ellipsoid, $\frac{1}{3}$ in. in diameter; *scales* 10–11 with the outer surface wrinkled, brownish, depressed in the centre, bearing a conspicuous quadrangular process. *Seeds* 2 on each scale, brown, oval, with narrow wings and conspicuous resin-tubercles.

This species differs from *C. pisifera* in the colour and shape of the leaves and in the ellipsoid cones.

A very remarkable cypress, occurring on Mount Morrison in Formosa at 7,000–10,000 ft. altitude, where it forms almost pure forests associated with *C. obtusa*. It was introduced in 1910 by Capt. (now Vice-Admiral Sir Lewis) Clinton-Baker, who sent a young plant[3] to Bayfordbury, where seedlings have since been raised from seed sent by Dr. Shirasawa. One is now 10 ft. high. The plant is also in cultivation at Kew. From its present appearance it promises to become a very useful and ornamental tree in Britain.

Mr. H. J. Elwes[4] saw *C. formosensis* growing in Formosa,

[1] Camus, *Les Cyprès*, p. 91 (1910).
[2] Clinton-Baker, *Illust. Conif.* iii, frontispiece (1913).
[3] Killed by the great drought of 1921, when 12 ft. high.
[4] *Quar. Journ. For.* (1912), 269–272.

and he informs us that the timber is very durable. He observed old trees that had fallen in the forest and were still sound, that had trees growing upon them which were 200–300 years old. Much of the timber that was being cut during his visit was going into railway construction: this he considered wasteful, as the

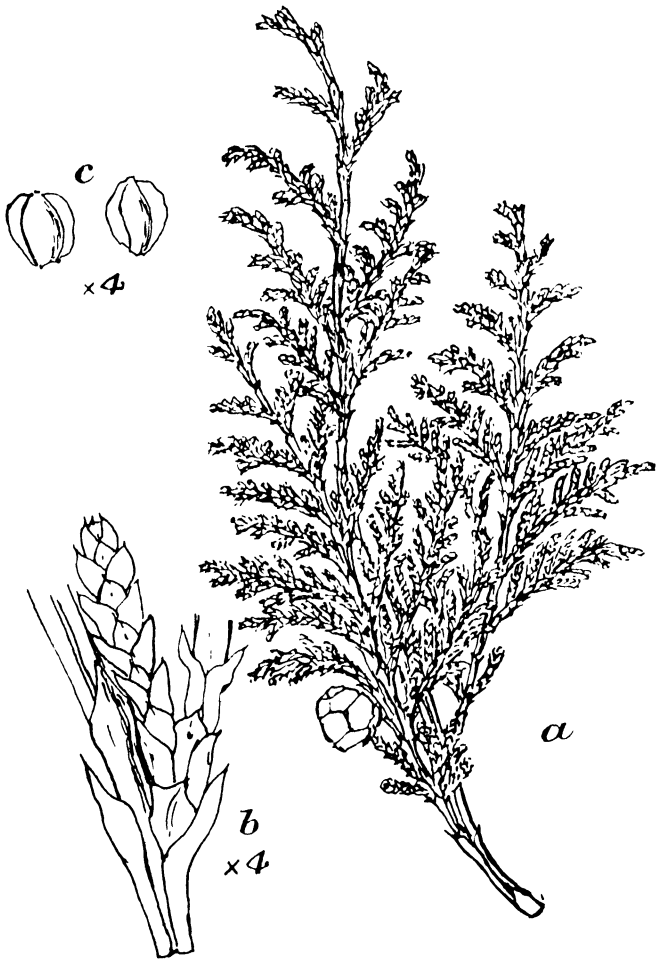

FIG. 37.—*CUPRESSUS FORMOSENSIS.*
a, spray with cone; *b*, branchlet between two branches; *c*, seeds.

wood was too good for such work. It would appear to be suitable for the same purposes as the wood of *C. obtusa*. The largest tree that Elwes saw, known to the Japanese as "God's Tree," was 162 ft. high and 60 ft. in girth, whilst the oldest trees he estimated at 1,200–1,500 years of age.

Cupressus funebris, Endlicher. (Fig. 38.)

CHINESE WEEPING CYPRESS.

Funereal Cypress.

A tree attaining in China 70 ft. in height and 6 ft. in girth. When growing in close formation it assumes a slender habit

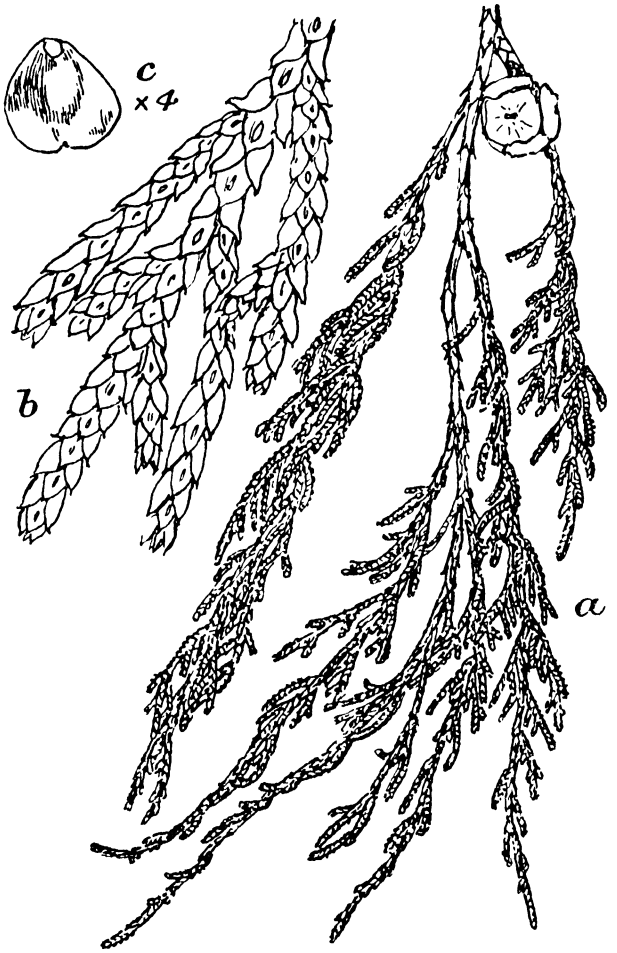

FIG. 38.—*CUPRESSUS FUNEBRIS.*
a, spray with cone; *b*, branchlets clothed with scale leaves; *c*, seed.

with short, pendulous branches, but isolated specimens develop a loose, wide-spreading head made up of massive branches. *Branchlet systems* alternate, flattened, bipinnate, the ultimate divisions compressed. *Leaves* greyish green, of two kinds; lateral pairs folded face to face; facial pairs flattened, ovate, keeled or

furrowed; all closely pressed, free and pointed at the apex. *Cones* globose, $\frac{1}{3}$–$\frac{1}{2}$ in. in diameter on slender, often curved stalks, ripening in the second year, dark brown; *scales* 8, each with a minute ovate process. *Seeds* 3–5 on each scale, $\frac{1}{8}$ in. long, shining reddish-brown with scattered resin tubercles and narrow wings.

Among the true cypresses this species is known by its compressed pendulous branches, greyish or sage-green foliage and small cones with few seeds.

This very elegant tree is found wild in Central China, occurring in mountain districts at elevations usually below 3,000 ft., and is cultivated in the E. Himalaya, Nepal, Sikkim, and Bhutan, at elevations of 4,000–8,000 ft., chiefly near temples and monasteries. It was discovered near Lake Sihoo, Chekiang, by Sir George Staunton in 1793. According to Wilson [1] it is widely distributed in the Yangtze Valley and is particularly abundant in steep limestone districts throughout W. Hupeh and Szechuen, and is commonly planted near tombs and temples.

C. funebris has been known in cultivation since about 1848, but is scarcely hardy except in the south and south-west counties of England and in Ireland.

This cypress yields a moderately hard, durable, and close-grained wood with very narrow medullary rays and inconspicuous annual rings It is largely employed by the Chinese in the hulls and decks of native boats and for general constructive work.

Where the climate is mild enough this tree thrives in any good garden soil, including that of a limy nature.

Cupressus Goveniana, Gordon. (Fig. 39.)

CALIFORNIAN CYPRESS.

Cupressus Sargenti, Jepson.[2] Gowen Cypress; Mountain Cypress; North Coast Cypress.

A tree attaining 50 ft. in height in cultivation, but usually much smaller in a wild state on mountain slopes in California, where it is often not more than 15 ft. high. *Bark* dark reddish brown, irregularly divided into narrow ridges, scaly. *Small branches* reddish brown, giving off short tripinnate branchlet systems, the ultimate divisions slender, quadrangular, and about $\frac{1}{24}$ in. diameter. *Foliage* fragrant when bruised. *Leaves* in four equal ranks, $\frac{1}{24}$–$\frac{1}{16}$ in. long, ovate, closely pressed, sub-acute, often sharp-pointed at the apex, convex on the back, which is usually marked with a glandular depression. *Male flowers* $\frac{1}{8}$ in. long, yellow. *Cones* ripening in the second year, persistent for several years, stalked, globose, dark shining brown, $\frac{1}{4}$–$\frac{3}{4}$ in. in

[1] *Pl. Wils.* ii, 56 (1914). [2] *Silv. Calif.* 153 (1910).

diameter; scales 6–10, bearing in the centre a short rounded or mucronate process. *Seeds* 10–12 on each scale, variable in size and colour, $\frac{1}{8}$–$\frac{1}{6}$ in. long, brown and shining, marked with resin vesicles and winged; or smaller, $\frac{1}{10}$–$\frac{1}{8}$ in. long, and blackish.

Three well-marked varieties occur:—

Var. **attenuata,** Carrière.

Branchlet systems more loosely arranged than in the type, the ultimate divisions very slender.

FIG 39.—*CUPRESSUS GOVENIANA.*

a, spray with three female cones; *b*, spray with three male cones; *c*, branchlet; *d*, seeds

Var. **pendula,** Carrière.

A shrub with long, pendulous branchlets, the leaves often spreading and sharp-pointed; probably a transition form between the juvenile and adult stages.

Var. pygmæa, Lemmon.[1]

MENDOCINO CYPRESS.

Usually a shrubby form producing cones with small blackish seeds. Occasionally on good soil this variety becomes larger.

C. Goveniana may be distinguished from the better known *C. macrocarpa* by the fragrant foliage, short tripinnate branchlet systems, and the smaller cones.

It is widely distributed in the hills of the coast mountains from Mendocino County near Ukiàh to San Diego County, California. It was first found in the mountains of Monterey in 1848 by Hartweg, who sent seeds to England, and plants were raised in the Horticultural Society's garden at Chiswick.

The economic properties are of little importance.

C. Goveniana may be grown in ordinary garden soil in the mildest parts of the British Isles.

Cupressus Lawsoniana, Murray. (Fig. 40.)

LAWSON CYPRESS.

Cupressus fragrans, Kellogg; Chamæcyparis Lawsoniana, Parlatore; C. Boursierii, Carrière (not Decaisne). Cedar; Ginger Pine; Matchwood; Oregon Cedar; Port Orford Cedar; White Cedar; Spruce Gum.

A tree attaining in Oregon a height of 175–200 ft. and a girth of 20 or more ft., with a narrow crown of drooping branches. *Bark* on old trunks up to 18 in. thick, reddish-brown and spongy on the surface, which is ridged and scaly. In cultivation it is very variable in habit but often assumes a columnar to broadly pyramidal outline, furnished to the ground with broad and flat, drooping, fan-like sprays of foliage. *Branchlet* systems tripinnate, the ultimate divisions compressed. *Leaves* closely pressed, arranged in opposite pairs marked with white streaks on the under-surface; the lateral pair keel-shaped, $\frac{1}{16}$–$\frac{1}{12}$ in. long, slightly overlapping the facial pair, which are rhomboidal and much smaller, about $\frac{1}{20}$ in. long, often glandular pitted; those on the main axes oblong, unequal, the lateral pair $\frac{1}{4}$ in., the facial pair $\frac{1}{5}$ in. long, with short or long slightly spreading points. *Male flowers* pink or crimson. *Cones* ripening in the first autumn, globose, $\frac{1}{3}$ in. in diameter, shortly stalked, reddish brown, glaucous; *scales* 8, each with a central depression in which is a ridge-like process. *Seeds* 2–5 on each scale, ovate, with conspicuous resin tubercles, winged.

The extraordinary variability of the Lawson cypress under cultivation has resulted in a large number of forms being given varietal names.[2] Only the most distinct of these are here

[1] This is described as typical *C. Goveniana* by Jepson, *loc. cit.* 153.

[2] Beissner, *Handbuch*, describes 77 varieties and forms, but many are scarcely worth distinguishing.

FIG. 40.—*CUPRESSUS LAWSONIANA.*

a, spray with expanded female cones and many branchlets whence male cones have fallen; *b*, branchlets; *c*, young female flowers; *d*, young cone-scale with four ovules; *e*, seed; *f*, juvenile leaves.

enumerated and they may be conveniently grouped as follows: —

Fastigiate Varieties.

Var. Allumi, Hort.

Var. Fraseri. Hort.

An attractive tree of narrow, compact habit with glaucous leaves.

Var. erecta filiformis.

Main branches stiff and short, branchlets slender and longer than in var. *erecta viridis*.

Var. erecta viridis, Waterer.

Narrowly pyramidal in habit, with a dense mass of strictly erect branches, the branchlet systems flattened and radiating from the stem. Foliage bright green. This is one of the best known and most distinct varieties. It originated in Mr. A. Waterer's nursery at Knap Hill in 1855 from Californian seed.

Var. ericoides.

Branchlets very slender, foliage bright green, the leaves spreading at the points.

Var. Fletcheri.

Leaves of the juvenile type, glaucous green, about $\frac{1}{6}$ in. long.

Var. Olbrichii.

Stiff and compact in habit, with dense branch systems. Branchlets arranged as in *Thuya orientalis*.

Var. Smithii.

Habit columnar, the tree scarcely tapering above; leaves glaucous.

Var. Wisseli.

Habit columnar, the branches and branchlet systems erect, crowded and tufted; leaves glaucous. Not an attractive variety.

Pendulous and Spreading Varieties.

Var. filifera.

A very attractive and elegant form, the main branches horizontal or slightly drooping; the branchlets long, slender, and whip-like, drooping to a depth of 2 ft., the lateral divisions short and remote. There is a good specimen at Kew.

Var. gracilis.

This includes several forms with slender pendulous branchlets, the young shoots being sometimes golden yellow, as in *gracilis pendula aurea*, or white, in *gracilis pendula alba*.

Var. intertexta.

A very vigorous tree with arching branches and remote, stout, widely spreading branchlet systems, the ultimate divisions less

crowded than is usual in the species. It is a very graceful and handsome tree, which originated in Lawson's nursery in Edinburgh about 1869.

Var. **juniperina.**

Branchlets regularly pinnate, the ultimate divisions very fine, with the leaves free at the tips.

Var. **Krameri.**

Habit thin and open, the ultimate divisions of the branches slender, contorted, and whip-like. More curious than beautiful.

Var. **lycopodioides.**

Branches irregular, branchlets twisted, lax. Of no decorative value.

Var. **patula.**

Habit compact, branchlet systems slender, fan-shaped, spreading and slightly drooping; foliage dark, shining green.

Var. **pendula.**

The branches are almost horizontal and the branchlets pendulous.

Var. **pendula vera.**

Branches and branchlets pendulous, drooping almost vertically from the trunk; more curious than beautiful.

Var. **Pottensii.**

The ultimate branch systems dense and compact, rather like those of dwarf forms of C. *obtusa*.

Var. **Youngii,** Masters.

Habit pyramidal and elongated with stoutish, loosely set, more or less twisted spreading branches.

Dwarf Varieties.

Var. **nana.**

A dwarf, rounded bush, broader than high, the erect, flattened branchlet systems arranged edgeways like those of *Thuya orientalis*. *Leaves* bright green. There are colour forms, including var. *nana alba*, with yellowish white foliage, and var. *nana glauca* (syn. *compacta*; *minima glauca*) with glaucous leaves. Var. *nana* was raised in 1861 by Dauvesse of Orleans.

Colour Varieties.

Var. albo-spica.

Densely pyramidal in habit; terminal branchlets variegated with creamy white. Varieties of very similar appearance are *albo-maculata*, *albo-picta*, and *argenteo-variegata*. These forms present a patchy appearance and are unattractive.

Var. albo-variegata.

A dwarf variety with foliage blotched with white.

Var. argentea.

Foliage silvery or glaucous in hue; very variable in habit and depth of colour. Some of the best forms have been given varietal names such as *Bowleri*, *californica*, *glauca*, *Silver Queen*, and *Triomphe de Boskoop*.

Var. aurea.

Foliage golden-yellow at first, becoming green during the first winter. A very effective plant.

Var. aurea Smithii.

A golden-leaved form that keeps its colour well throughout the year.

Var. aureo-marginata.

The generally green foliage blotched with patches of gold. Not beautiful.

Var. gracilis aurea.

A very beautiful tree with graceful, plumose, pendent branchlets and golden foliage.

Var. lutea.

An effective variety with pale yellow foliage. It forms a fine specimen.

Var. ochroleuca.

Another showy variety with pale yellow leaves.

Var. Stewarti.

Young shoots rich yellow, eventually becoming green. One of the best of the yellow-leaved forms.

Var. Westermanni.

A form with a stiff pyramidal habit and light yellow leaves.

C. Lawsoniana may be recognized among the small-fruited

species by the ill-defined white markings of the foliage and by the lateral leaves being larger than the glandular facial leaves. In spring the pink or crimson staminate flowers will often distinguish it at sight.

It occurs as a wild tree in the coniferous forests of S.W. Oregon and N.W. California in a very moist climate, being most abundant and luxuriant in a region below 3,000 ft. altitude where it comes under the influence of ocean winds. Its associates are Douglas fir, Sitka spruce, hemlock, and *Thuya*. Murray first sent seeds to Britain in 1854, the recipients being Messrs. Lawson of Edinburgh.

Wood light in weight, white or light yellow, close and compact, moderately strong, very durable, finishes with a glossy surface, easily worked, and with a pleasant but peculiar lasting, spicy odour. Howard [1] reports that its oily character is inclined to clog tools, necessitating constant attention to sharpening. It is one of the most valuable timbers of W.N. America. The wood is used for building purposes, interior finish of houses, flooring, boat-building, railway sleepers, furniture, fence-posts, matches, and to some extent in the construction of aircraft. When used for linings and drawers in chests and cabinets, it is credited with keeping away moths and other insects. The fragrant essential oil contained in the wood is stated to be a powerful diuretic, and this property is so active that workmen in factories where it is being sawn and worked have occasionally to change to other woods.[2]

The Lawson cypress is one of the most useful conifers we have. It will grow on almost any soil, and is unaffected by the severest frost. Its extreme hardiness in this country is remarkable, considering the mildness of the climate in which it grows naturally. It is one of the most popular of evergreens, and there are few gardens where it is not represented by one or other of its varieties. Trial plantations of Lawson cypress have been started under forest conditions in some parts of the country, but so far there is little information as to its adaptability or otherwise for the purpose. Timber produced by ornamental trees is of good quality, and Elwes and Henry [3] refer to 30 acres of forest plots of this species in Prussia, where after 20 years' experience the wood grown is as good as that produced in Oregon. The variable character of the species under cultivation suggests that considerable care should be exercised in the selection of seed trees for raising plants for sylvicultural work, only the best-grown trees being selected, and those in isolated positions for preference. It is a light-demanding tree, and recommendations have been made

[1] *Timbers of the World*, 54 (1920).
[2] Hough, *American Woods*, x, 241, pp. 41–42.
[3] *Trees of Great Brit. and Ireland*, v, 1207 (1910).

that for forest work it should be planted 3 ft. apart each way. When used for hedges the plants may be spaced from 2–3 ft. apart according to size.

Cupressus lusitanica, Miller. (Fig. 41.)

MEXICAN CYPRESS.

Cedar of Goa.

A tree varying greatly in habit, attaining in Mexico and

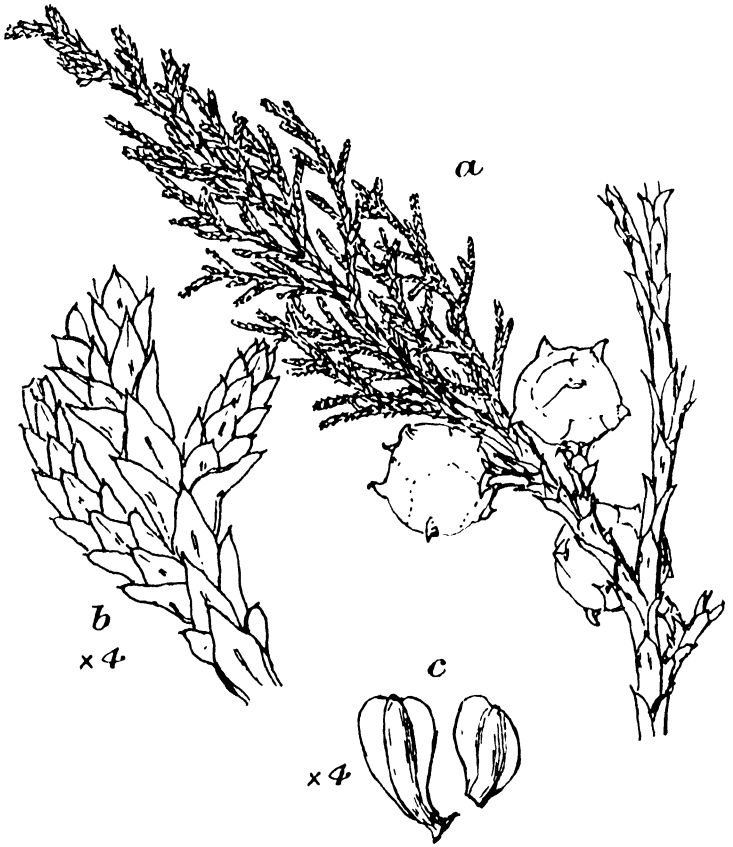

FIG. 41.—*CUPRESSUS LUSITANICA*.
a, spray with three mature cones; *b*, branchlets; *c*, seeds.

Portugal 100 ft. in height and 12 ft. in girth. *Bark* reddish brown with longitudinal fissures. *Branches* widely spreading, with usually pendulous branchlets. *Branchlet systems* alternate, not flattened, bipinnate, the ultimate divisions quadrangular. *Leaves* in four ranks, $\frac{1}{16}$ in. long, closely pressed, ovate, often long and sharp-pointed, occasionally pitted. *Cones* about $\frac{1}{2}$ in.

in diameter when mature, glaucous at first, ripening in the second year when they become brown, the points of the scales spreading and reflexed. *Seeds* 8–10 on each scale, $\frac{1}{6}$ in. long, winged, bearing resin tubercles.

This species is distinguished by its glaucous young cones and the prominent and often reflexed points of the cone scales.

Var. **Benthami**, Carrière.

Cupressus Benthami, Endlicher; C. Knightiana, Knight and Perry. C. lusitanica, var. Knightiana, Rehder.

A tree of elegant habit, with regularly pinnate flattened branchlet systems, the ultimate divisions more flattened and compressed than in the typical form. According to Bentham this variety was introduced as *C. thurifera* in 1838.

This variable species is widely distributed in Mexico and extends into the high mountains of Guatemala. According to Pringle it is found at altitudes between 4,000–10,000 ft. It is well known not to be indigenous in Europe, where its numerous forms have been long cultivated under the names of *C. lusitanica*, *C. Lindleyi*, *C. Benthami*, and *C. Coulteri*. There is good evidence that *C. lusitanica* has existed at Bussaco in Portugal for at least 300 years. Its native country was long in doubt, and for many years it bore the misleading name of Cedar of Goa. However, it is unknown in India, and the suggestion that it was introduced by Spanish friars from Mexico seems more likely than that it was brought by Portuguese monks from Goa. This cypress has been known in English gardens since 1682, when it was in cultivation at Chelsea, Fulham, and Badminton, having probably been introduced from Portugal a short time before. The best trees are found in the south-western counties where the climate is mild.

Cupressus Macnabiana, Murray.

MacNab's Cypress.

Cupressus glandulosa, Hooker; Juniperus Macnabiana, Lawson. California Mountain Cypress; Fragrant Cypress; Shasta Cypress; White Cedar.

A shrub or small tree up to 40 ft. high and 4 ft. in girth. *Bark* thin, reddish brown, scaly. *Branches* widely spreading. *Branchlet* systems irregularly arranged, tripinnate, the ultimate divisions slender, compressed. *Foliage* pale green or glaucous, often fragrant when fresh. *Leaves* about $\frac{1}{20}$ in. long, closely pressed, blunt, marked on the back with a minute resin-bearing pit. *Cones* ripening in the second year, clustered, shortly stalked, globose, $\frac{1}{2}$–$\frac{3}{4}$ in. long, reddish or greyish brown, often glaucous; *scales* 6–8 with conical umbos, the uppermost pairs conical and more or less incurved. *Seeds* 10–12 on each scale, $\frac{1}{8}$ in. long.

This species may be recognized by its slender, compressed branchlet systems and minute, blunt or rounded, glandular leaves and conical cone scales.

C. Macnabiana is a native of California, where it is found on dry hills or in the bottoms of cañons from Napa County to Shasta County eastward to the Northern Sierras, and westward to the coast ranges. It was introduced into England in 1854 by Messrs. Veitch, but old trees are seldom seen, and it appears to have almost gone out of cultivation. It is apparently a short-lived tree.

Although the wood of wild trees appears to be of good quality it is small and has no definite commercial value.

This cypress is suitable only for the milder parts of Britain.

Cupressus Bakeri, Jepson.[1] This tree appears to differ only from *C. Macnabiana* in its smaller, glaucous cones, with smaller, less prominent umbos.

[1] Jepson, *loc. cit.* 159.

Cupressus macrocarpa, Hartweg. (Fig. 42.)

MONTEREY CYPRESS.

Cupressus Hartwegii, Carrière; C. Reinwardtii, Boissner.

A tree attaining in California a height of 70 ft. and a trunk girth of 20 ft., the branches ascending and forming a conical crown, or flat-topped like that of a Lebanon cedar with dense masses of foliage. *Bark* thick, reddish brown at first, becoming nearly white on older, exposed trunks, divided into flat, scaly ridges. *Branchlets* alternate, ascending, spreading at various angles, bipinnate, the ultimate divisions numerous, rather slender, four-sided. *Leaves* scale-like, triangular, closely pressed, $\frac{1}{24}$–$\frac{1}{9}$ in. long, blunt at the apex and slightly swollen towards the tip, sometimes furrowed on the back. *Male flowers* yellow, $\frac{1}{8}$ in. long, stamens 6–8. *Female flowers* with reflexed, thin-edged brownish scales. *Mature cones* sub-globose, 1–1½ in. long, ¾–1 in. broad, shining brown; *scales* 8–14, flat-topped, with a central crescent-shaped projecting process. *Seeds* about 20 on each scale, $\frac{1}{24}$–$\frac{1}{12}$ in. long, irregular in shape, narrowly winged, with minute resin tubercles on each surface. *Cotyledons* 3–4.

Under cultivation *C. macrocarpa* is known by two more or less distinct types which are connected by intermediates; both forms have been raised from the seeds of one tree. They are:—

Var. fastigiata, Carrière.

Branches fastigiate, forming a tree of narrowly pyramidal habit.

[1] *Fl. Calif.* pt. i, p. 61 (1909).

Var. **Lambertiana**, Masters.

Cupressus Lambertiana, Carrière.

Branches spreading, the mature tree resembling an aged Lebanon cedar.

The following varieties have also arisen in cultivation.

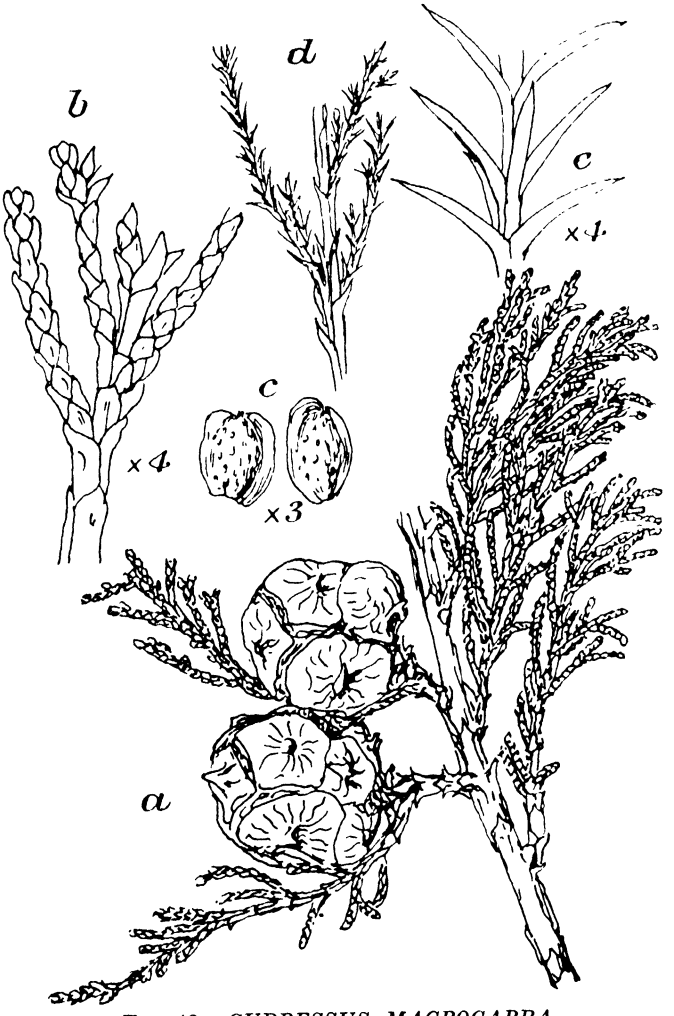

FIG. 42.—*CUPRESSUS MACROCARPA.*

a, spray with two cones; *b*, branchlets; *c*, seeds marked with resin glands; *d*, *e*, juvenile foliage.

Var. **Crippsii**, Gordon.

Branches short, rigid, with leaves more or less spreading, sharp-pointed, and of a silvery hue more particularly about the

points of the young shoots. It was raised from imported seed in the Tunbridge Wells nursery of the late Thomas Cripps about the middle of last century.

Var. **farallonensis,** Masters.

A curious form reported to exist on the Farollones Islands near San Francisco, but which really appears to have arisen as a sport in the California University garden. It has glaucous foliage and is not known to be in cultivation in England.[1]

Var. **flagelliformis,** Cripps.

In 1875 this variety was grown in Mr. Cripps's nursery at Tunbridge Wells, and specimens may exist in the southern counties. It is said to differ from the type in its more slender, spreading branches, which are pendent at the points, and by its light, glaucous-green leaves.

Var. **guadalupensis,** Masters.

C. guadalupensis, S. Watson.

This variety[2] grows on Guadalupe Island, and is usually regarded as differing from typical *C. macrocarpa* by its glaucous leaves and globose cones. Dr. E. Fenzi, of Bogliasco, Italy, however, states that these characters are not permanent, and that it is best distinguished from the typical form by the bark not peeling off; by the dome-shaped outline of the mature trees and the non-fragrant foliage. It is also stated to be much less hardy. There is a young plant in the Temperate House at Kew.

Var. **lutea,** Dickson.

A very beautiful variety, with the shoots and leaves of the first year bright yellow in colour, changing to green during the second year. The cones also are yellow. This handsome form was distributed by Messrs. Dicksons, of Chester, in 1895, it having originated in their nursery a few years earlier.

Var. **variegata,** Lemaire.

Young shoots blotched with white; not very attractive, and rarely met with in cultivation.

The Monterey cypress is distinguished from *C. sempervirens* by its larger leaves being swollen at the tip, and by its tuberculed seeds. From all other species it is separated by its large cones.

This tree has probably the most restricted range of any conifer, as it only occurs wild at Monterey, in California, where it was first found by Hartweg in 1846, and on the Island of Guadalupe

[1] Elwes and Henry, *loc. cit.* v, 1166 (1910).
[2] *Gard. Chron.* April 3, 1915, p. 177.

Photo. by F. R. S Balfour, Esq.

PLATE XII. *CUPRESSUS MACROCARPA* AT MONTEREY, CALIFORNIA.

off the coast of Lower California. At Monterey the main grove occupies an area along the sea coast about two miles long and 200 yards wide, from Cypress Point to the shores of Carmel Bay. The older trees, with their gnarled stems and flattened crowns, are remarkably picturesque.

The Monterey cypress was in cultivation at Chiswick in 1838, the trees having been raised from seeds of unknown origin presented to the Horticultural Society by Lambert.

Wood grown in Britain is of good quality, fragrant, yellowish or brownish yellow in colour, but usually too knotty for good-class work. From trees grown in close plantations, however, it is probable that good furniture wood could be produced. It is durable, and that which is too knotty for high-class work can be profitably used in outbuildings, for fencing and many other purposes.

The tree is extensively planted in the south and south-west counties for decorative purposes, and as a windbreak flourishes in exposed places near the sea. It is one of the trees used at Tresco to provide shelter for the many subtropical plants in the famous Abbey gardens on that island. Thriving in a great variety of soils, it is specially adapted for clay, and gives good results on chalky ground and in heavy soil overlying limestone. As it is a very difficult tree to transplant, seedlings should be placed in permanent positions when not more than 12–18 in. high unless they are established in pots. The most suitable planting time is early autumn and late spring. Plants established in pots may be planted at almost any time, but if the tops are heavy each one should be staked to keep it from being blown about and loosened at the collar. *C. macrocarpa* is unsuitable for cold parts of the country, but suggestions have been made that it is worth planting under woodland conditions in the south and west.

The Monterey cypress is being grown successfully in South Africa, New Zealand, Australia, Uganda, and Kenya.

Elwes and Henry, *loc. cit.* v, 1165 (1910); Jepson, *Silv. of Calif.* 155 (1910).

Cupressus nootkatensis, Lambert. (Fig. 43.)

Yellow Cypress.

Cupressus nutkaënsis, Hooker; C. americana, Trautvetter; Chamæcyparis nootkatensis, Sudworth; C. nutkaënsis, Spach; Thuya excelsa, Bongard; Thujopsis borealis, Carrière; T. Tschugatscoi, Fischer. Alaska Cypress; Alaska Ground Cypress; Nootka Cypress; Nootka Sound Cypress; Sitka Cypress; Yellow Cedar.

A tree similar in habit to the Lawson cypress, attaining in America 120 ft. in height and 18 ft. in girth. *Bark* brownish grey, separating on the surface into large, thin, loose scales.

Branches smooth, brown, the younger ones roughened with persistent brown remote leaves. *Branchlet systems* in flattened, pendulous, fern-like sprays with alternate pinnæ arranged in two ranks. *Leaves* dull green without white streaks, emitting an unpleasant smell when rubbed ; closely pressed, disposed in opposite

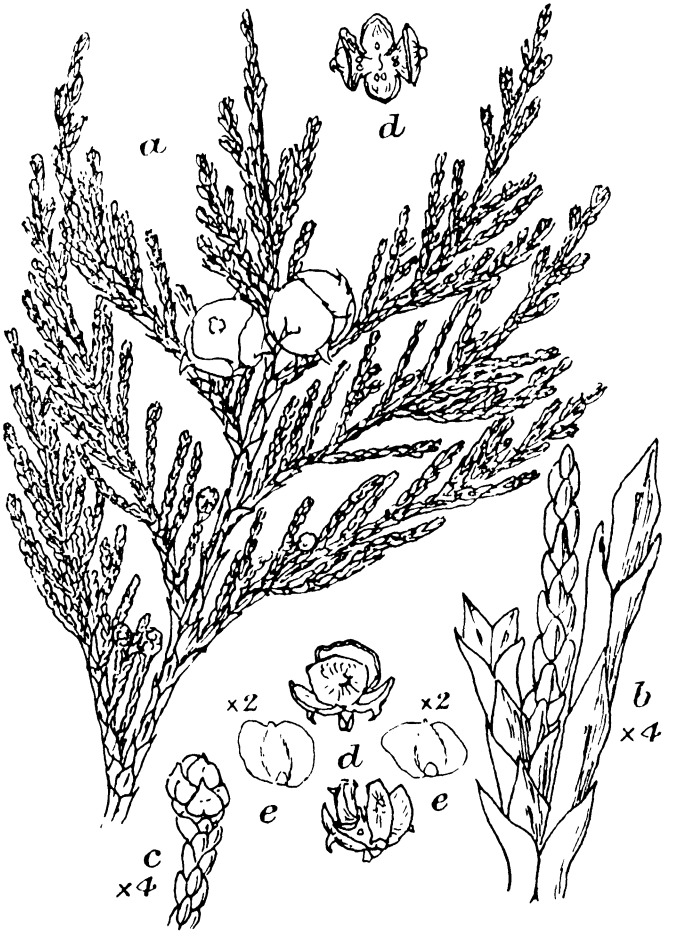

FIG. 43.—*CUPRESSUS NOOTKATENSIS.*

a, spray with two cones ; *b*, branchlet ; *c*, male cone ; *d*, expanded female cones in various positions ; *e*, seeds.

pairs equal in length, $1\frac{1}{2}$–$\frac{1}{8}$ in. long, abruptly narrowed or sharp-pointed at the apex, the lateral pair keeled, the facial pair flattened, rhomboidal ; shining, not or rarely glandular ridged ; those on the main axes equal in length, $\frac{1}{4}$ in. long, free at the acute tips. *Male flowers* yellow. *Cones* ripening in May of the second year, globose, stalked, green tinged with plum-colour

before ripening, about ⅛ in. in diameter; *scales* 4–6, each with a triangular sharp-pointed process. *Seeds* 2 on each scale, flattened, winged, without resin.

The most notable varieties in cultivation are:—

Var. **argenteo-variegata,** Hort.

Foliage variegated with creamy white. Not attractive.

Var. **aureo-variegata,** Hort.

Foliage variegated with yellow. Not attractive.

Var. **compacta.**

A dwarf form of dense habit resembling a high mountain specimen. Suitable for rockeries.

Var. **glauca,** Regel.

Leaves glaucous. An attractive variety.

Var. **lutea.**

Young shoots and leaves yellowish, changing to green. One of the most vigorous and handsome varieties.

Var. **nidifera.**

A plumose form, the slender shoots clothed with closely pressed, deep green, awl-shaped leaves, each with a central gland on the back.

Var. **pendula.**

Branches almost horizontal, branchlets very pendulous, hanging vertically in slender streamers several feet long. A very graceful and handsome variety.

The yellow cypress is sometimes confused with *C. Lawsoniana*, but the foliage is coarser and of a duller green than in the latter species, the leaves are equal or nearly equal in size, the male flowers are yellow (not pink or crimson, as in *C. Lawsoniana*), the cones take longer to mature and are furnished with prominent triangular-pointed processes which are absent in Lawson's cypress.

It is a native of the Pacific Coast region of W.N. America, occurring in the Cascade Mountains of N. Oregon, Washington, British Columbia, and Alaska to Prince William Sound. It was discovered at Nootka Sound by Menzies in 1793, and was introduced into England about 1853.

Wood of excellent quality, hard, very close-grained, yellow, very durable, fragrant, finishing with a satiny surface, and sometimes prettily marked. It is used in boat-building, general carpentry, and in cabinet-work. Timber has been exported to China and used as a substitute for satinwood, although the two woods are not alike. Cabinet and furniture manufacturers

in this country use the wood to some extent, and mistakes have arisen through the substitution of the wood of the deciduous cypress (*Taxodium distichum*) for this species. Care should therefore be taken to keep these woods separate from each other.

The yellow cypress succeeds well in Britain, even in cold situations and on poor gravelly soils. It also grows well on thin soil overlying limestone. On good soil and in sheltered positions growth is correspondingly faster. The late Mr. H. J. Elwes[1] had great confidence in the tree becoming a valuable forest tree in Britain for planting on poor dry soils, and he planted 10,000 trees on his own estate for the production of timber. As an ornamental tree its value is well known.

Cupressus obtusa, Koch. (Fig. 44.)

HINOKI.

Chamæcyparis obtusa, Siebold and Zuccarini; C. breviramea, Maximowicz; C. pendula, Maximowicz; Retinispora obtusa, Siebold and Zuccarini; Thuya obtusa, Masters.

A tree 80–120 ft. high, and 10–12 ft. in girth in Japan, with a straight trunk more or less buttressed at the base. *Bark* reddish brown, shed in long, narrow strips. *Branches* close set, spreading or horizontal, reddish. *Branchlet systems* flattened, tripinnate, slightly drooping at the tips. *Leaves* closely pressed, of two sizes, the lateral pairs much the larger, boat-shaped, $\frac{1}{12}$ in. long, blunt at the apex or with a minute point; the smaller pairs about $\frac{1}{24}$ in. long, triangular, with a thickened apex, all prominently lined below with white ×-shaped markings produced by a coating of wax. *Leaves* on the branchlets oblong, unequal, the lateral $\frac{1}{4}$ in. long, the facial $\frac{1}{8}$ in. long, with spreading, blunt points. *Cones* stalked, $\frac{1}{3}$ in. in diameter, orange-brown when ripe; *scales* 7–10, the outer surface depressed with a minute ridge in the centre. *Seeds* 2–5 on each scale, $\frac{1}{8}$ in. long, winged.

The following are the principal varieties in cultivation:—

Var. albo spica.

Young shoots cream-coloured, gradually changing to pale green in summer.

Var. aurea.

Young shoots golden yellow.

Var. compacta.

A dwarf dense form with very short branches and branchlets.

Var. Crippsii.

A very beautiful golden-leaved form, the branchlets in dense flattened sprays.

[1] *Loc. cit.* v, 1198 (1910).

Var. erecta.

Fastigiate and narrow in habit.

Var. filicoides, Masters.

A plant of dense habit, with short branches and the ultimate divisions of the branchlets very short, compact, and fern-like,

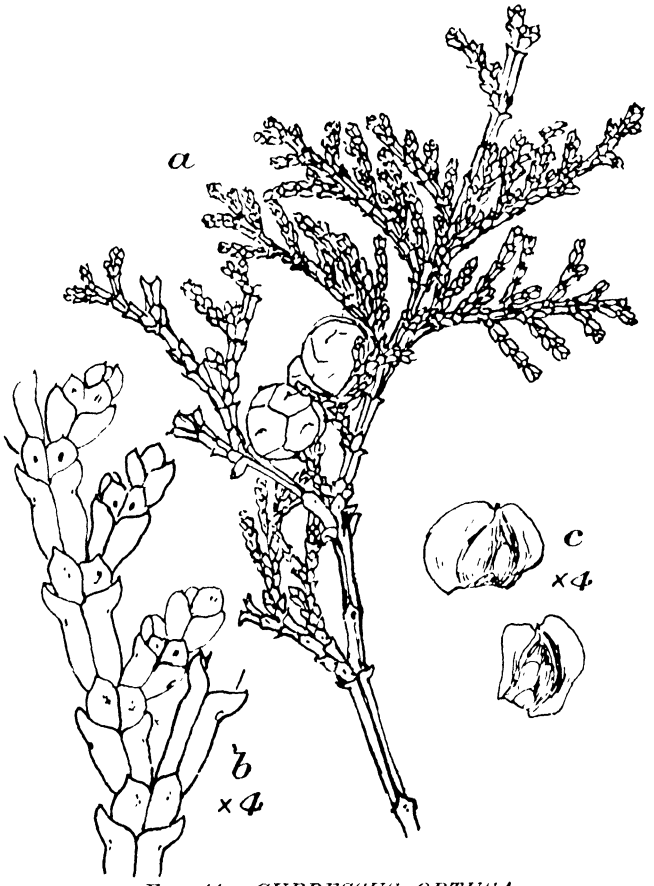

FIG. 44.—*CUPRESSUS OBTUSA*.
a, spray with two cones; *b*, branchlets; *c*, seeds.

less flattened than in the type. Leaves nearly equal in size, in four ranks, ovate, obtuse, often glandular.

Var. formosana.

Cupressus obtusa, forma formosana Hayata.

A tree attaining 130 ft. high in the mountains of Formosa. Leaves, cones, and seeds smaller than in the typical form. Ripe cones about ¼ in. in diameter. *Seeds* about ⅛ in. across. Intro-

duced in 1910 by Matsamura, who sent seeds to Bayfordbury, but only one seedling was raised.

Clinton-Baker, *op. cit.* iii, 56 (1913).

Var. Keteleeri.

A form with golden leaves similar to var. *Crippsii*.

Var. lycopodioides, Masters.

Of dwarf habit with irregular rigid branches and coarser branchlets than in the type, the ultimate branchlets decidedly crowded and angled, and the leaves arranged in many ranks, closely pressed, elongated and blunt at the apex. It was introduced in 1861.

Var. tetragona aurea, Masters.

Shrubby in habit, branchlet systems tufted, irregularly arranged, the ultimate divisions quadrangular. *Leaves* almost uniform in size, ovate, sharp and spreading at the points. Young growths golden yellow, becoming ultimately dark green. First noticed in the Elvaston nursery, Derbyshire, in 1873.

Var. Troubetzkyana, Rovelli.

Dwarf and compact, with short, widely spreading branchlets and closely pressed light green, thick, lance-shaped leaves which are glandular on the back. First noticed in the garden of Prince Troubetzky at Pallanza.

C. obtusa is easily recognized among the small-coned species by its unequal, blunt leaves with clearly defined white markings.

It is found wild in S. and Cent. Japan at elevations of 2,000–5,000 ft., where it grows in mixed forests. It was introduced into cultivation in 1861 by John Gould Veitch.

Wood often white or straw-coloured, but sometimes pink. It is light, strong, very durable, fine and straight grained fragrant, easily worked, and finishes with a good lustrous surface. It is very popular in Japan for high-class building construction, houses, bridges, etc., and is also used for general joinery, ceilings, panelling, and for cabinets and furniture, especially for high-class lacquer ware. Mr. H. J. Elwes [1] regarded it as unsurpassed amongst coniferous woods for fine, high-class work, the nearest to it being *C. nootkatensis*. In some instances the wood is very beautifully marked, and such samples command a high price for furniture. The tree is sacred amongst the disciples of the Shinto faith and is cultivated in the vicinity of temples. The palaces of the Mikado in Kyoto are said to be largely built of this wood, and the bark is used for roofing purposes. So straight and even-grained is the wood that it can be cut up into very thin shavings which are used for chip-braid for the manufacture of ladies'

[1] *Trees of Great Brit. and Ireland.* 1189 (1910).

hats. Examples of the shavings are to be seen in Museum 3 at Kew. A replica of a famous Japanese gateway, "The Gate of the Imperial Messenger," made of the wood, was erected at Kew in 1910.

Hinoki is one of the five most important trees of Japan, and is found in extensive natural and planted forests. The Imperial forests in Kiso are said to be composed largely of this species and are celebrated as being one of the three best forest areas in Japan. The tree is grown on rotations of 80–160 years. In addition to its value as a timber tree it is much grown for decoration and is largely employed for dwarfing. In Britain its use is limited to ornamental work and it is not so often seen as the allied *C. pisifera*. Nevertheless it forms a handsome small tree, and together with its varieties is well worth the attention of garden enthusiasts. It requires similar conditions to *C. pisifera*.

Cupressus pisifera, Koch. (Fig. 45.)

SAWARA CYPRESS.

Chamæcyparis pisifera, Siebold and Zuccarini; Retinispora pisifera, Siebold and Zuccarini; Thuya pisifera, Masters.

A tree 90–120 ft. high and 9–12 ft. in girth in Japan. *Bark* reddish brown, scaling off in long, thin strips. *Branches* and *branchlets* as in *C. Lawsoniana*, with the ultimate divisions flattened. *Leaves* closely pressed, with spreading, spine-like tips, the lateral pair boat-shaped; the facial pair flattened, ovate, acuminate, obscurely glandular, shining green above, marked below with white patches; those on the main branchlets reddish-brown, equal in length, in 4 ranks, oblong, $\frac{1}{8}$–$\frac{1}{4}$ in. long, with long, spreading, triangular points. *Cones* on short scaly branchlets, globose, $\frac{1}{4}$ in. in diameter, dark brown when mature; *scales* usually 10, depressed in the centre, with a minute point. *Seeds* 1–2 on each scale, brown, ovate, with prominent resin-tubercles and broad lateral wings.

C. pisifera has been cultivated for hundreds of years in Japan and has given rise to numerous varieties. The majority are marked by the continuance for an indefinite period of the juvenile type of foliage. Varieties possessing this peculiarity were at one time thought to belong to a distinct genus and were included under the name of *Retinispora*. The best varieties are :—

Var. **aurea.**

An adult form with the young leaves yellow. It originated in Messrs. Barron's nursery near Derby.

Var. **filifera**, Masters.

Retinispora filifera, Standish; Chamæcyparis pisifera, var. filifera, Beissner.

A bush or shrub, usually broader than high, with spreading

branches and long, whip-like branchlets which are undivided for the greater part of their length, and terminate towards the end in two-parted divisions. *Leaves* in alternately opposite pairs, awl-shaped, sharp-pointed, about $\frac{1}{8}$ in. long, white on the inner surface. A very distinct variety, and seemingly far removed

FIG. 45.—*CUPRESSUS PISIFERA*.

a, spray with five cones; *b*, branchlets; *c*, cone; *d*, seeds; *e*, spray with juvenile foliage, known as *C. Squarrosa*.

from the type, although it occasionally bears cones exactly like those of *C. pisifera*.

Var. **filifera aurea**, Hort.

Exactly like the last-named except that the young leaves and shoots are golden.

Var. **plumosa**, Masters.

Retinispora plumosa, Veitch; Chamæcyparis pisifera, var. plumosa, Veitch.

Usually a dense bush of conical habit with crowded, more or less overlapping branchlet systems; the leaves awl-shaped, soft and spreading. This juvenile type of the foliage is more or less permanent; now and then, however, a tree breaks away and produces the adult type of leaves. This variety is very hardy and is one of the commonest conifers in cultivation. It was introduced by John Gould Veitch at the same time as the type. The following colour-forms are known :—

Var. **plumosa albo-picta.**

Foliage often white at the tips.

Var. **plumosa argentea.**

Foliage grey or silvery, becoming green in the following spring.

Var. **plumosa aurea.**

Young branchlets golden yellow, changing to green as the season advances.

Var. **Sanderi**, Hort.

Retinispora Sanderi, Hort.

A very dwarf plant with juvenile leaves. It is not certain that this variety belongs to *C. pisifera*, but it is placed here provisionally until it bears fruit.

Var. **squarrosa**, Masters.

Retinispora squarrosa, Siebold and Zuccarini.

A small tree or dense shrub with handsome glaucous foliage; the leaves are soft in texture, in alternately opposite pairs, or whorls of four, with the bases clasping the branchlets, narrow, flattened, $\frac{1}{4}$ in. long, whitened on both surfaces. It was introduced in 1843.

Var. **squarrosa sulphurea.**

Very like the preceding, but the leaves have a yellowish hue.

From the other species of the *Chamæcyparis* section this cypress is separated by its sharply pointed leaves and prominent white markings below, and by its small cones.

The Sawara cypress is indigenous in the Central and S. parts of the mainland of Japan at an elevation of 2,000–5,000 ft., and has much the same distribution as *C. obtusa*. It is a common tree in temple grounds and was introduced into England in 1861. With the exception of the ubiquitous "Lawson cypress," it is

the conifer most often met with in one or other of its many forms.

The timber appears to be less valued in Japan than that of *C. obtusa*, although it is very similar in appearance and suitable for general carpentry. Wood grown in this country works well, and is fragrant and white in colour. It is used in Japan for doors, boxes, and bent wood articles.

As a garden plant this species and its varieties thrive throughout the greater part of the country, except in very cold and wind swept areas. It succeeds in any good garden soil, but is unsuitable for smoky towns. The varieties are easily increased by cuttings or by grafting upon stocks of the type. It has no value for sylvicultural purposes in Britain.

Wilson, *Conifers of Japan*, 78 (1916).

Cupressus sempervirens, Linnæus. (Fig. 46.)

MEDITERRANEAN CYPRESS.

Cupressus lugubris, Salisbury; C. patula, Spadoni; C. Tournefortii, Audibert.

A tree of spreading habit like that of a cedar, or with erect branches nearly parallel to the stem. In the Mediterranean region it attains an immense size and age, trees up to 150 ft. high and 10 ft. in girth being known. *Bark* thin, smooth, greyish-brown, lightly fissured. *Branchlets* alternate, tripinnate, irregularly spreading, the ultimate divisions four-angled, about $\frac{1}{25}$ in. in diameter. *Leaves* in four equal ranks, closely pressed, blunt, often marked on the back with a longitudinal furrow. *Male flowers* yellow, about $\frac{1}{8}$ in. long, stamens in about 10 pairs. *Female flowers* globose, $\frac{1}{4}$ in. wide. *Cones* sub-globose or ovoid, on short-curved stalks, 1–1$\frac{1}{4}$ in. long, shining brown or greyish; *scales* 8–14, rising to a point in the centre or flattened with a thin ridge-like process. *Seeds* 8–20 on each scale, about $\frac{1}{6}$ in. long, winged, without resin tubercles.

Var. **horizontalis**, Gordon.

Branches spreading out flat like a Lebanon cedar. Common in the wild state.

Var. **indica**, Parlatore.

C. Whitleyana, Carrière; C. Doniana, Royleana and australis, Koch.

Habit stiff and fastigiate, cones globose.

Var. **stricta**, Aiton.

C. pyramidalis, Targioni-Tozzeti; C. fastigiata, De Candolle; var. pyramidalis, Nyman; var. fastigiata, Hansen.

Branches erect, giving the tree a pyramidal or columnar outline. This form is often cultivated in gardens in S. Europe.

Var. **thujæfolia**, Knight and Perry.

A form of conical habit with flattened, tripinnate branchlets.

C. sempervirens is distinguished from all the other species except *C. macrocarpa* by its large cones, and from the latter species by its smaller, closely pressed leaves which are not swollen towards the tip, and by the non-tubercled seeds.

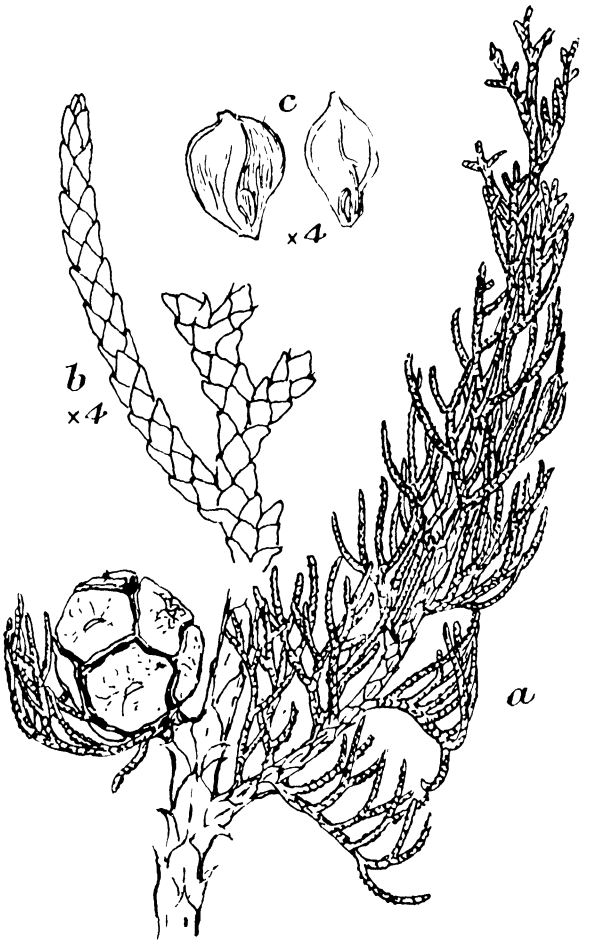

FIG. 46.—*CUPRESSUS SEMPERVIRENS.*
a, spray with ripe cone; *b*, branchlets; *c*, seeds.

The Mediterranean cypress is found wild in the mountains of N. Persia; in Syria, Cilicia, Greece, and the islands of Rhodes, Crete, and Cyprus. It represents the cypress of the ancients and there are numerous allusions to it in classical literature. In Italy the fastigiate form is a characteristic feature of gardens and

cemeteries. In S. Europe it lives to a great age, some trees being at least 500 years old.

Wood yellow or light brown, moderately hard, close-grained, with very narrow medullary rays, fragrant, easily worked, and very durable. It has long been used for building purposes and for furniture. In S. Europe, and particularly in Italy, it has been much used for family clothes chests, the fragrant wood being obnoxious to insects and said to keep moths away from clothes. It is sometimes, however, attacked by the larvæ of boring beetles.

C. sempervirens is not very hardy and is only suitable for the milder parts of the British Isles. Both the type and the pyramidal variety form excellent garden and park trees for places where the climatic conditions are suitable. They give the best results in good, moist, loamy soil. In some places they are used for hedges with excellent results. An essential oil is obtained from shoots and leaves.

Elwes and Henry, *loc. cit.* v, 1151 (1910).

Cupressus thyoides, Linnæus. (Fig. 47.)

White Cypress.

Chamæcyparis sphæroidea, Spach; C. thyoides, Britton, Sterns and Poggenburg; Thuya sphæroidalis, Richard; T. sphæroidea, Sprengel. Cedar; Coast White Cedar; White Cedar.

A tree attaining in N America, under the best conditions, a height of 70–90 ft. and a girth of 9–12 ft. *Bark* thick, reddish brown, fissuring into narrow, spirally twisted ridges. *Branchlets* reddish brown, bearing triangular, acuminate, sharply pointed leaves, each marked on the back with a conspicuous resinous gland. *Branchlet systems* alternate, forming short, erect, fan-shaped, tripinnate, flattened sprays. *Leaves* $\frac{1}{16}$–$\frac{1}{2}$ in. long, glaucous-green with white margins, lateral pairs boat-shaped with sharp-pointed, spreading tips, facial pairs closely pressed, ovate-triangular, short-pointed, flat or keeled; most of the leaves being marked on the back with a resinous gland. *Male flowers* minute, dark brown, with 4–6 pairs of stamens. *Cones* ripening in the autumn of the first year, globose, $\frac{1}{4}$ in. in diameter, on a short scaly stalk, bluish purple when ripe, becoming ultimately reddish brown; *scales* 6, each with an ovate, pointed, often reflexed central process. *Seeds* 1–2 on each scale, $\frac{1}{10}$ in. long, brown, without resin-tubercles, wings narrow.

The following varieties are known in cultivation:—

Var. ericoides, Beissner.

A small, dense, pyramidal bush, glaucous at first but turning bronze or purplish brown in winter, of doubtful origin, and has been referred to various genera but is definitely stated to have

been raised from a seed of *C. thyoides* and to have retained the juvenile form of leaf.

Var. **glauca,** Endlicher.

A shrubby form with glaucous foliage.

Var. **Hoveyi.**

A variety of slender habit, the ultimate divisions of the branchlets forming dense terminal tufts.

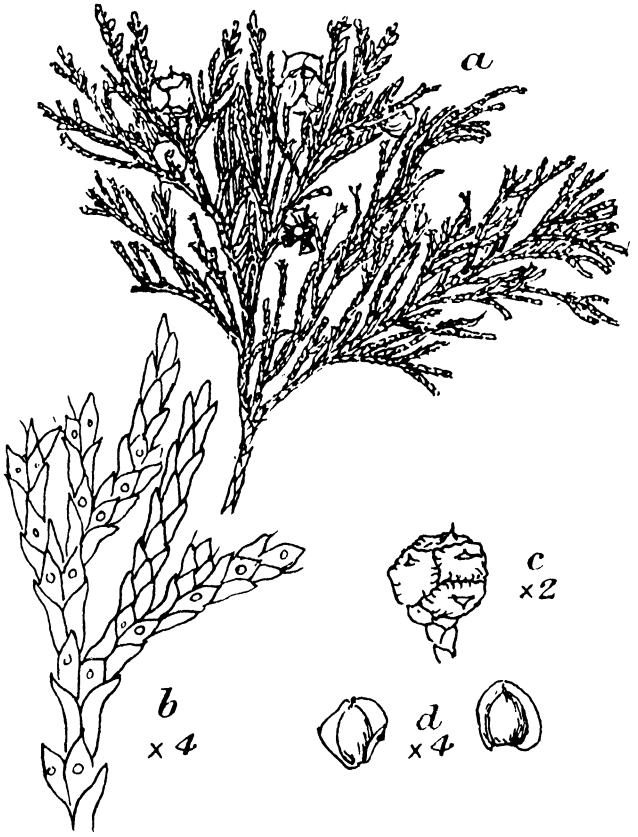

FIG. 47.—*CUPRESSUS THYOIDES.*
a, spray with four cones; *b*, branchlets; *c*, cone; *d*, seeds.

Var. **kewensis,** Hort.

Shoots reddish, habit looser and leaves darker in colour than in the type.

Var. **leptoclada,** Kent.

A shrub with close-set branches terminating in flattened branchlet systems, bearing partly adult and partly juvenile

needle-like leaves which tend to fall away. It fruits freely, but is of slow growth and is apparently less hardy than the type. First raised in France about 1850.

Var. **nana**, Endlicher.

A dwarf form making a compact, rounded bush with glaucous leaves. Suitable for the rock-garden.

Var. **variegata**, Endlicher.

The greenish leaves mixed with blotches of yellow.

The white cypress is recognized from the other species of the section *Chamæcyparis* by the flattened, fan-shaped branchlet systems and the small glaucous cones.

As a native tree *C. thyoides* has its headquarters in the Atlantic and Gulf States. It flourishes in maritime swamps and extends from Maine to N. Florida and westward to Pearl River, Mississippi, but it does not occur far inland. It was introduced by Peter Collinson in 1736, but seldom becomes a large tree in this country.

C. thyoides is a valuable timber tree in America. The wood is light reddish brown darkening with age, fragrant, easy to work, and suitable for building purposes, fence posts and telegraph poles, cooperage, mine timbers, etc. In addition to newly felled timber, large quantities of the wood are found buried in salt marshes in S. New Jersey, where no timber now grows. Trees 200–1,000 years old are found lying across each other, some partly decayed and others sound; these trunks have been dug up and the sound wood sawn into shingles.

The species has no value for forest planting in Britain, and is not of first importance as an ornamental tree.

Rev. Hort. 1880, p. 96.

Cupressus torulosa, Don. (Fig, 48.)

A large tree attaining in the Himalaya a height of 150 ft. and a girth of 37 ft. *Bark* about ½ in. thick, brown, peeling off in long, narrow strips. *Branches* horizontal or ascending, forming a broadly pyramidal crown, the branchlets pendulous at the tips. *Branchlet* systems flattened, bi- or tri-pinnate, the ultimate divisions curved and whip-like. *Leaves* regularly arranged in 4 ranks, closely pressed, $\frac{1}{16}$ in. long, ovate, blunt, often pitted on the back. *Young cones* green, often with a plum-coloured tinge, ripening in the second year, dark brown when mature, on short recurved stalks, globose or ellipsoid, ½ in. in diameter; *scales* 8–10, with the centre of the outer surface depressed and bearing a small, triangular, often recurved process. *Seeds* 6–8 on each scale, ⅛ in. long, pale brown, winged.

Var. **Corneyana**, Carrière.

Cupressus Corneyana, Knight; Juniperus Corneyana, Hort.; J. chinensis Corneyana, Gordon.

Branchlet systems more pendulous, irregularly arranged, not conspicuously flattened as in the typical form.

FIG. 48.—*CUPRESSUS TORULOSA.*

a, spray with two female and many male cones; *b*, branchlet; *c*, seed marked with resin glands.

C. torulosa may be known by the slender, curved, whip-like divisions of the flattened branch systems and the uniform leaves.

This beautiful tree is found wild in the outer ranges of the W. Himalaya, where it usually grows on limestone at from 5,000–

9,000 ft. elevation. It also occurs in W. Szechuen, China, where, according to Wilson,[1] it is a common tree throughout the arid upper reaches of the Tung River between 5,000–8,000 ft. altitude, and at one time evidently formed extensive forests in this region. It was introduced into European cultivation by Dr. Wallich in 1824. Although planted in many places since that date, it has never become a common tree, the best examples being found in the mild climate of the western and south-western counties.

Wood hard, close-grained, even in texture, pale yellow with light brown heart wood, medullary rays, very fine. Gamble[2] says that it is very durable and that in tests upon buried sleepers made at Dehra Dun between the years 1881 and 1892 the wood of this tree resisted decay better than any other wood for the eleven years. He regards it as equal to deodar for sleepers and says that it is a good building wood and often used in the Himalaya for temples, images, and poles for carrying the sacred arks. The wood is also burnt as incense. He reports that young plants are subject to attack by the fungus *Gymnosporangium Cunninghamianum*, which also attacks *Pyrus Pashia* as an alternate host.

DISELMA, Hooker fil.

A monotypic genus endemic in Tasmania, belonging to *Pinaceæ* and characterized by minute, scale-like, closely-pressed leaves; male and female flowers borne on different plants; and by the small cones made up of two pairs of scales, the upper pair fertile.

Diselma Archeri, Hooker fil.

Fitzroya Archeri, Bentham and Hooker fil.

An erect bush or small tree, 5–20 ft. high, of compact or straggling habit according to situation, the branchlets divided into fine spray. *Leaves* scale-like, closely pressed, and overlapping, alternately opposite or sometimes whorled, blunt at the apex. *Male and female flowers* borne on different plants, the former terminal, oblong, with the stamens in 3 or 4 pairs; female flowers terminal, solitary. *Cones* small, composed of 2 pairs of scales, the upper pair with 2 three-winged seeds.

Native of the Western Coast Ranges and Lake St. Clair, Tasmania, growing at elevations of 3,000–4,000 ft. The plant has no economic value.

Baker and Smith, *Pines of Australia*, 299 (1910).

[1] *Pl. Wils.* ii, 55 (1914).

[2] *A Man. of Ind. Timbers*, 696 (1922 ed.). See also Elwes and Henry, *loc. cit.* v, 1158 (1910).

Photo by I. F. Wallis

PLATE XIII. FITZROYA PATAGONICA.

FITZROYA, Hooker fil.

A monotypic genus belonging to the tribe *Cupressineæ* of *Pinaceæ*, distinguished by the normal cones being composed of 9 scales in 3 alternating whorls, the lowest whorl small and sterile, the middle whorl larger and sterile, or with a single two-winged seed to each scale, the upper whorl fertile, each scale bearing 2–6 two- or three-winged seeds.

Fitzroya patagonica, Hooker fil. (Fig. 49.)

An evergreen tree 80–160 ft. high and 10–16 ft. in girth in Chile, but reduced to a bush at high elevations. *Bark* reddish, furrowed, peeling off in long strips. *Branchlets* flexible, slender, pendulous, green when young, becoming reddish with age. *Buds* ovoid or globose, composed of shortened leaves. *Leaves* persisting several years, in alternating whorls of 3, their bases flattened and attached to the branchlet, the free part spreading, oblong or lance-shaped, about $\frac{1}{8}$ in. long with a minute incurved point, upper surface concave with 2 sunken white stomatic bands, lower surface convex with a broad green midrib, on each side of which is a white band of stomata extending from the base to near the apex. *Male and female flowers* on the same or on different trees, sometimes hermaphrodite. *Male* flowers solitary in the leaf axils near the points of the shoots, cylindrical with 15–24 stamens in whorls of 3. *Female flowers* solitary, about $\frac{1}{4}$ in. in diameter, on short, stalk-like, leafy shoots. *Cones* woody, $\frac{1}{4}$–$\frac{1}{3}$ in. in diameter, ripening the first year, composed of 9 scales in 3 whorls, the lowest minute and sterile, the middle empty or each bearing a two-winged seed, the upper scales the largest and bearing two- or three-winged seeds, the apex of the cone terminating in gland-like, resin-secreting bodies about $\frac{1}{8}$ in. long, which exhale a fragrant odour. *Cotyledons* 2. Hermaphrodite flowers have a larger number of scales.

Fitzroya is a native of Chile and N. Patagonia from the coast range north of Valdivia to the Cent. Cordillera of the Andes and covering extensive tracts of marshy country. It was introduced into cultivation in 1849 by William Lobb and again by R. Pearce, the Veitchian collector, ten years later. Although quite hardy in Britain, it is more often seen as a shrub than a tree, but specimens 30 ft. or more high are occasionally met with in the west of England and elsewhere.[1]

Wood reddish brown, easily worked on account of its straight grain and much used for shingles, furniture, cooperage, masts, and spars.

Elwes and Henry[2] state that most of the cultivated trees

[1] A specimen at Stonefield, Argyleshire, was 40 ft. high by 5 ft. 10 ins. in 1923.

[2] *Loc. cit.* vi, 1454 (1912); *Bot. Mag.* t. 4616 (1851); Clinton-Baker, *Illust. Conif.* iii, 81 (1913).

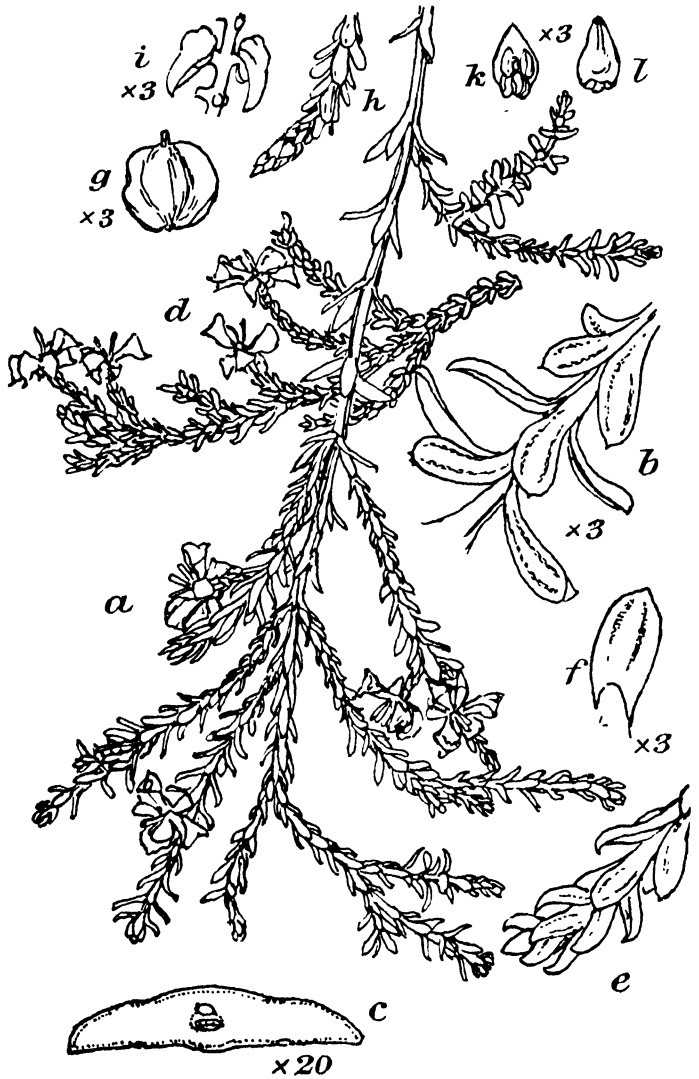

FIG. 49.—*FITZROYA PATAGONICA.*

a, spray bearing loose foliage and many expanded cones; *b*, leaves showing two bands of stomata on both upper and lower surfaces; *c*, section of leaf, showing central resin canal; *d*, spray bearing closer foliage; *e*, branchlet with close foliage; *f*, inner surface of leaf, showing bands of stomata; *g*, seed; *h*, male cone with stamens in whorls of three; *i*, two stamens attached to the axis, and stalks of other stamens; *k*, inner aspect of stamen bearing five anthers; *l*, outer aspect of stamen.

appear to bear only female flowers, the seed, although freely produced, being consequently infertile. It can be propagated by seeds, which should be sown as soon as ripe, or by cuttings inserted in sandy soil in a close frame during summer. Cultivation as in *Cupressus*.

FIG. 50.—*FOKIENIA HODGINSII.*

a, spray with juvenile foliage; *b*, under-surface of leaves, showing bands of stomata; *c*, spray with mature foliage (after H. H. Thomas); *d*, expanded cone; *e*, seed with unequal wings (after H. H. Thomas); *f*, barren seed, with only one wing.

FOKIENIA, Henry and Thomas.

Fokienia Hodginsii, Henry and Thomas. (Fig. 50.)

Cupressus Hodginsii, Dunn.

A tree 40 ft. high and 3 ft. in girth in E. China. *Leaves* arranged in flattened tripinnate branchlet systems, the pinnæ disposed in one plane like a Thuya, the branchlets tapering above. *Leaves* on adult trees arising in whorls of 4 at the same level, sub-acute, about $\frac{1}{12}$ in. long, the lateral leaves ovate, compressed, with white stomatic depressions on their ventral surfaces, facial leaves oblanceolate with a triangular apex, furrowed above.

Internodes longer on older branchlets, the leaves arising at different levels in alternately opposite pairs. *Leaves* on young plants larger, about ½ in. long with spine-like points. *Male flowers* not seen. *Cones* resembling those of the *Chamæcyparis* section of *Cupressus*, ripening in the second year, globose or subglobose, about 1 in. long, ⅞ in. wide, shortly stalked, composed of numerous (12–16) scales, each with a central spine or short process. *Seeds* 2 on each fertile scale, about ⅛ in. long, angular, pointed, with 2 large resin blisters on the upper and lower surface ; wings lateral, very unequal.

Fokienia, which is intermediate in character between *Cupressus* and *Libocedrus*, strongly resembles *Libocedrus macrolepis* in foliage, but in the latter plant the leaves are sharply pointed.

This remarkable plant was discovered in 1908 by Captain Hodgins in the Yung-fu district of Fokien at a few hundred feet above sea-level. It has also been found near Temping and Amoy. It was introduced into cultivation by Captain (now Vice-Admiral Sir Lewis) Clinton-Baker, who in 1909 sent two plants, received from the discoverer, to Bayfordbury. There is a small plant in the Temperate House at Kew, received from the same source.

Wood light in weight and colour and very similar in appearance to that of *Cupressus obtusa*. It is not known to be of any economic importance.

Fokienia is probably too tender for outdoor cultivation in Britain, except in the mildest parts.

Gard. Chron. April 4 and 11 (1911) ; Clinton-Baker, *Illust. Conif.* iii, 85 (1913)

GLYPTOSTROBUS, Endlicher.

Differs from *Taxodium* in the pear-shaped, long-stalked cones, obovate scales, and small-winged seeds.

Glyptostrobus heterophyllus, Endlicher.

CHINESE DECIDUOUS CYPRESS.

Taxodium heterophyllum, Brongniart ; T. sinense, Forbes. Canton Water Pine.

A small tree with deciduous lateral branchlets and foliage, allied to *Taxodium distichum*. Two kinds of leaves are produced, those on barren branchlets ⅓–½ in. long, arranged in 3 ranks, and those on the fruiting branchlets over-lapping and scale-like, both kinds delicate green when young, rich brown in autumn. The male inflorescences resemble those of *Taxodium*, but the cones differ in being pear-shaped and borne on stalks ½–¾ in. long. *Mature cones* are about ¾ in. long with obovate, rather thin scales. *Seeds* oval or oblong, $\frac{3}{16}$–¼ in. long, thin-coated and terminated by a hatchet-shaped wing about ⅛ in. long.

A native of the province of Canton, S. China, where it is usually

found in damp situations on the banks of streams. It is only hardy in the very mildest parts of Britain and is very rarely seen in gardens. It has no economic importance.

Gard. Chron. xxvi, 489 (1899); *Journ. Bot.* xxxviii, 37 (1900).

JUNIPERUS, Linnæus.

JUNIPERS.

A genus comprising about thirty-five species of evergreen trees or shrubs distributed over the northern hemisphere from the Arctic Circle to Mexico and the West Indies, Azores, Canary Islands, N. Africa, Abyssinia, the mountains of E. Tropical Africa, Himalaya, China, and Formosa. *Bark* usually thin and scaling off in longitudinal strips. *Leaves* on young plants spreading and awl-shaped; on adult plants either awl-shaped and spreading or closely pressed and scale-like. *Male and female flowers* on the same or on separate trees. *Male flowers* composed of numerous stamens on a central axis, with ovate or peltate scale-like connectives, each bearing 2–6 globose pollen sacs. *Female flowers* surrounded at the base by minute scale-like bracts, which persist unchanged under the fruit, composed of 3–8 opposite or ternate, pointed, united scales, which become fleshy and form a berry-like fruit bearing one or more seeds.

Wood fragrant, usually highly coloured, reddish or reddish brown, easily worked, very durable, rarely injured by insects; useful for a wide range of purposes, one of the most important uses of a N. American species being the manufacture of cases for lead pencils. Oil is expressed by distillation from wood and leaves. That from the wood is often used for perfumery, sometimes in medicine. Oil from the leaves and shoots is also used in medicine. They have powerful diuretic properties and stock should not be allowed to eat branches.

The junipers give excellent results on limy soil, but they also thrive in other good soil. Propagation is by seeds, cuttings, or by grafting. *Seeds* often lie a year before germinating, though at other times they may vegetate in a few weeks. Germination may be hastened by soaking the seeds in hot water for a few minutes before sowing. *Cuttings* are inserted in a close frame in July or August and grafting is practised indoors in spring on stocks previously established in pots.

The compact columnar or pyramidal forms are excellent for narrow avenues in formal gardens; the spreading kinds make a good covering for ground in semi-wild places, whilst those of bushy habit may be used for hedges, as they withstand a good deal of clipping.

Several species, particularly *J. communis* and *J. Sabina*, are sometimes seriously injured by fungus (species of *Gymnosporan-*

gium), which form golden gelatinous patches surrounding the stems. One stage of the fungus is passed upon juniper and another upon a rosaceous tree such as mountain ash, hawthorn, blackthorn, bird cherry, or crab apple. The only way to check the spread of the fungus is to eradicate the host of one stage throughout the neighbourhood.

Key to Juniperus.

Leaves always awl-shaped or needle-like, jointed at the base, rigid, usually sharp-pointed.

Leaves not decurrent on the branchlets. Staminate flowers solitary in the axils of the upper leaves. Fruit composed of three or four scales, marked at the apex by three radiating lines or furrows. Seeds normally three, free.

Leaves with one white stomatic band above.

Leaves $\frac{2}{5}$–$\frac{1}{3}$ in. long, slightly concave above without any trace of a green midrib near the base except in rare cases. Fruit about $\frac{1}{4}$ in. in diameter. In var, *nana* leaves shorter, $\frac{1}{6}$–$\frac{1}{3}$ in. long.—*J. communis.*

Leaves $\frac{1}{2}$–$\frac{3}{4}$ in. long, very slender, deeply concave above, with the margins inflexed, forming a narrow median groove. Fruit about $\frac{1}{4}$ in. in diameter.—*J. rigida.*

Like *J. rigida* in foliage, but with leaves densely imbricated and larger glaucous fruit, $\frac{1}{3}$–$\frac{1}{2}$ in. in diameter.—*J. conferta.*

Leaves with two white stomatic bands above.

Shrubs with leaves spreading horizontally outwards from branchlets which are usually not pendulous.

Leaves $\frac{1}{2}$–$\frac{3}{4}$ in. long, gradually tapering from the middle to the sharp-pointed acuminate apex; upper surface with a conspicuous midrib, about half the width of the white bands, which are equal in width to the marginal green bands.—*J. Oxycedrus.*

Leaves $\frac{3}{4}$–1 in. long, tapering from the base to the sharp-pointed acuminate apex; upper surface with a conspicuous midrib less than half the width of the white bands, which are broader than the marginal green bands.—*J. macrocarpa.*

Leaves $\frac{1}{2}$–$\frac{3}{4}$ in. long, with a conspicuous midrib much narrower than the white bands, which are broader than the marginal green bands.—*J. formosana.*

Trees with leaves directed towards the apices of the pendulous branchlets.

Leaves $\frac{1}{2}$–$\frac{3}{4}$ in. long, with a conspicuous midrib above, about half the width of the white bands, which are equal in width to the marginal green bands. *J. Cedrus.*

Leaves decurrent on the branchlets. Staminate flowers 3–6 in a head on a scaly stalk. Fruit much larger than in the other sections, composed of 6 or 9 ternate scales. Seeds consolidated into a thick, globose, 3-celled bony mass.

Leaves $\frac{1}{2}$–$\frac{7}{8}$ in. long, widely spreading, rigid, sharp-pointed; upper surface with a broad green midrib, deeply furrowed near the base, and two broad white bands.—*J. drupacea.*

Leaves on adult plants always awl-shaped or needle-like, never jointed at the base.

Branchlets curved or pendulous. Leaves in threes, loosely appressed, $\frac{1}{8}$–$\frac{1}{4}$ in. long, sharp-pointed, greyish green on the dorsal surface, which is channelled in the middle line near the base.—*J. recurva.*

Leaves in threes, appressed or spreading, broader and shorter than in *J. recurva*, $\frac{1}{6}$ in. long, green on the dorsal surface, which is channelled from the base to near the apex.—*J. squamata.*

Leaves larger than *J. squamata*, otherwise similar; branchlets also glaucous in tint.—*J. procumbens.*

Leaves on adult trees all scale-like and appressed, or with awl-shaped and needle-like foliage on occasional branches.

Leaves minutely toothed on margins.

Fruit large, usually about $\frac{2}{5}$–$\frac{1}{2}$ in. in diameter.

Ultimate branchlets $\frac{1}{10}$ in. in diameter. Fruit blue, ovoid, with one large seed.—*J. Wallichiana.*

Ultimate branchlets $\frac{1}{15}$ in. in diameter; leaves closely appressed, ovate, blunt, with an inconspicuous depression on the back. Fruit globose or pyriform, yellow or reddish brown, with fibrous yellow flesh. Seeds 3–9. *J. phœnicea.*

Tree with long pendulous branchlets, $\frac{1}{16}$ in. in diameter. Leaves ovate, lanceolate, slightly spreading, $\frac{1}{12}$ in. long, sharp-pointed, with resin-glands on the back. Fruit globose, reddish brown. Seeds 6–12.—*J. flaccida.*

Tree with thick bark divided into small square plates, unique in the genus. Ultimate branches quadrangular, $\frac{1}{15}$ in. in diameter. Leaves appressed, rhombic, with a depressed oval gland, often exuding

resin. Awl-shaped or needle-like leaves often present. Fruit reddish brown, tuberculate on the surface. Seeds 4.—*J. pachyphlœa.*

Leaves entire in margin.

Fruit $\frac{1}{3}$–$\frac{1}{2}$ in. long.

Branchlets more or less regularly pinnate; ultimate divisions $\frac{1}{20}$ in. in diameter. Leaves ovate appressed, free at their acute or acuminate tips with a conspicuous glandular depression on the back. Needle-like foliage often present. Fruit blue. Seeds 2–4.—*J. thurifera.*

Branchlets more or less radially arranged, slender, $\frac{1}{30}$ in. in diameter. Leaves ovate-triangular, free at their acute or sub-acute tips, marked on the back with a depressed gland.—*J. excelsa.*

Fruit $\frac{1}{6}$–$\frac{1}{4}$ in. in diameter.

Ultimate branchlets very slender, $\frac{1}{30}$ in. in diameter, terete. Leaves appressed, ovate, acute, or acuminate, often with a small oval depression on the back. Needle-like foliage usually present. Fruit bluish, $\frac{1}{6}$–$\frac{1}{4}$ in. in diameter. Seeds 1–2.—*J. virginiana.*

Shrub, similar in foliage to *J. virginiana*, but with an unpleasant smell when rubbed, and the peduncle of the fruit curved, not straight, as in the latter species. *J. Sabina.*

Closely allied to *J. virginiana*, but distinguished by its somewhat larger fruits, ripening in the second year. Branchlets also somewhat shorter and stouter. Foliage usually glaucous or yellowish-green.—*J. scopulorum.*

Foliage glaucous. Ultimate branchlets $\frac{1}{20}$–$\frac{1}{12}$ in. in diameter, quadrangular. Leaves closely appressed, ovate, obtuse at the incurved apex, with a conspicuous dorsal furrow. Needle-like foliage usually present. Fruit $\frac{1}{4}$ in. in diameter. Seeds 2–3.—*J. bermudiana.*

Ultimate branchlets terete, $\frac{1}{25}$ in. in diameter, marked with white crosses due to the pale margins of the leaves, which are compressed rhombic, obtuse, with an inconspicuous gland. Needle-like foliage usually present. Fruit with a white mealy bloom, sub-globose and widest at the summit. Seeds 2–5.—*J. chinensis.*

Juniperus barbadensis, Linnæus.

BARBADOS CEDAR.

Juniperus virginiana, var. australis, Endlicher; J. virginiana, var. barbadensis, Gordon. Red Cedar; Southern Red Cedar.

A tree attaining a height of 50 ft. and a girth of 6 ft., with pendulous branches and branchlets. *Branchlets* more slender and drooping than in *J. virginiana*. *Leaves* smaller, $\frac{1}{8}$–$\frac{1}{5}$ in. long in a juvenile state, about $\frac{1}{20}$ in. long when mature, glandular on the back. *Male and female flowers* on different trees. *Fruit* ripening in the first year, sub-globose, smaller than in *J. virginiana*, $\frac{1}{8}$–$\frac{1}{6}$ in. in diameter, glaucous. *Seeds* one or two to each fruit, ovoid, pointed, ridged.

This juniper is found wild in coastal swamps from S. Georgia to Florida, and also occurs in the West Indies. It is not known to be in cultivation in Britain.

Wood soft, close grained, red, and fragrant. It is of the same importance as *J. virginiana* for pencil-making when it can be procured in quantity, but the tree is scarce. In suitable parts of the West Indies the cultivation of this tree is worthy of attention. A small plantation has already been formed at Réunion.[1]

J. Bedfordiana, a tree of columnar habit, with slender, drooping branchlets and bright green awl-shaped leaves, is considered to be a form of *J. barbadensis*, but in the absence of fruit its identity is difficult to decide.

Mohr, *U.S. Forest. Bull.* No. 31, p. 37, t. ii (1901); Sargent, *Silva*, xiv, 89, t. 738 (1902).

Juniperus bermudiana, Linnæus.

BERMUDA CEDAR.

Juniperus fragrans, Hort. Bermuda Red Cedar.

A tree 40–50 ft. high, with a trunk 9–12 ft. in girth in the Bermudas, where it is the only indigenous, exogenous tree. *Bark* dark red. *Branches* much divided, the ultimate branchlets, except in juvenile trees, four-sided, about $\frac{1}{20}$ in. in diameter, with scale-like, overlapping leaves, arranged in 4 ranks, each about $\frac{1}{12}$ in. long, ovate, blunt, incurved at the apex, greyish green or glaucous on the back, which is often furrowed. *Leaves* on the main branchlets in threes, up to $\frac{1}{7}$ in. long; juvenile leaves awl-shaped, occasionally seen on old trees. *Male and female flowers* on different trees. *Fruit* ripening in the first year, globose, about $\frac{1}{4}$ in. in diameter, glaucous, each scale marked by a depression with a minute point. *Seeds* 2–3, shining chestnut brown, ovoid, furrowed.

Formerly abundant in Bermuda, thriving both on the limestone hills and in brackish swamps, but large trees are no longer common. It was cultivated in England as early as 1684, but it is not hardy here, and has not attained a large size. Specimens

[1] *Rep. on the Agric. Dept. St. Lucia* (1914–15).

15–20 ft. high, however, have been grown in the Temperate House at Kew.

The wood is of good quality, red in colour, very durable, and sometimes prettily marked. It has been used for shipbuilding and furniture. Cabinets made of the wood are highly prized and treated as heirlooms in Bermuda.

Clinton-Baker, *Illust. Conif.* iii, 6 (1913).

Juniperus brevifolia, Antoine.

A small tree with a stem up to 5 ft. in girth. *Branches* short, numerous, densely clothed with foliage. *Leaves* narrow, $\frac{1}{4}$–$\frac{1}{3}$ in. long, about $\frac{1}{12}$ in. wide, glaucous, jointed and swollen at the base, the apex rounded or short-pointed; upper surface with a narrow, green midrib, on each side of which is a broad, white, stomatic furrow bounded by an external green band; lower surface green, with a prominent midrib. *Fruit* sub-globose, dark reddish brown. Seeds 3, ovoid.

A very distinct juniper, found wild only in the Azores, where it ascends to 5,000 ft. elevation. It is not known to be under cultivation in Britain, and is of no economic importance.

Clinton-Baker, *Illust. Conif.* iii, 7 (1913).

Juniperus californica, Carrière.

CALIFORNIAN JUNIPER.

Sweet-berried Juniper; Sweet-fruited Juniper; White Cedar.

A much-branched shrub or small tree up to 40 ft. high, with a trunk up to 3 ft. in girth. *Bark* brown or ashy grey, with thin, persistent outer layers. *Leaves* closely pressed, usually in threes, short and thick, rounded at the tip, $\frac{1}{16}$–$\frac{1}{12}$ in. long, conspicuously glandular on the back, margins minutely toothed. *Fruit* globose or oval, $\frac{1}{3}$–$\frac{1}{2}$ in. long, reddish brown covered with a glaucous bloom and containing 1–2 large, pitted seeds.

This is the common species of the coast mountains of California, occurring chiefly south of San Francisco; and also found on the western foothills and on the dry slopes of the Sierra Nevada. It was introduced by William Lobb, who sent seeds to Veitch's nursery at Exeter in 1853.

The wood is soft, close-grained, and light reddish brown. It is very durable and used for fence-posts in its native country.

Jepson, *Silv. Calif.* 162 (1910); Clinton-Baker, *Illust. Conif.* iii, 8 (1913).

Juniperus Cedrus, Webb and Berthelot.

CANARY ISLAND JUNIPER.

Canary Island Cedar; Sabina Tree.

A tree attaining a height of 70–80 or occasionally 100 ft. in the Canary Islands. Trunk stout, branches spreading, with slender, pendent branchlets. The ultimate divisions of the

branchlets numerous, short, angular, and glaucous. *Leaves* in whorls of 3, rigid, erect, spreading, narrowly lance-shaped, closely set on the branchlets and directed forwards, slightly concave, glaucous, $\frac{1}{2}$–$\frac{3}{4}$ in. long, with a conspicuous midrib above, about half the width of the two white bands. *Male and female flowers* on different trees. *Fruit* globular, $\frac{1}{3}$ in. in diameter, reddish brown when mature, glaucous.

This species is closely allied to *J. Oxycedrus*, of which it is probably an insular form differing chiefly in habit.

It is a native of the Canary Islands, where it was formerly abundant in the sub-alpine districts and higher valleys, but has been nearly exterminated owing to the demand for its timber. Large trees are still to be found in the Island of Palma, growing on the inaccessible walls of the crater and on isolated rocks above 7000 ft. elevation. Two forms of the species have been mentioned, one more free growing and of looser habit than the other. Local conditions, however, may account for the difference.

The tree has become too scarce to be of much economic importance, but Dr. G. V. Perez, of Teneriffe, considers that it might be planted with advantage for the sake of its timber, not only in the Canary Islands, but in the West Indies, New Zealand, S. Africa, and other warm temperate countries. He regards it as being quick-growing for a juniper, whilst its wood is of first-rate quality and very durable. It can only be expected to succeed out of doors in the very mildest parts of England, although unprotected plants are growing in the North of Ireland.

Clinton-Baker, *Illust. Conif.* iii, 9 (1913).

Juniperus chinensis, Linnæus. (Fig. 51.)

CHINESE JUNIPER.

Juniperus densa, Gordon; J. japonica, Carrière; J. struthiacea, Knight and Perry; J. Thunbergii, Hooker and Arnott.

A tree very variable in habit in the wild state, sometimes exceeding 60 ft. in height in China and Japan. In cultivation the typical form is pyramidal or columnar in shape, both adult and juvenile foliage being generally found on the same plant. In a wild state both male and female plants are sometimes found bearing only juvenile leaves. *Adult branches* with the ultimate divisions about $\frac{1}{20}$ in. in diameter, clothed with 4 ranks of leaves in opposite pairs, which are closely pressed, overlapping and rhombic in outline, $\frac{1}{16}$ in. long, blunt, the outer surface convex, green with a paler margin marked with a glandular depression on the back. *Juvenile leaves* awl-shaped, $\frac{1}{3}$ in. long, spreading, in whorls of 3, or in opposite pairs, with a green midrib and 2 glaucous bands above, convex beneath, ending in a spiny point. *Male and female flowers* on different trees. *Male flowers* bright yellow, very numerous, usually borne on

adult branchlets, but occasionally on branchlets bearing the juvenile type of leaves. *Fruit* ripening in the second year, brown, conspicuously glaucous, sub-globose, or top-shaped, ⅓ in. in diameter, composed of 4–8 scales. *Seeds* 2–5, broadly ovoid, grooved.

FIG. 51.—*JUNIPERUS CHINENSIS.*

a, spray with scale-like foliage and berries; *b*, branchlet with scale leaves; *c*, spray with both scale- and needle-like foliage and many male cones; *d*, needle leaves in whorls of three; *e*, section of needle leaf.

Var. **albo-variegata**, Veitch.

Var. variegata, Fortune; var. argentea, Gordon; var. argenteo-variegata, Hort.

Branchlets and leaves often creamy white at the tips.

Var. **aurea,** Young.

Upright in habit, with the adult foliage deep golden yellow at first, gradually becoming green in summer.

Var. **glauca.**

Leaves more deeply glaucous or silvery than in the type.

Var. **japonica,** Vilmorin.

Habit bushy, leaves mostly awl-shaped, in threes, the terminal branchlets bearing adult leaves. A juvenile form.

Var. **japonica aurea,** Masters.

Similar to var. *aurea* but of decumbent habit. Of Japanese origin.

Var. **japonica aureo-variegata,** Masters.

Of dwarf habit, with many of the branchlets deep golden yellow.

Var. **Pfitzeriana,** Spath.

A densely branched shrub with long, slightly drooping branchlets chiefly clothed with awl-shaped glaucous leaves. Originated in Spath's nursery, Berlin.

Var. **Sargenti,** Henry.

J. chinensis, var. procumbens, Takeda (not Endlicher); J. procumbens, Sargent (not Siebold).

Prostrate in habit, forming dense mats with long, creeping stems. Foliage and fruit similar to that of the typical form, except that no juvenile foliage is present.

Var. **sphærica.**

J. sphærica, Lindley.

This appears to be merely a variety of *J. chinensis,* differing mainly in the roundish fruit not covered with a glaucous bloom, and containing numerous seeds. Introduced by Fortune from China in 1846.

J. chinensis, which is one of the commonest species in cultivation, may generally be recognized by the pale margins of the blunt, scale-like leaves and the presence of juvenile foliage on adult trees. It is a native of China, Mongolia, and Japan. In China it is found wild in the mountains of Hupeh, Shensi, and Szechuen, and is also commonly cultivated in China and Japan. Linnæus appears to have been the first to describe the tree; it was first introduced into England by William Kerr, who sent plants from Canton to Kew in 1804.

Wood durable and sometimes prettily burred, but too scarce to be of commercial importance.

The tree is grown for decorative purposes in the British Isles and succeeds in moist soil of varying character, being specially adapted for limy formations.

Juniperus communis, Linnæus. (Fig. 55.)

COMMON JUNIPER.

Ground Juniper.

A shrub or small tree rarely attaining a height of 40 ft. *Bark* reddish brown, scaling off in papery sheets. *Young shoots* slender, triangular, with projecting ridges. *Buds* about $\frac{1}{8}$ in. long with acuminate scales. *Leaves* awl-shaped, persisting for three years, sessile, spreading, $\frac{2}{5}$–$\frac{3}{5}$ in. long, tapering from the swollen base to a spine-like point, upper surface concave with a broad white band of stomata, lower surface bluntly keeled. *Male and female flowers* usually on different plants. *Male flowers* solitary, cylindrical, $\frac{1}{3}$ in. long, the yellow stamens in 5–6 whorls. *Female flowers* solitary, green, $\frac{1}{12}$ in. long. *Fruit* ripening in the second or third year, green when young, bluish or black when ripe, covered with a waxy bloom ; globose or slightly longer than broad, $\frac{1}{3}$ in. in diameter, with 3 minute points at the top, the 3 scales of which the fruit is composed occasionally gaping and exposing the seeds. *Seeds* 2–3 elongated, ovoid, three-cornered, with depressions between.

Var. **compressa,** Carrière.

A very small cone-shaped bush, generally not more than 1 ft. high, with short, crowded leaves, forming a dainty little shrub peculiarly suitable for the rock-garden.

Var. **cracovia,** Knight.

A robust plant with pendulous, terminal branchlets. Said to be of Polish origin and rare in cultivation.

Var. **echiniformis.**

Hedgehog Juniper.

A rounded bush 1–2 ft. high, with densely crowded branches, branchlets, and leaves.

Var. **hemisphærica,** Parlatore.

Resembling var. *nana* in habit, but with longer leaves and larger fruits. Recorded from Mount Etna, Calabria, Greece, and Algeria.

Var. **montana**, Aiton.

Var. alpina, Gordon; var. nana, Loudon.

A prostrate shrub seldom more than 1 ft high. *Branchlets* stouter than in the typical form, and very dense. *Leaves* shorter, less spreading, $\frac{1}{6}$–$\frac{1}{3}$ in. long. *Fruit* smaller. An alpine form

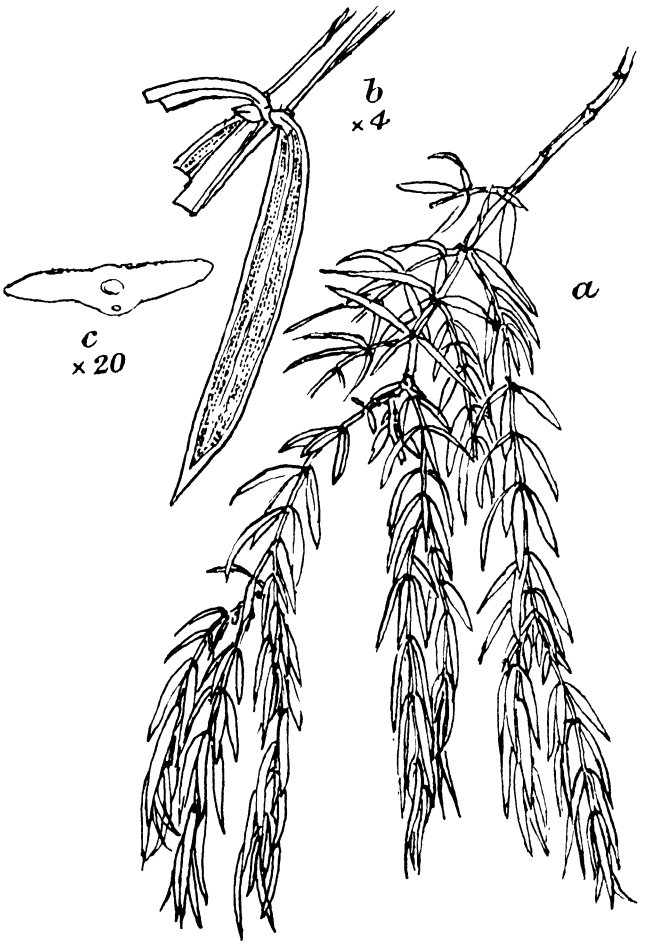

FIG. 52.—*JUNIPERUS COMMUNIS*, var. *OBLONGA PENDULA*.
a, drooping spray; *b*, inner surface of leaf; *c*, section of leaf, showing dorsal resin canal.

probably produced by climatic conditions. Intermediates connect it with the type.

Var. **oblonga**, Loudon.

A bush 4 ft. high, of very slow growth. *Leaves* $\frac{3}{4}$ in. long. *Fruit* small, $\frac{1}{6}$ in. in diameter, oblong. *Seeds* solitary or in pairs. Apparently not recently seen in cultivation in England.

Var. **oblonga pendula**, Loudon.[1] (Fig. 52.)

A tree described as of graceful habit, the main branches fastigiate and the points of the shoots pendulous.

This name was first applied to a small plant 5 ft. high, growing at Kew in 1838. An old tree 28 ft. high at Eastnor Castle, and a smaller one at Bayfordbury planted in 1843, agree well with the above description, and appear to us to belong to *J. communis* rather than to *J. formosana*, to which Chinese species (probably not introduced until 1844), they have hitherto been referred.[2] The latter has much narrower, longer, spine-tipped leaves.

According to Wilson,[3] the plant cultivated in N. America under the name of *J. oblonga pendula* is a variety of *J. communis*.

Var. **suecica**, Aiton.

Var. fastigiata, Parlatore; J. hibernica, Gordon; J. hispanica, Booth.

Strictly columnar in habit, with short, ascending branches, short leaves, and oblong fruits. It is not uncommon in cultivation and is found wild in Scandinavia and E. Prussia, where it is seen as a tree 30–40 ft. high. At Westonbirt it is 25 ft. high.

Var. **variegata-aurea**, Carrière.

Young shoots golden yellow, becoming green in the second year.

The common juniper has a wider distribution than any other tree or shrub. It is common through N. and Cent. Europe and also occurs in the mountains of the countries bordering on the Mediterranean. It is also found in Asia Minor, the Caucasus, Persia, Afghanistan, the W. Himalaya, the United States, and Canada. On many chalk hills in the S. of England, the juniper (which is one of our three indigenous conifers) is a conspicuous feature of the vegetation, whilst it is also abundant in some parts of the N. of England, Wales, the Scottish Highlands, and in Ireland.

Although the wood is too small for building purposes, it is used for fencing with very satisfactory results in some European countries, and is also made into pails and other domestic articles. The fruits are used for flavouring gin, though not to so great an extent as formerly; in 1838 it was recorded that "the distillers of Schiedam were formerly in the habit of carrying over annually a shipload of juniper berries from Inverness, for the use of their distilleries."[4] An oil distilled from the unripe berries is used for medicinal and flavouring purposes. The berries are also said to be used with beechwood in the smoking of Westphalian hams

[1] *Arb. et. Frut. Brit.* iv, 2490, fig. 2345 (1838).
[2] Elwes and Henry, *loc. cit.* vi, 1416 (1912).
[3] *Pl. Wils.* ii, 57 (1914).
[4] T. Thomson, *Chemistry of Organic Bodies*, 463 (1838).

the peculiar piquant taste of the hams being attributed to the juniper-berry smoke.[1]

Juniperus conferta, Parlatore.

J. litoralis, Maximowicz.

A prostrate shrub with brownish bark, thick branches, and dense, erect branchlets. *Leaves* crowded, overlapping, about ½ in. long, awl-shaped, glaucous green, tapering to a prickly point, deeply grooved above with one band of stomata, convex below. *Fruit* produced in abundance, globose, ⅓–½ in. in diameter, black with a glaucous bloom when ripe. *Seeds* 3, ovoid, triangular.

This species is like *J. rigida*, but differs from it in its crowded, overlapping shorter leaves and conspicuously glaucous fruit. In its native country, Japan, it is widely spread on sandy shores, forming dense, broad mats. It has recently been introduced into cultivation.

The juniper formerly grown in gardens under the name of *J. litoralis* is not this plant, but another Japanese species, *J. procumbens*.

J. conferta has no economic importance. Cultivation as in *J. procumbens*.

Clinton-Baker, *Illust. Conif.* iii, 18 (1913) (as J. littoralis); Wils., *Conifers of Japan*, 83 (1916).

Juniperus convallium, Rehder and Wilson.[2]

A tree 15–30 ft. high, the branches erect or spreading, the bark greyish and smooth. *Leaves* pale green or glaucous, scale-like, appressed, in 4 rows, overlapping, ovate, acute or blunt, about $\frac{1}{12}$ in. long rounded on the back, with a glandular depression. *Fruit* sub-globose or ovoid, ⅛–¼ in. long, shining chestnut brown, decurved, one-seeded. *Seed* globose or egg-shaped.

A well-marked juniper like *J. excelsa* in habit, but very distinct in fruit; found, according to Wilson,[1] only in the drier parts of the principal river valleys of the China-Tibetan borderland.

Juniperus drupacea, Labillardière. (Fig. 53.)

SYRIAN JUNIPER.

Juniperus rufescens, Hort.; Arceuthos drupacea, Antoine. Drupe-fruited Juniper.

A tree attaining 60 ft. in height, usually pyramidal in the wild state, but assuming a columnar habit in cultivation. *Young shoots* triangular, prominently ridged or winged. Older branchlets smooth. *Buds* about ⅛ in. long, with minute, sharp-pointed scales. *Leaves* narrowly lance-shaped, spreading, in whorls of 3, ½–⅞ in. long, $\frac{1}{10}$–⅓ in. broad, jointed at the base, apex

[1] *Journ. Roy. Soc. Arts.*, 1912, 416.
[2] *Pl. Wils.* ii, 62 (1914).

sharply pointed, upper surface concave with a broad green mid-rib, which is furrowed near the base, and two white stomatic bands. *Male and female flowers* on different trees. *Male flowers* axillary, 5–6 in a head, with 9–10 stamens in each flower.

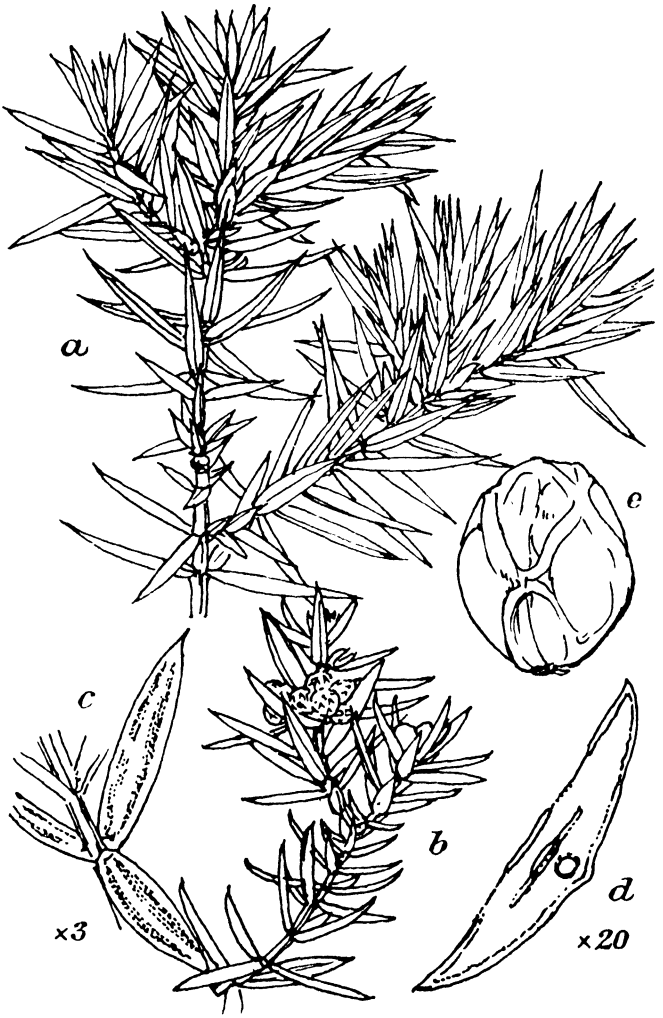

FIG. 53.—*JUNIPERUS DRUPACEA.*

a, spray ; *b*, spray with cluster of male cones ; *c*, whorl of three leaves ; *d*, section of leaf ; *e*, berry

Fruit ripening in the second year, the largest in the genus, ¾–1 in in diameter, brown or bluish with a glaucous bloom, usually composed of 9 fleshy scales which are often pointed at the apex, enclosing a bony stone with 3 cells, each containing a minute kernel.

This remarkable juniper, easily recognized from all the other species by its large, stiff leaves with adherent bases and large fruits, is a native of the mountains of Asia Minor, Syria, and Greece. It is found at elevations of 1,600–5,600 ft., either forming pure woods or mixed with other conifers. It was probably introduced into cultivation about 1854, but so far as is known has never produced fruit in England, where all the trees in cultivation are believed to be males.

Clinton-Baker, *Illust. Conif.* iii, 14 (1913).

Juniperus excelsa, Bieberstein. (Fig. 54.)

GRECIAN JUNIPER.

A tree of columnar or pyramidal habit, attaining in Asia Minor a height of 80–100 ft., and a girth of 9–12 ft. *Bark* ashy grey or brownish, peeling off in strips. *Branchlets* slender, the ultimate divisions $\frac{1}{10}$ in. or less in diameter. *Leaves* scale-like, closely pressed, in 4 ranks, arranged in opposite pairs, ovate, rhombic, about $\frac{1}{4}$ in. long, acute or obtuse, with a glandular furrow on the back, or on the oldest branchlets in threes or in pairs. Juvenile type of leaves rarely seen on adult plants, spreading, in opposite pairs, $\frac{1}{3}$–$\frac{1}{4}$ in. long, concave above with two stomatic bands marked on the lower surface with a narrow gland at the base. *Male and female flowers* on the same tree or on different trees. *Fruit* globose, $\frac{1}{3}$–$\frac{1}{2}$ in. in diameter, dark purplish brown, glaucous, composed of 4–6 scales, each marked by a minute point. *Seeds*, about 6 in each fruit, oblong.

Var. **stricta**, Rollisson.

Narrowly pyramidal in habit with glaucous juvenile foliage; leaves awl-shaped, slightly spreading, about $\frac{1}{8}$ in. long, whitened with a stomatic band above and showing a minute gland near the base on the lower surface.

The varieties *Perkinsii* and *venusta*, described in Gordon's Pinetum, are forms of this variety with more glaucous foliage.

As a native tree *J. excelsa* attains its greatest development in Asia Minor, where it forms extensive woods in mountainous regions. It is also found in the Balkan States, Armenia, and the Caucasus, and was probably first grown in England in 1836, although the actual date of introduction is somewhat uncertain.

The wood of *J. excelsa* is of good quality, very durable and suitable for building purposes, furniture, posts, and railway sleepers. It is chiefly used in the Mediterranean region. It has been suggested that the wood of this tree was actually the "Cedar of Lebanon" of the Bible and not that of *Cedrus Libani*.[1]

[1] *Natural History Review*, January, 1862; Elwes and Henry, *op. cit.* vi, 1446 (1912); Clinton-Baker, *op. cit.* ii, 75, No. 3 (1909).

In Britain it does not exceed 40 ft. in height, and its only value is for decorative gardening and for planting in scientific collections.

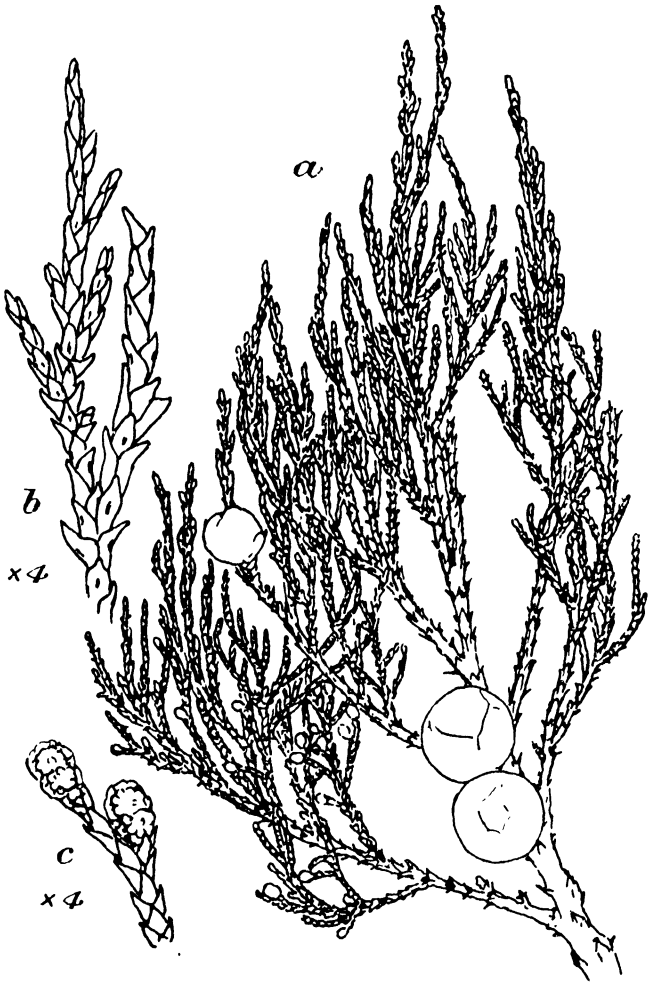

FIG. 54.—*JUNIPERUS EXCELSA.*

a, spray with three berries; *b*, branchlets; *c*, two male cones.

Juniperus flaccida, Schlechtendal.

MEXICAN JUNIPER.

A tree attaining a height of 30–40 ft., with brown, scaly bark. *Branches* widely spreading, with long, pendulous branchlets. *Adult leaves* in opposite pairs, slightly spreading, broadly lance-shaped, about $\frac{1}{12}$ in. long, the base clasping the stem, the apex

sharp-pointed, and the back rounded with a sunken resin gland. *Juvenile leaves*, which occasionally appear on the ends of branchlets of adult trees, awl-shaped, spreading, in whorls of 3, rarely in pairs, about ¼ in. long, the base closely clasping the stem, gradually tapering to a horny, pointed apex; the upper surface concave with inflexed margins, and two narrow lines of stomata, the lower surface marked near the base with a gland. *Male and female flowers* on different branches of the same tree. *Fruit* ripening in the second year, sub-globose, ¼ in. in diameter, reddish brown, with a waxy bloom, marked on the surface with minute tubercles, composed of 6–8 opposite scales, each indicated by a reflexed point. *Seeds* 6–12, several often imperfect.

A native of the Chisos Mountains in Texas and common in N.E. Mexico at 6,000–8,000 ft. elevation. It was introduced in 1838 by Hartweg, but has proved too tender for our climate, the only known specimen in Britain being one at Bicton, which is now about 40 ft. high.

The useful qualities of the timber are limited to its native countries.

Clinton-Baker, *op. cit.* iii, 15 (1913).

Juniperus formosana, Hayata.

PRICKLY CYPRESS.

J. taxifolia, Masters (not Hooker and Arnott).

An elegant tree, attaining in China a maximum height of 75 ft., although often but 40 ft. high, with a slender trunk often dividing a few feet from the ground into three or more erect stems. *Bark* grey-brown, fibrous, fissured, peeling off in thin narrow strips. *Leaves* in whorls of 3, narrow, about ½ in. long, $\frac{1}{10}$–$\frac{1}{12}$ in. broad, jointed and swollen at the base, ending in a spiny point, upper surface concave, with two broad, white, stomatic bands separated by a narrow green or glaucous midrib. *Fruit* sub-globose, or broadly ovoid, ¼–⅓ in. diameter, ripening in the second year, shining dark reddish brown when ripe, with three deep furrows at the summit, showing the separation of the fruit into three scales. *Seeds* three, elongated-ovate, triangular.

J. formosana is widely spread throughout the mountains of China, and has also been found in Formosa between 8,000–13,000 ft. altitude. Wilson,[1] apparently writing of this species, says: "At Erb-tao-chiao I photographed a magnificent juniper tree 75 ft. tall, and 22 ft. in girth, with graceful pendent branches."

This beautiful juniper is rarely seen in cultivation and does not appear to bear fruit in this country. It was probably one of the plants sent home by Fortune in 1844. It closely resembles

[1] *A Naturalist in Western China*, i, 176 (1913).

J. rigida in habit, but the upper surface of the leaves is not grooved as in that plant, which has, moreover, black fruit.

The economic uses appear to be local.

Clinton-Baker, *op. cit.* iii, 17 (1913); *Pl. Wils.* ii, 156 (1914).

Juniperus horizontalis, Moench.

WAUKEGAN JUNIPER.

Juniperus hudsonica, Loddiges; J. Sabina, var. procumbens, Pursh.; J. Sabina, var. prostrata, Loudon. American Savin.

A handsome juniper with prostrate or procumbent, rooting stems, which spread for a considerable distance over the ground. Leaves conspicuously glaucous, of two kinds, scale-like, about $\frac{1}{6}$ in. long, closely pressed, in four ranks, shortly pointed, each with a glandular depression on the back, and awl-shaped leaves in opposite pairs, slightly spreading. *Fruit* bluish on recurved stalks, $\frac{1}{3}$ in. long, not produced on cultivated plants, which usually bear only awl-shaped leaves.

Native of North America, found on sea cliffs, gravelly slopes, and in swamps from the coast of Maine to British Columbia, ranging south to Massachusetts, W. New York, Illinois, and Montana. The plant was formerly confused with *J. Sabina*, and may be grown under similar conditions to dwarf forms of that species.

Juniperus lucayana, Britton.[1]

RED CEDAR.

A tree closely allied to *J. barbadensis*, from which it is said to differ in its smaller, four-ranked leaves, and in its depressed, globose, and somewhat laterally flattened fruit. It inhabits the N. Bahama Islands, though little is now left of it on account of the use of its wood for lead pencils.

Juniperus macrocarpa, Sibthorp and Smith.

LARGE-BERRIED JUNIPER.

Juniperus Oxycedrus, var. macrocarpa, Aschus.

This juniper is closely allied to *J. Oxycedrus*, with which some botanists have united it, but differs in the longer, broader leaves, which are $\frac{3}{4}$–1 in. long, and about $\frac{1}{12}$ in. broad, gradually tapering from the base to the spiny point. *Fruit* larger than in *J. Oxycedrus*, globose or tapering at the base (var *ellipsoidea*), glaucous blue, but turning purplish brown after ripening, about $\frac{1}{2}$ in. broad, $\frac{5}{8}$ in. long.

It has a similar distribution to *J. Oxycedrus*, but generally grows in sandy places near the sea, extending through the Mediter-

[1] *Trees of N. America*, 121 (1908).

ranean region from Spain to Syria, and is also found in Bulgaria. Although introduced into England about 1838, it has never become established and is very rarely seen.

The fragrant wood appears to be used with that of *J. Oxycedrus* for distillation, for perfumery purposes.

Clinton-Baker, *op. cit.* iii, 14 and 15 (1913).

Juniperus macropoda, Boissier.[1]

A shrub or a tree 40–50 ft. high, or sometimes taller, with a trunk 6–7 ft. in girth. Foliage like that of *J. excelsa*, but coarser. *Fruit* globose, $\frac{1}{3}$ in. in diameter, brownish-purple, tinged with a glaucous bloom, each of the 4 to 6 scales with a prominent boss. *Seeds*, 2–4 to each fruit, ovoid. This species appears to connect the Eastern Asiatic *J. chinensis* with the Western *J. excelsa*.

The wood is fragrant, moderately hard, with red heartwood and yellow sapwood. It has been used in India for wall-plates, beams, and fuel, and has been suggested as being suitable for pencils. The wood of this and other junipers is burnt as incense. Native of Persia, Afghanistan, and Baluchistan, where it forms extensive forests.

Juniperus mexicana, Schlechtendal.

ROCK CEDAR.

Juniper Cedar; Mountain Cedar; Cedar.

A tree occasionally 95 ft. high, but usually much smaller, and sometimes a shrub. *Bark* with persistent scales. *Leaves* of the ultimate branchlets scale-like, appressed, in opposite pairs; long- or short-pointed, $\frac{1}{15}$–$\frac{1}{10}$ in. long, minutely and irregularly denticulate, glandular on the back. *Leaves* on vigorous young shoots awl-shaped, $\frac{1}{4}$–$\frac{1}{2}$ in. long. *Fruit* globose or ovoid, $\frac{1}{3}$–$\frac{1}{2}$ in. long, brownish, glaucous. *Seeds* 2–3, similar to those of *J. californica*.

A native of the limestone mountains and hills of Mexico and Texas, where it forms the limit of arborescent vegetation. It is not known to be in cultivation.

The wood is hard, close-grained, rather brittle, but durable, and is used in its native countries for general construction, fencing, sills, telegraph poles, railway sleepers, and fuel.

Clinton-Baker, *Illust. Conif.* iii, 19 (1913).

Juniperus occidentalis, Hooker.

WESTERN JUNIPER.

Juniperus pyriformis, Lindley; Chamæcyparis Boursieri, Decaine (not Carrière). Californian Juniper; Canadian Juniper; Western Red Cedar; Yellow Cedar.

A tree varying from 20–60 ft. high in N. America, with a tall, straight stem up to 9 ft. in girth. *Bark* scaly, about $\frac{1}{2}$ in.

[1] *Fl. Orientalis*, v, 709 (1884).

thick, bright cinnamon red. *Ultimate branchlets* stout. *Leaves* arranged in six ranks, three in a whorl, closely pressed, long or shortpointed, grey-green, $\frac{1}{8}$ in. long, rounded and conspicuously glandular on the back. *Fruit* sub-globose or oblong, $\frac{1}{4}$–$\frac{1}{3}$ in. long, bluish-black, with a glaucous bloom. *Seeds* 2–3 to each fruit, ovate, acute, about $\frac{1}{8}$ in. long, deeply grooved or pitted on the back.

This species occurs on the mountain slopes and high prairies in W.N. America, British Columbia to the Sierra Nevada mountains in California, where it is found up to an altitude of 10,000 ft., sometimes attaining a large size and great age. It is in cultivation at Dawyck, Peebles.

The timber is moderately heavy, close-grained, fragrant, and durable. It is comparable to rough grades of *J. virginiana*, and is much used for fences.

Sargent, *Silva of N. America*, x, 87.

Juniperus Oxycedrus, Linnæus. (Fig. 55.)

SHARP CEDAR.

Brown-berried Cedar.

A compact shrub or small tree occasionally 30 ft. high and 10 ft. in girth. *Branchlets* angled. *Leaves* awl-shaped in alternate whorls of 3, spreading, narrow, $\frac{1}{2}$–$\frac{3}{4}$ in. long, tapering to an acuminate point, swollen and jointed at the base, margin entire; upper surface with a narrow green midrib, on each side of which is a white stomatic band which is equal in width to the marginal green band; lower surface green, convex, keeled. *Male and female flowers* on different trees. *Male flowers* solitary in the axil of a leaf, 2–3 in each whorl, stalkless, ovoid, about $\frac{1}{5}$ in. long. *Fruit* ripening in the second year, solitary in the leaf axils, on short stalks about $\frac{1}{16}$ in. long, globose, $\frac{3}{8}$–$\frac{1}{2}$ in. in diameter, shining reddish brown when ripe, occasionally glaucous, composed of 3–6 scales, each with a minute point. *Seeds* normally 3, reddish brown, oblong, triangular, ridged, with two resin glands at the base.

This species is very variable in the wild state, and the following varieties have been described:—

Var. **brachyphylla**, Loret.

Leaves short, bluntly pointed, pinkish, glaucous. On limestone rocks at Saint Béet, Haute Garonne, France.

Var. **maderensis**, Menezes.

Leaves very slender, $\frac{1}{3}$–$\frac{2}{3}$ in. long, $\frac{1}{16}$ in. broad, rounded, or shortly pointed at the apex. Fruit brown with a glaucous tinge.

Var. **umbilicata**, Rikli.

J. macrocarpa, var. umbilicata, Asch and Grab.

Fruit glaucous when young, chestnut brown when ripe, and larger than in the type; very variable in shape. Italy.

FIG. 55.—*JUNIPERUS OXYCEDRUS* and *J. COMMUNIS*.

Juniperus Oxycedrus—*a*, spray with male cones in axils of leaves, *b*, leaves and leaf-buds; *c*, section of leaf, showing two bands of stomata; *d*, spray with two berries. *J. communis*.—*e*, inner side of leaf, showing single band of stomata; *f*, section of leaf.

Var. **viridis**, Pospichal.

Fruit dull green when ripe. Found in Istria.

J. Oxycedrus is widely distributed throughout the Mediterranean region, extending eastwards through Syria, W. Asia Minor, and the Caucasus to Armenia and N. Persia. It was cultivated in England as early as 1739, but is now rarely seen.

Wood of small size, but very fragrant. Chiefly used for distillation, the oil extracted being known as "oil of cade." Factories for the distillation of the oil are established in the Maritime Alps. The oil is used for medicinal purposes, particularly in skin diseases.

Juniperus pachyphlæa, Torrey.

CHEQUER-BARKED JUNIPER.

Mountain Cedar; Oak-barked Cedar; Thick-barked Cedar.

A tree attaining in America a height of 60 ft. and a girth of 15 ft. *Bark* unlike all other junipers; up to 4 in. thick, and deeply divided into small, square, scaly plates. *Branchlets* slender, four-angled. *Leaves* scale-like in opposite pairs, overlapping, closely pressed, about $\frac{1}{16}$ in. long, ovate, blunt, margin finely toothed, with a glandular furrow on the back; those on the older branchlets tipped with a sharp point. *Juvenile leaves* awl-shaped, spreading, in threes or in opposite pairs, $\frac{1}{8}$–$\frac{1}{4}$ in. long, tipped with horny points; upper surface concave, whitened; lower surface greyish-green, keeled. The juvenile leaves gradually pass into the adult foliage. *Male and female flowers* on different trees. *Fruit* ripening in the second year, sub-globose, nearly $\frac{1}{2}$ in. in diameter, reddish brown, glaucous, warted, with 6–8 pointed scales. *Seeds* 4, angled, shining brown.

This juniper grows wild on dry mountain slopes at 4,000–6,000 ft. elevation, from S.W. Texas to New Mexico, Arizona, and southwards into Mexico.

The largest specimen in England is at Kew; it shows the characteristic scaly bark. Reputed juvenile forms of this species are very ornamental on account of their intensely glaucous foliage.

Samples of wood in the Kew Museums are straight-grained, and bear a resemblance to wood of *J. virginiana*.

Sargent, *Silva of N. America*, x, 85, t. 520 (1896).

Juniperus phœnicea, Linnæus. (Fig. 56.)

PHŒNICIAN JUNIPER.

Juniperus bacciformis, Carrière; J. tetragona, Moench.

A shrub or a small tree 20–40 ft. high. *Leaves* on young plants and rarely on isolated branches of adult trees, awl-shaped, spreading, in whorls of 3, the base clasping the shoot, about $\frac{1}{4}$ in. long, with 2 lines of stomata on both the upper and lower surfaces. Branchlet systems on adult trees 2–3 pinnate; ultimate branchlets roundish; leaves scale-like, either in 4 ranks or in opposite pairs, or in 6 ranks in alternating whorls of 3; closely pressed, ovate, rhombic, about $\frac{1}{25}$ in. long, blunt at the apex, margin toothed, furrowed on the back. *Male and*

female flowers on the same tree, rarely on different trees. *Fruit* globose or sub-globose, $\frac{1}{4}$–$\frac{1}{2}$ in. in diameter, yellowish or reddish brown, composed of 6–8 scales, with 3–9 seeds.

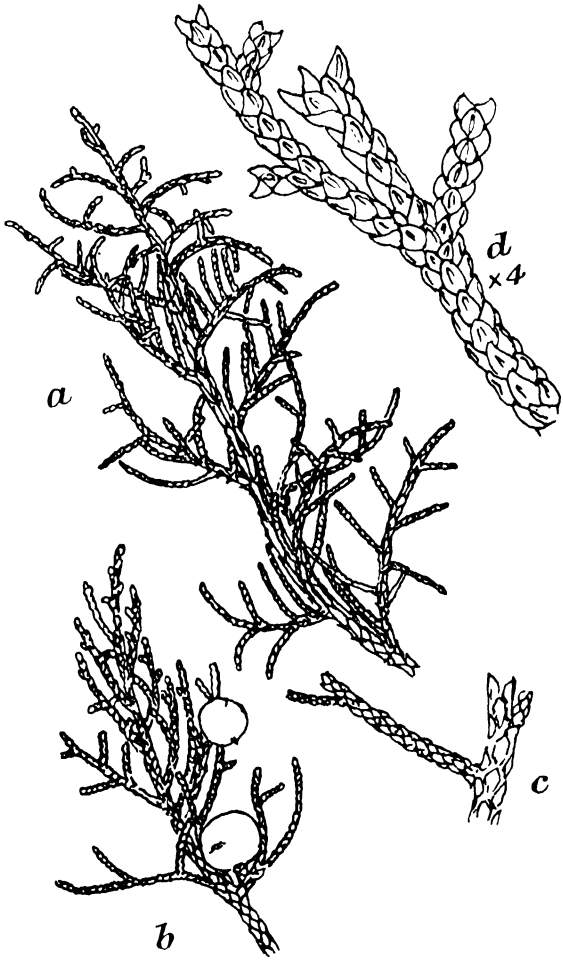

FIG. 56.—*JUNIPERUS PHŒNICEA*.
a, spray; *b*, spray with two berries; *c*, branch and branchlet; *d*, branch, showing resin glands on leaves.

Var. **filicaulis**, Carrière.

A shrub with elongated, twisted branches and slender, pendulous branchlets which occasionally bear juvenile leaves. Said to have originated from a seed of typical *J. phœnicea*.

Var. **turbinata**, Parlatore.

Fruits egg-shaped or top-shaped. *Seeds* deeply furrowed from base to apex. Often found with the typical form.

J. phœnicea is widely distributed throughout the Mediterranean region, growing in dry situations on rocky hills. In Algeria it often constitutes the only arborescent vegetation, ascending to 6,000 ft. In the Canary Islands it attains a great age and enormous size, one of the largest specimens reputed to be 1,000 years old. According to Aiton this species was first cultivated in Britain in 1683, but it is rarely seen in England except in the milder parts of the country.

The timber is used for building purposes, posts and firewood; and is sometimes distilled for the fragrant oil.

Clinton-Baker, *Illust. Conif.* iii, 11, No. 3 (1913).

Juniperus Pinchoti, Sudworth.

A tree rarely 20 ft. high with a trunk 3 ft. in girth, bearing stout, wide-spreading branches, forming an open, irregular head, or more often a shrub up to 12 ft. high. *Bark* thin, light brown, scaly. *Leaves* on adult plants in pairs or in threes, scale-like in 3 rows, $\frac{1}{16}$ in. long, glandular pitted on the back, dark-yellowish green; on young plants awl-shaped, $\frac{1}{4}$–$\frac{1}{3}$ in. in length. *Fruit* ripening in one season, sub-globose, bright red, $\frac{1}{4}$ in. in diameter. *Seed* solitary, ovoid, bluntly pointed, deeply grooved.

Found on dry, rocky slopes in W. Texas. Not in cultivation.

The soft, close-grained, light brown wood is used locally for fencing and fuel.

Juniperus procera, Hochstetter.

EAST AFRICAN JUNIPER.

Cedar; East African Cedar.

A large tree, attaining in Kenya 80–100 ft. in height with a straight trunk sometimes 35 ft. in girth. *Branchlets* irregularly pinate, the ultimate divisions slender, more or less four-sided, about $\frac{1}{36}$ in. in diameter. *Leaves* on the main branchlets lance-shaped, narrowing to sharp points, closely pressed, about $\frac{1}{6}$ in. long, becoming smaller and shorter on the ascending branches or ultimate divisions, where they are acute or sub-acute and often furrowed on the back. Awl-shaped or juvenile leaves in threes, but rarely present on adult trees. *Fruit* globose, conspicuously glaucous, $\frac{1}{5}$ in. in diameter. *Seeds* 2–3, ovate.

This species has been regarded as a variety of *J. excelsa* by some authorities, but differs in its smaller fruit and widely different distribution. It is a native of Kenya, where it occurs in the drier forests from 5,000–6,800 ft. altitude, and is widely spread in the equatorial highlands of Africa and in Abyssinia. The plant is too tender for outdoor cultivation in England, but is sometimes grown under glass.

Wood reddish brown, soft, fragrant, with a fine and even

grain except in very old trees; works and polishes well, but is rather brittle. It is very durable, resists damp and insect attacks, and is useful for building-work, furniture, cabinet-making, shingles, posts, and is being tried for pencils. Some of the older trees are suffering from decay, but younger wood is excellent in every way.

Juniperus procumbens, Siebold.

CREEPING JUNIPER.

J. litoralis, Hort. (not Maximowicz.).

A handsome shrub of lax, prostrate habit. *Branches* somewhat stiff, the shoots turning upwards at the ends. *Branchlets* glaucous on the ridges. *Leaves* adherent to the shoots, except for the upper part, about $\frac{1}{3}$ in. long, gradually tapering to a spine-like point; upper surface concave with a broad, white, stomatic band, the green midrib not extending to the apex; lower surface convex, bluish, spotted with white, furrowed. *Fruit* unknown.

This juniper, which differs from *J. squamata* in its longer, stiffer leaves and glaucous shoots, occurs wild, as stated by Siebold, in the mountains of Japan, but does not seem to have been found during recent years, although it is common in Japanese gardens. It appears to have been introduced into English gardens about 30 years ago, and is now commoner and more vigorous in cultivation than *J. squamata.*

Planted on banks in semi-wild positions it is very effective. As is the case with other junipers, it thrives in limy soil.

Clinton-Baker, *op. cit.* iii, 25 (1913).

Juniperus recurva, Buchanan-Hamilton.

A shrub or small tree of graceful, drooping habit, attaining a height of 30–40 ft. in the Himalaya, and usually broadly pyramidal in shape. *Bark* greyish brown, thin, peeling off in fibrous strips. *Branches* and *branchlets* ultimately recurved or pendent. *Leaves* dull or greyish green, awl-shaped, densely overlapping, in whorls of 3, all pointing forwards and more or less closely pressed, $\frac{1}{8}$–$\frac{1}{4}$ in. long, ending in a sharp, horny point; outer surface convex, channelled; inner surface concave, whitened. *Male and female flowers* on the same tree. *Male flowers* terminal or in the axils of the leaves of the ultimate divisions of the branchlets, about $\frac{1}{6}$ in. long, with 12–16 stamens. *Fruit* axillary, ripening in the second year, dark purplish brown, ovoid, $\frac{3}{8}$ in. long; *scales* 3–6 united, each with a triangular, spreading point. *Seed* solitary, ovoid, pitted.

A native of the E. Himalaya occurring in Sikkim and Bhutan between 9,000–12,000 ft. altitude. Introduced, according to Loudon, in 1830; but not common in cultivation. There

are, however, good trees at Bicton, Claremont, and elsewhere.

This is one of the most distinct and ornamental junipers. It seems to do best in a moist climate.

The wood is burned as incense in Buddhist temples in the Himalaya.

Clinton-Baker, *op. cit.* ii, 75, No. 1 (1909).

Juniperus religiosa, Carrière.[1]

SACRED JUNIPER.

J. excelsa Brandis[2] (not Bieberstein); J. macropoda, Hooker (not Boissier).

A tree up to 50 ft. high with a girth of 6–7 ft., or, occasionally, much larger. *Leaves* similar to those of *J. macropoda* and *J. chinensis*. *Fruit* obvoid, $\frac{1}{4}$ in. in diameter, bluish black, with a soft, juicy pulp. *Seeds* 1–3 ovoid, sharp-pointed, with large resin glands.

Native of the dry inner ranges of the N.W. Himalaya, from Chitral and Kashmir to Nepal, at altitudes of 5,000–10,000 ft. Wood burned as incense in Buddhist temples.

Juniperus rigida, Siebold and Zuccarini. (Fig. 57.)

A bush or small tree of pyramidal habit, attaining in Japan a height of 20–30 ft. *Bark* thin and scaly, furrowed on old trees. *Young shoots* with projecting ridges. *Leaves* awl-shaped, persistent for several years, and spreading in whorls of 3, $\frac{1}{2}$–$\frac{3}{4}$ in. long, tapering from the middle to a sharp point; swollen and jointed at the base; upper surface deeply grooved with incurved margins and a white band of stomata scarcely as wide as the green margins; lower surface green, keeled. *Male and female flowers* on different trees. *Fruit* ripening in the second year, black with a glaucous bloom, globose, $\frac{1}{4}$–$\frac{1}{3}$ in. wide, usually composed of 6 glaucous scales, the upper ones with prominent points at the apex, brownish black when ripe. *Seeds* 2–3 in each fruit, angled, marked near the base with 3–4 resinous pits.

J. rigida resembles *J. communis*, but has a more elegant habit with longer and narrower leaves which are more deeply grooved above.

It is a native of Japan, where, according to Wilson,[3] it is common on grass and shrub-clad mountain slopes from Cent. Hondo, southwards to Kyushu. It is much cultivated by the Japanese in their temple gardens. It has also been found in Manchuria and Corea. *J. rigida* was introduced into England in 1861 by John G. Veitch, but is rare in cultivation, although it succeeds in the South of England.

The wood is durable, and is put to many local uses in Japan.

[1] *Conif.* 41 (1855). [2] Brandis, *Forest Fl. N.W. India*, 538 t. 68 (1874).
[3] *Conifers of Japan*, 82 (1916); Clinton-Baker, *op. cit.* iii, 11, No. 1 (1913).

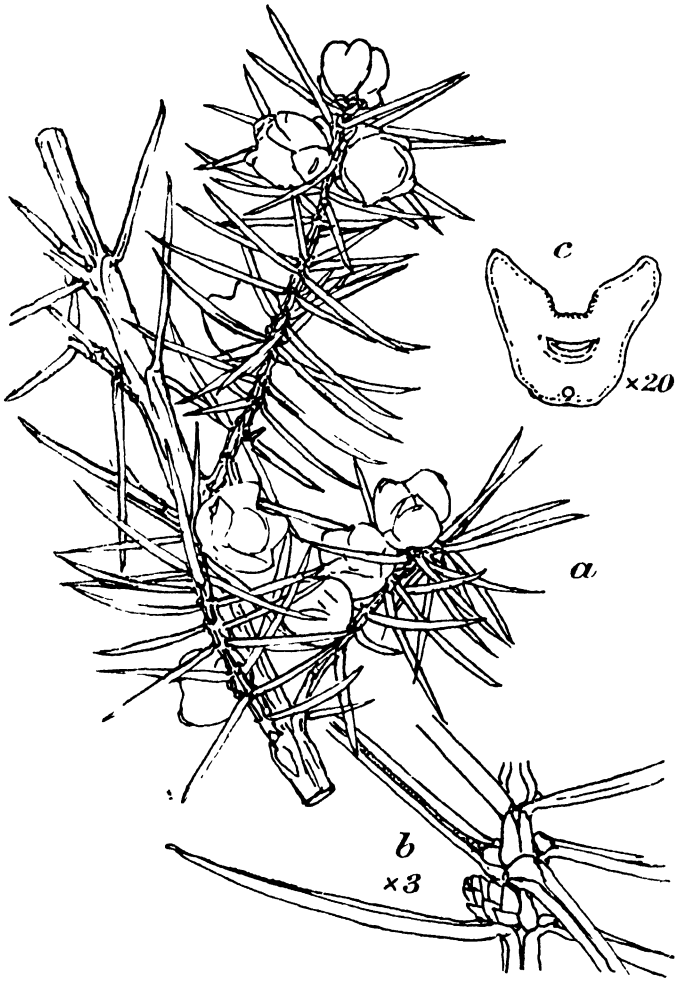

FIG. 57.—*JUNIPERUS RIGIDA.*
a, spray with berries; *b*, winter bud and grooved leaves; *c*, section of leaf.

Juniperus Sabina, Linnæus. (Fig. 58.)

SAVIN.

A shrub attaining a maximum height of 15 ft., the foliage emitting a disagreeable odour when bruised and having a bitter taste. *Ultimate branchlets* slender, four-cornered, clothed with 4 ranks of *scale leaves* in opposite pairs which are overlapping, ovate, shortly pointed or blunt at the apex, about $\frac{1}{16}$ in. long, rounded on the back, which usually bears a resin gland; leaves on older branchlets more elongated, about $\frac{1}{8}$ in. long, long-pointed, becoming brown and withered in the third or fourth year.

Juvenile leaves on young plants, and on isolated branches of adult specimens, awl-shaped, in opposite pairs, about ⅛ in. long, pointed; upper surface glaucous with a prominent midrib; lower surface green, convex, with a depressed gland on the back. *Male and*

FIG. 58.—*JUNIPERUS SABINA.*

a, spray with berries (from the Tyrol); *b*, spray with both scale and needle-like leaves; *c*, scale foliage and berries; *d*, needle leaves, merging into scale leaves.

female flowers on the same bush or on different plants. *Fruit* ripening in the autumn of the first year or in the following spring; irregularly globose or ovoid, about ⅛ in. in diameter, brownish with a waxy covering, compressed, composed of 4–6 pointed scales. *Seeds* 1–3, ovoid, furrowed.

Var. "**Knap Hill,**" Hort.

A garden variety of dwarf habit with plumose branches. A decorative plant.

Var. **lusitanica,** Ascherson and Graebner.

An erect shrub with sharply pointed, scale-like leaves. Common in S.. Europe.

Var. **tamariscifolia,** Aiton.

SPANISH JUNIPER.

A spreading shrub with erect branches and mostly awl-shaped leaves. *Leaves* on the ultimate branchlets in opposite pairs, slightly spreading, glandular on the back, bright green in tint, about $\frac{1}{8}$ in. long ; on the older branchlets occasionally in threes. This variety has been known in cultivation for more than 200 years.

Var. **variegata,** Carrière.

A dwarf shrub with scale-like foliage, the tips of some of the young branchlets creamy white.

J. Sabina has a wide distribution in Cent. and S. Europe, the Caucasus and N. America. It usually grows on limestone formations.

The savin has been known in English gardens since 1548, and is now a very common shrub.

Wood of little value except for walking sticks and firewood. Oil of savin is distilled from the fresh and dried leaves and shoots. It is used in medicine for its powerful diuretic properties. Inferior substitutes are obtained from *J. phœnicea* and *J. thurifera.*

Juniperus saltuaria, Rehder and Wilson.

A tree up to 30 ft. high and 3 ft. in girth, pyramidal in habit, the branches dense, erect or ascending. *Bark* greyish brown or cinnamon-coloured. *Branchlets* short, quadrangular, slightly recurved. *Leaves* light green, scale-like, closely pressed, triangular, ovate, short-pointed, or blunt and slightly incurved at the apex, obscurely glandular on the back, about $\frac{1}{12}$ in. long, those on the main branchlets larger. *Male and female flowers* on the same tree. *Fruit* ovoid or sub-globose, about $\frac{1}{4}$ in. in diameter, shining black, one-seeded. *Seed* ovoid, about $\frac{1}{8}$ in. long.

This new species is recognized by its dark green leaves and small, erect, shining black, one-seeded fruits. It is closely allied to *J. pseudo-Sabina,* Fischer and Meyer, which is a shrub differing in its foliage and larger, oblong, recurved fruit.

Native of N.W. Szechuen, China, where it forms extensive woods, the timber being used for housebuilding.

Pl. Wils. ii, 61 (1914).

Juniperus scopulorum, Sargent.

Juniperus virginiana, var. scopulorum, Jones; J. fragrans, Knight and Perry.

A tree about 40 ft. high and 9 ft. in girth, often divided near the base into several stems. *Adult leaves* very similar to those of *J. virginiana*, but on stouter branchlets, the leaves marked on the back by a conspicuous glandular pit. *Fruit* ripening in the second year, globose, ¼ in. in diameter, glaucous. *Seeds* 2, triangular, reddish brown, prominently angled, grooved.

Differs from *J. virginiana* in its stouter branchlets and slightly larger fruits which ripen in the second year.

Found wild on dry, rocky ridges, usually over 5,000 ft. elevation, from the eastern foothills of the Rocky Mountains from Alberta and Texas, westward to Vancouver, Washington, E. Oregon, Nevada, and N. Arizona. Introduced in 1836 under the name of *J. dealbata*, Loudon, and has also been grown as *J. fragrans*, a name still found in nursery catalogues. It is rare in cultivation, but there are good plants at Dawyck, Peebles.

The best wood can be used as that of *J. virginiana*.

Silva of N. America, xiv, 93, t. 739 (1912).

Juniperus squamata,[1] Buchanan-Hamilton.

Juniperus densa, Gordon; J. excelsa, var. densa, Endlicher; J. recurva, var. densa, Hort.; J. recurva, var. squamata, Parlatore.

A prostrate shrub with decumbent main stems and short, erect, reddish brown branchlets. *Young shoots* green, grooved. *Leaves* awl-shaped, overlapping, in whorls of 3, pressed together or slightly spreading, the lower portion adherent to the shoot, the upper part free and about ⅛ in. long, curved, tapering to a sharp point; upper surface concave, whitened, usually with a faint midrib; lower surface convex, green, furrowed. *Fruit ellipsoid*, ¼–⅓ in. long, becoming black when ripe in the second year; *scales* 3–6, pointed. *Seeds* solitary, ovoid, ridged, with 3–4 depressions below the middle.

Var. Fargesii, Rehder and Wilson.[2]

A tree up to 40 ft. high, but sometimes larger, often divided a few feet above the ground into several erect stems. *Bark* brown or grey-brown, fairly smooth, and peeling off in longitudinal strips. *Branches* ascending and spreading; branchlets pendulous. *Leaves* mostly longer and narrower, and fruits smaller and less shining than in the typical form. It may be regarded as the arborescent form of the type and is not uncommon in woodlands throughout the Chino-Tibetan borderland.

[1] Elwes and Henry, *loc. cit.* vi, 1420 (1912).
[2] *Pl. Wils.* ii, 59 (1914). Clinton-Baker, *op. cit.* iii, 29 (1913)

The type occurs wild in Afghanistan, at high elevations in the Himalaya and the mountains of China.

It was introduced into England about 1836, and is occasionally cultivated in rockeries, sometimes under the name of *J. pseudo-Sabina*.

J. squamata is much like some of the dwarf forms of *J. communis*, but is distinguished by its one-seeded fruit. *J. recurva* differs in its closely pressed leaves, recurved branches, and much larger fruit.

Juniperus taxifolia, Hooker and Arnott.

YEW-LEAVED JUNIPER.

A shrub or tree about 40 ft. high, with a more or less twisted trunk. *Branches* horizontal, spreading, with pendulous branchlets. *Young shoots* narrowly winged. *Leaves* bright green, narrow, about ½ in. long, $\frac{1}{20}$–$\frac{1}{15}$ in. broad, blunt at the apex, with two broad bands of stomata on the upper surface, keeled below. *Fruit* about ¼ in. in diameter, globose. *Seeds* 3, with 2–3 resin glands.

J. taxifolia has been much confused with *J. formosana*, Hayata, but may be easily distinguished by its obtuse leaves.

It is found only in the Bonin Islands, where it grows on Mukō-jima, Chichi-jima, and Ani-jima. Formerly it was a common tree, called "Spruce" by the original Bonin Islanders and used by them for posts in their houses and for fuel. Seeds were recently sent to the Arnold Arboretum by Wilson.

Clinton-Baker, *op. cit.* iii, 30 (1913); Wilson, "The Bonin Islands" (*Journ. Arn. Arb.* 1, 109 (1919)).

Juniperus tetragona, Schlechtendal.

ROCK CEDAR.

Juniperus sabinoides, Sargent.

Usually a bush or small tree 20–30 ft. high, more rarely of larger dimensions. *Branchlets* stout, four-sided. *Leaves* in pairs closely appressed, strongly keeled on the back, blunt- or short-pointed, about $\frac{1}{16}$ in. long, minutely toothed on the margins. Juvenile leaves awl-shaped, ¼–½ in. long. *Fruit* globular, bluish-black, ¼ in. in diameter. *Seeds* 3–5, angular, more or less grooved or pitted.

This species, allied to *J. occidentalis*, is best distinguished from that plant by its four-angled branchlets. It is found on limestone hills in W. and S. Texas, spreading southwards. Not known to be in cultivation.

Clinton-Baker, *Illust. Conif.* iii, 31 (1913).

Juniperus thurifera, Linnæus. (Fig. 59.)

SPANISH JUNIPER.

Juniperus Bonatiana, Visiani; J. cinerea, Carrière; J. fœtida, var. thurifera, Spach; J. hispanica, Miller. Incense Juniper.

A tree attaining in S.W. Europe a height of 30–40 ft. and a girth of 6–12 ft. *Juvenile foliage* often persistent on adult trees,

FIG. 59.—*JUNIPERUS THURIFERA.*
a, spray with berries; *b*, branchlets.

the leaves being awl-shaped in opposite pairs, spreading, $\frac{1}{12}$–$\frac{1}{4}$ in. long, whitened on the upper surface. *Adult foliage* with the flattened branchlet systems pinnately divided, mostly in one plane, the ultimate divisions slender, four-sided, about $\frac{1}{26}$ in. in diameter. *Leaves* closely pressed, in opposite pairs, but free at

their pointed tips, ovate, about $\frac{1}{16}$ in. long, furrowed on the back. *Male and female flowers* on different trees. *Fruit* ripening in the second year, sub-globose, about $\frac{1}{3}$ in. in diameter, glaucous when ripe; *scales* 6, the upper pointed. *Seeds* 2–4 ovate, shining brown, $\frac{1}{8}$ in. long, with 2–3 resin-pits at the base.

Var. **gallica**, De Coincy.

This is said to differ from the type in its seeds being striate and less angular.

Common on the mountains of Cent. and S. Spain, and also occurs in S.E. France, Portugal, Sardinia, Morocco, and Algeria.

J. thurifera has been known in cultivation since 1752, but is now rare in collections, thriving only in warm situations.

The wood is used for incense, posts, and possibly other purposes, but is unknown in commerce.

Elwes and Henry, *loc. cit.* vi, 1427 (1912); Clinton-Baker, *Illust. Conif.* iii, 11 (1913).

Juniperus utahensis, Lemmon.

DESERT JUNIPER.

A species very near *J. californica*, from which it may be recognized by its more slender branches, usually glandless leaves, which are sometimes arranged in twos instead of in whorls of 3, and by its usually globose berries, which are blue-black with a whitish bloom like those of *J. occidentalis*.

According to Jepson,[1] *J. utahensis* takes the place of *J. californica* in the arid regions of the Great Basin between the Rocky Mountains and Sierra Nevada, where it is common in the plateau valleys at 5,000 ft. elevation, or on the mountains up to 8,000 ft.

Juniperus virginiana, Linnæus. (Fig. 60.)

PENCIL CEDAR.

Cedar; Red Cedar; Virginian Cedar.

A tree up to 100 ft. high and 12 ft. in girth, with a pyramidal head of spreading branches, the trunk often fluted at the base. *Bark* reddish brown, peeling off in long strips. *Ultimate branchlets* of adult trees slender, $\frac{1}{30}$ in. in diameter, with scale-like leaves arranged in 4 ranks, overlapping, closely pressed, about $\frac{1}{16}$ in. long, short- or long-pointed, free at the apex, with a glandular depression on the back. *Leaves* on older branchlets broader, about $\frac{1}{12}$ in. long, becoming brown and withered. Juvenile leaves often present on adult trees, and spreading, in pairs, $\frac{1}{8}$–$\frac{1}{4}$ in. long, ending in a spiny point, concave and glaucous above, green and convex beneath. *Male and female flowers* usually on

[1] *Silva of California*, 163 (1910).

different trees. *Fruit* ripening in one year, sub-globular or ovoid, up to ¼ in. long, often glaucous. *Seeds* 1–2, ovoid, furrowed, shining brown.

There are numerous varieties in cultivation, some of the most distinct being :—

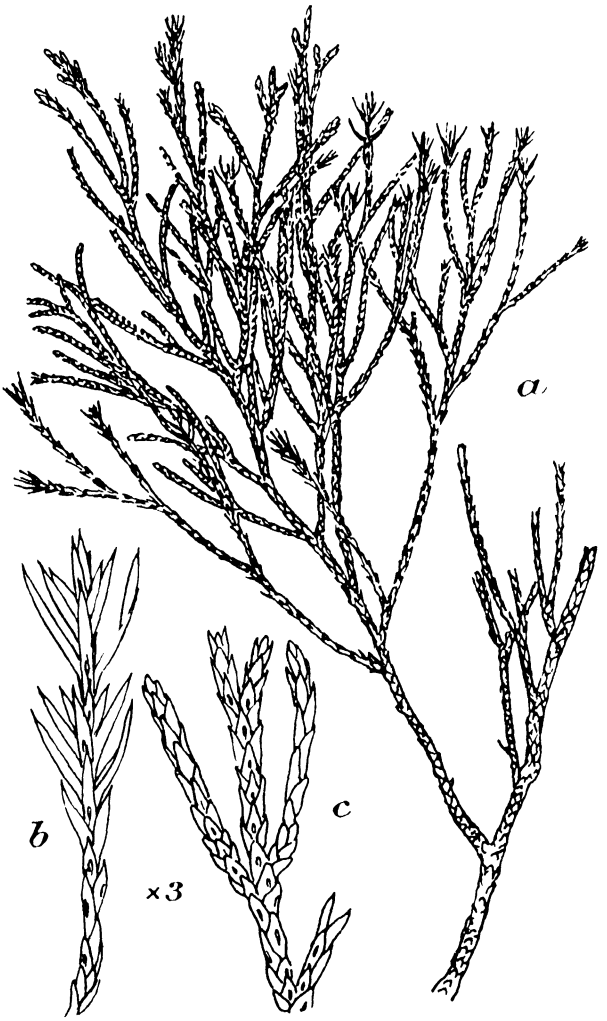

FIG. 60.—*JUNIPERUS VIRGINIANA*.
a, spray ; *b*, branchlet with scale and needle leaves ; *c*, branchlet with scale leaves.

Var. **argentea.**

Young shoots and leaves silvery.

Var. **aureo-spica.**

Tips of young shoots golden.

Var. **aureo-variegata.**

Patches of shoots and leaves yellow.

Var. **Chamberlainii,** Knight.

Branchlets pendulous, but the leaves mostly awl-shaped and of a greyish tint.

Var. **compacta.**

A compact, rounded bush with juvenile and adult leaves. Very slow-growing, and suitable for the rockery. Vars. **dumosa** and **humilis** are very similar in appearance and scarcely distinct.

Var. **elegantissima.**

Young shoots tipped with yellow.

Var. **glauca,** Knight.

Foliage glaucous or silvery, especially in spring. A handsome plant.

Var. **Kosteriana.**

Leaves silvery; habit pyramidal.

Var. **pendula,** Carrière.

Branchlets pendulous, leaves scale-like; a male form.

Var. **pendula viridis.**

Branches pendulous, leaves bright green.

Var. **Schottii,** Gordon.

Narrowly pyramidal in habit, with scale-like leaves.

Var. **tripartita,** R. Smith.

A low, spreading bush, densely branched, with light green, usually awl-shaped leaves.

Var. **Triomphe d'Angers,** Beissner.

Young branchlets creamy white.

This species may usually be recognized by its short- or long-pointed scale-leaves and the presence of juvenile foliage on adult trees. The dwarf forms often strongly resemble *J. Sabina*, but the latter species may generally be known at once by the disagreeable odour of the bruised foliage.

A native of the E. and Cent. United States and E. Canada, where it has a wide distribution from S. Nova Scotia to E. Texas. It was introduced about the middle of the seventeenth century

by Evelyn, and is the largest juniper in cultivation in Britain, though somewhat less common than *J. chinensis*.

Wood pink or reddish, rather soft, brittle, straight-grained, very durable. The most valuable of all known woods for the manufacture of casings for lead pencils, and practically all wood free from defects is used for that purpose. Knotty wood is used for fencing and railway sleepers. Shavings and dust from pencil factories are distilled for the fragrant oil contained in the wood, the oil being used for scenting soap and other kinds of perfumery. After distillation the shavings are used as a substitute for coconut fibre for horticultural purposes ; also in the manufacture of linoleum.

J. virginiana is perfectly hardy in the British Isles and thrives under a wide range of conditions.

Elwes and Henry, *op. cit.* vi, 1435 (1912); Clinton-Baker, *Illust. Conif.* ii, 74, No. 4 (1909).

Juniperus Wallichiana, Hooker fil. (Fig. 61.)

BLACK JUNIPER.

Juniperus pseudo-Sabina, Hooker (not Fischer and Meyer).

A tree 60 ft. high in the Himalaya. Adult branchlets with the ultimate divisions four-sided and about $\frac{1}{20}$ in. in diameter, the leaves closely pressed or overlapping, arranged in 4 ranks, narrowly ovate, about $\frac{1}{16}$ in. long, sub-acute, with the points incurved, furrowed on the back ; margins whitish. *Leaves* on the main axis larger, up to $\frac{1}{4}$ in. long, with acuminate points. Juvenile foliage often predominating on adult trees ; leaves awl-shaped, in whorls of 3, $\frac{1}{3}$–$\frac{1}{4}$ in. long, sharply pointed, directed forwards, concave and glaucous above, furrowed on the back. *Male and female flowers* on different trees. *Fruit* ripening in the second year, ovoid, $\frac{2}{3}$ in. long, $\frac{1}{3}$ in. wide near the base, blue when mature, with minute points above indicating the 3–5 scales. *Seed* solitary, $\frac{1}{4}$ in. long, ovoid, compressed, with two or three depressions.

This species is a native of the Himalaya from the Indus to Bhutan, between 9,000–15,000 ft. elevation, becoming shrubby in the western part of its range. It was introduced in 1849, when Sir Joseph Hooker sent seeds to Kew, but is very rare in cultivation.

Wood much used as firewood and burned as incense in Buddhist temples.

Clinton-Baker, *Illust. Conif.* iii, 32 (1913).

KETELEERIA, Carrière.

Evergreen trees natives of China and Formosa. *Branches* horizontal, spreading. *Buds* ovoid or roundish, with numerous

overlapping scales which persist as a conspicuous sheath at the base of the branchlet. *Leaves* linear, leathery, spirally arranged, but more or less two-ranked on the lateral shoots by means of a basal twist; acuminate and spine-tipped on young plants, blunt on adult trees, leaving a circular scar on the branchlet when they fall, as in *Abies*; upper surface with a prominent midrib in a

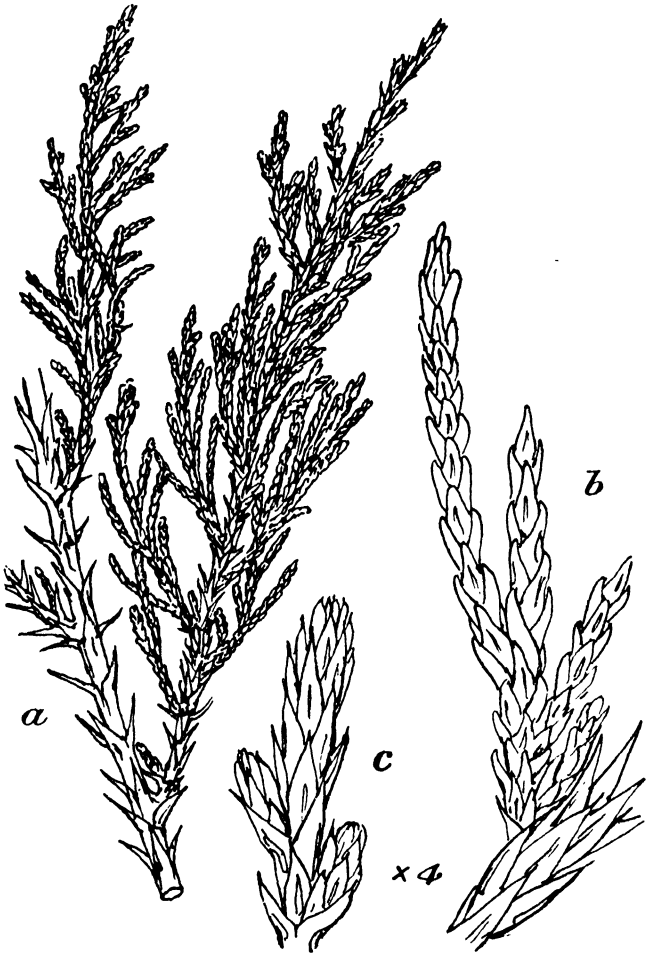

FIG. 61.—*JUNIPERUS WALLICHIANA*.
a, spray with both scale and needle-like leaves; *b*, *c*, scale and needle leaves.

longitudinal depression, lower surface with a raised midrib on either side of which are two indistinct bands of stomata. *Male flowers* in terminal or axillary umbels or clusters, each consisting of 5–10 flowers and arising on a short, scaly stalk, bearing numerous anthers, each with two pollen sacs. *Female flowers* on

the same tree. *Cones* erect on the branches, ripening in the first year; scales and bracts persistent. *Seed* as in *Abies*, 2 to each scale, with a prominent hatchet-shaped wing.

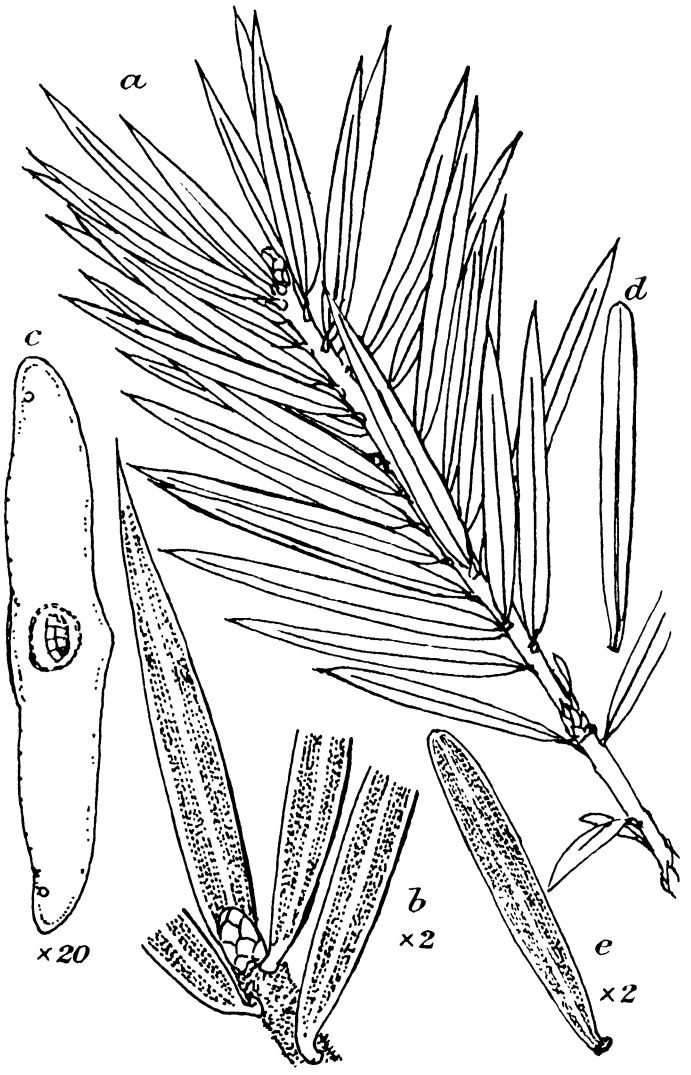

FIG. 62.—*KETELEERIA DAVIDIANA.*

a, spray; *b*, winter bud and under leaf-surface, showing bands of stomata; *c*, section of leaf, showing small marginal resin-canals; *d*, *e*, blunt leaves of mature foliage, upper and under surface.

The genus is closely allied to *Abies*, differing chiefly in the clustered male flowers, the persistent cone-scales, and the peculiar buds and young foliage.

Keteleeria Davidiana, Beissner.

Keteleeria sacra, Beissner; Abies Davidiana, Franchet.

A tree 100 ft. high and 16 ft. in girth in China, resembling a silver fir when young but eventually assuming an irregular habit with massive branches and large, buttress-like roots spreading from the base of the bole. *Bark* grey on the outside, shed in small plates, reddish within. *Buds* rounded at the apex with numerous keeled scales, becoming reddish and conspicuous in spring. *Young shoots* slender, densely covered with short, stiff, brown hairs, many of which remain until the end of the second year. *Leaves* on young plants linear, flat, stiff, dark shining green, up to 2½ in. long, $\frac{1}{7}$–$\frac{1}{6}$ in. broad, ending in a long sharp point. *Leaves* on adult trees ½–1½ in. long, prominently keeled on both surfaces, entire and rounded at the apex. *Cones* erect, 3–8 in. long, 1½–2 in. wide, cylindrical, reddish when young, pale brown when mature, on stout stalks 1–1¼ in. long; *scales* about 1 in. long and ¾–1 in. wide, widest immediately above the claw-like stalk, narrowing to the rounded and slightly reflexed apex; *bracts* half as long as the scales, about ⅛ in. wide with a three-pointed apex. *Seeds* up to ½ in. long with a wing ½–¾ in. long, or the same length as the scales, appearing longer when the scales expand, bright glossy brown.

Native of China, where it is widely distributed in the central, western, and south-western provinces, occasionally forming woods where the climate is dry. It is also found in Formosa. *K. Evelyana*, Masters, *K. Esquirolii*, Léveillé, and *K. formosana*, Hayata, appear to be variants of *K. Davidiana*, and according to Wilson are doubtfully distinct.

K. Davidiana was discovered by Père David in 1869 and seeds were sent to Kew by Henry in 1888. It is occasionally met with in collections, and a healthy plant about 4 ft. high may be seen near the Pagoda at Kew. It is growing in sandy loam to which a little peat has been added. The tips of the shoots are sometimes injured by early autumn frosts.

Wilson, *Pl. Wils.* ii, 39 (1914); Clinton-Baker, *Illust. Conif.* i, 72 (1909); Elwes and Henry, *Trees of Great Brit. and Ireland*, vi, 1475 (1912).

Keteleeria Fortunei, Carrière.

Abies Fortunei, Murray; Abietia Fortunei, Kent.

A tree 80 ft. high in China, with corky bark and the habit of a Lebanon cedar. *Branches* horizontal and spreading. *Branchlets* orange-red, young shoots slender, with scattered hairs. *Buds* ovoid, rounded at the apex, with numerous keeled scales. *Leaves* of young trees linear, stiff, 1–1¼ in. long, with spiny tips. *Leaves* of mature trees ½–1¼ in. long, rounded or shortly pointed at the apex. *Cones* cylindrical, 4–7 in. long, 1¼–2 in. wide (or 3 in. wide

when expanded), on stout, hairy stalks about 1 in. long, purple or brownish when mature; *scales* larger and broader at the apex than in *K. Davidiana*, the widest part (about 1¼ in.) being above the middle, the upper margin rounded and slightly toothed. *Seed* about ¾ in. long, with a wing 1–1¼ in. long, both seed and wing larger than in *K. Davidiana*, bright glossy brown in colour, the seed greyish beneath.

A native of the mountains near Foochow, E. China, where it was first noticed by Fortune in 1844 and was also seen in quantity by Maries in 1878. Seeds were distributed by Fortune, but none of the original plants survived in England. A fine plant at Pallanza, Italy, is said to be over 80 ft. high, and from this tree, which produces seeds freely, large numbers of plants have been raised.

LARIX, Miller.

Larches.

Pinus, Linnæus; Abies, A. L. de Jussieu.

Deciduous trees widely distributed in the colder regions of the northern hemisphere, occurring in Europe, Asia from the Himalaya northwards, and in N. America. *Trunks* tall, tapering very gradually in the forest, less symmetrical when isolated. *Bark* thin and scaly on young trees, thick and deeply fissured at the base of old trees, particularly in very cold regions. *Branches* irregularly disposed and small on young trees which are of pyramidal outline, spreading on old trees which develop flat heads. *Branchlets* of two kinds: (1) *Long terminal shoots* bearing solitary, spirally arranged leaves; (2) *short secondary shoots* which increase very slowly in length but have each year's growth marked externally by a distinct ring of leaf-scars and bear compact, terminal tufts of leaves of unequal length. *Long shoots* channelled or grooved, roughened by the bases of fallen leaves. *Buds* of three kinds: (1) Terminal on the long branchlets, producing long or short shoots. (2) Axillary on the long shoots, solitary in the leaf axils, producing long or short shoots, but usually the latter. (3) Buds from the points of short shoots, usually producing a tuft of leaves or flowers accompanied by a slight elongation of the shoot, or less often a long shoot with spirally arranged leaves. *Leaves* flat, keeled beneath, and in some species on the upper side also; those on the long shoots more uniform in size and broader than those on the short shoots; thin, narrow, bright green, turning yellow in autumn, pointed or rounded at the apex, stalkless, with stomata on each surface but more abundant beneath; resin canals 2, near the outer margin of each leaf. *Male and female flowers* from short shoots on the same tree, expanding in advance of the leaves. *Male flowers* globular, egg-shaped or

oblong, composed of numerous stamens, enclosed at the base by brown fimbriated scales. *Female* flowers erect, cone-like, with long, often bright-coloured bracts, the points usually bending outwards or distinctly recurved, set in a circle of partly developed leaves surrounded by brown, fringed scales. *Cones* usually short-stalked, erect, ripening the first year, shedding the seed during autumn or the following spring, and remaining on the tree for an indefinite period ; *scales* rounded above, stalked at the base, each accompanied by a bract which at flowering time greatly exceeds the scale in length ; often green, reddish or purple during development, brown and woody when mature, the bract at maturity either hidden or slightly exceeding the scale in length. *Seeds* small, each with a well-developed wing along the outer edge and at the apex which aids in wind distribution.

In branch and leaf arrangement *Larix* closely resembles *Cedrus* and *Pseudolarix*. From the former the species are easily distinguished by their deciduous leaves and from the latter by their less elongated short shoots and by the smaller cones with persistent scales.

Wood coarse-grained, strong, hard, heavy, and durable, with well marked heart- and sap-wood, the former usually reddish or brown, occasionally yellowish-brown, sapwood narrow and yellow. Early and late wood well defined, thus forming a very distinct line between each year's growth. Resin ducts fairly numerous, but small and scattered, most prominent in the late wood and visible with a lens. Medullary rays narrow. The timber is durable in contact with the ground and is much used for telegraph and telephone poles, posts and rails, colliery props, street paving, railway sleepers, building material, and for the construction of ships and barges. Careful seasoning is necessary to prevent undue shrinkage and warping.

The bark is rich in tannin and is sometimes utilized for tanning purposes. Turpentine is sometimes obtained from the wood.

Larches may be grown in Britain from sea-level to the timber line where the soil is well drained. They are, however, essentially alpine trees which, in a natural state, have a comparatively short, sunny growing season followed by a long resting period accompanied by severe cold. When growing at low elevations in some parts of Britain they are stimulated into premature growth by mild winter weather and the soft young shoots are liable to injury by late frosts. This is specially the case with trees growing on low-lying, wet ground.

They succeed on a great variety of soils, even where the surface soil is shallow, provided the subsoil is porous. A hard, impervious pan beneath the surface soil is, however, fatal to their well-being. Land that is permanently wet is unsuitable for most

of the larches, and they are injured by long periods of drought. Sandy loam overlying loose gravel forms excellent larch soil, whilst success is also obtained on heavy loam, soils containing lime, and on drained peat or moss. Trees planted on sandstone formations usually grow more rapidly than those on limey soils, whilst those planted on shallow soil overlying limestone do not make large timber trees. Although larches withstand storms better than most conifers, they are not good trees for windbreaks, and isolated trees or small plantations in positions exposed to high winds are rarely successful; even large plantations in exposed places are improved by a shelter belt of pines. At the same time larches require a free circulation of air and are better adapted for mountain sides than for valley bottoms.

Two or three species are valuable forest trees in Britain, and all the species are more suitable for groups than for isolated specimens. When an isolated specimen is required, it is advisable to plant a group and gradually remove the surplus trees.

The larches demand full light and must be the dominating species in mixed plantations. Where not planted close enough to kill side-branches through lack of light and air, pruning may be carried out as required without injury to the trees. The branches should however be removed whilst quite small and the wounds protected. Broken leading shoots are often renewed by natural means, sometimes by erect growths from adventitious buds and at others by a side-branch assuming an erect position. Natural grafting of roots often takes place, and the stumps of cut-over trees sometimes form a cap of new wood by the aid of food material supplied by neighbouring trees.

Propagation is by seeds, which should not be collected until the cones are thoroughly ripe, and they should only be taken from well-grown and healthy trees. They should be sown thinly in nursery beds, or, in the case of small quantities, in boxes, in well-worked, light, loamy soil, the distance apart averaging $\frac{1}{4}$–$\frac{1}{3}$ in. Sowing may be carried out any time between the middle of March and the middle of April, or in well-drained ground they may even be sown in autumn, care being taken to select a time when the soil is moderately dry and works well; a covering of fine soil $\frac{1}{4}$ in. deep should be given. As vermin are fond of the seeds it is advisable to mix them with dry red lead before sowing. Seedlings are easily injured by frost and drought, and protection and shading may be necessary. They may remain for one or two years in the seed-bed and then be lined out in the nursery for one or two years, or be planted direct in permanent places. Other remarks on planting are given under *L. europæa* and *L. leptolepis*.

Larches are attacked by several insect and fungus pests which are encouraged by indiscriminate planting. If care were

taken to limit larch plantations to suitable soils and situations, much could be done to keep some of the worst diseases in check. Conditions peculiarly favourable to the spread of disease are brought about by planting on low-lying, wet ground; on land at both high and low elevations that is cold and wet; on land with an impenetrable subsoil; and by overcrowding. Larch often succeed better when planted on land with a north exposure than in positions facing south or west.

Chermes laricis, Hartig (Larch Aphis), is one of the most conspicuous insect pests of larch. It is found on bark, young shoots, and leaves, but is most abundant on the latter, its presence being easily detected by a white protective exudation. The " queen-mother " generation hibernates on the trees and becomes active about the end of March; egg-laying begins as soon as the leaves appear. The larvæ spread rapidly, and by the middle of summer a tree may be covered by the perfect insects. The larvæ cause great damage by sucking the sap of leaves and young shoots, thus preventing proper development. The punctures of this insect are also a fertile source of infection for the *larch canker fungus* (see p. 274). *C. laricis* is usually most prevalent during hot and dry summers. Isolated trees and nursery stock may be cleaned by spraying with a paraffin wash several times during summer. Nursery stock can also be cleaned by fumigation with hydrocyanic gas before dispersal, but it is not possible to clean large plantations by this method. *Larix occidentalis* growing with common larch usually escapes injury from this pest.

Nematus erichsoni, Hartig (Large Larch Sawfly). This insect came into prominent notice during the early years of the present century, when it caused a good deal of loss in several parts of England and in southern Scotland. It was first noticed in Cumberland and quickly spread to other places. The injury is caused by the larvæ. Mature insects appear in June and eggs are laid in clusters about the base of the leaves. On hatching, the larvæ begin to feed on the foliage and continue until the middle of August. They are so voracious that whole plantations may be denuded of leaves. The fully fed caterpillars leave the trees in August and encase themselves in cocoons amongst moss or leaves at the base. Pupation takes place in late spring. When once it becomes well established it is difficult to eradicate this pest, and a careful look-out should be kept for the first sign of its presence, which may be recognized by the browning of the young shoots on the higher branches. By collecting and destroying larvæ and cocoons its spread may be checked. Trees easy of access should be sprayed with an arsenical wash, made by mixing 1 lb. of Paris green with 150 gallons of water.

Coleophora laricella, Hubner, is a small moth which causes considerable harm to the leaves of larch. Mature moths are to

be found in June. Eggs are laid on the leaves and the caterpillars hatch out in July. They first bore into the leaves, causing the upper half to shrivel. Each larva then forms for itself a case of dead leaves lined with silk, the case appearing as a tiny cigar-shaped body. When the larva is feeding the case is seen in an erect position with the head pointing downwards. The larvæ feed until autumn, then hibernate in bark crevices until spring. As soon as young leaves appear the larvæ recommence feeding and continue until they pupate. Trees injured by this moth appear as if they had been badly frost-bitten or scorched by fire. No practical means of coping with the pest is known.

Argyresthia atmoriella, Banks [1] (Larch-shoot Moth). This small moth lays its eggs at the lower part of the current year's shoots during late May and early June. The caterpillars bore into, feed upon the shoot, and hibernate in it during winter. In early spring the larvæ recommence feeding and continue until ready to pupate. The shoots are weakened or killed and growth is checked in consequence. In other countries two other moths, *Argyresthia lævigatella*, Zeller, and *A. zelleriana*, Hartig, affect larch in the same way.

Dasyscypha calycina, Fuckel (Larch Canker Fungus). This fungus has caused great destruction amongst larch trees in Britain and other countries. Although it is rarely absent from young plantations of common larch the attack may be slight and cause little harm, or almost every tree may be seriously affected. Trees growing on high, well-drained land are less liable to the disease than those at a low elevation or on wet soil, and trees over eighteen years of age are rarely injured. The fungus can only gain entrance to the trees through wounds, and the spores often germinate upon wounds caused by frost or the punctures of *Chermes laricis* and other insects. The only way to avoid the disease in its more serious forms is to confine plantations to suitable positions and soils, where the natural vigour of the trees enables them to overcome an attack. Some good can be done in preventing the spread of the disease by planting larch in mixed instead of in pure plantations. European larch is more subject to injury than Japanese larch, although the latter is not immune, as is sometimes suggested.

Meria laricis, Vuillemin, causes the premature fall of the leaves. The fungus occurs as tiny white specks of mould, and a severe attack is followed by considerable browning of the leaves.

Rhizina inflata, Karsten, is parasitic upon the roots of several species of young coniferous trees, including larch. Badly infected trees usually have a large mass of mycelium and soil about the junction of the stem and upper roots; later on, cushion-like fructifications appear. Diseased trees should be burnt, and

[1] Ministry of Agric. and Fish. Bull, 208 (*Larch-shoot Moths*).

as the fungus spreads rapidly upon sawmill refuse, all such refuse in the vicinity of young woods should be destroyed in the same manner.

Armillaria mellea, Vahl. (Tree Root Rot or Honey Fungus), is one of the commonest fungi injurious to young trees. It usually attacks trees about the junction of the stem and roots, the mycelium finding its way into the cambium and sapwood. It is common on old forest land, where stumps and roots have been left to decay. When only a few trees have been attacked they should be dug up and burnt, and a trench 2 ft. deep should be made round the affected area to check the spread of the black bootlace-like rhizomorphs. The fructifications also should be collected and burnt.

Pumped or *Puncked Wood* or *Heart-rot* are terms applied to a condition of decay found in larch and other trees. A fungus may be present in trees less than twenty years old, and trees 35–40 years of age are sometimes hollow or have the heartwood reduced to touchwood. The reason for pumped wood is usually assigned to unsuitable soil, but that cannot be the only cause, for unsound trees may be found on almost all kinds of soil, and sound and unsound trees may grow side by side. Reduced vitality due to the long growing season, followed by a shorter resting period than the trees are accustomed to in a natural state, may be a contributory cause. *Larix europœa* is very susceptible to attack, and large numbers of trees are injured by the disease. The fungus responsible for the decay of the wood is a species of *Polyporus*.

Phomopsis pseudotsugæ, a fungus disease that has caused injury to young Douglas fir trees during the last few years, has also been observed on Japanese larch.[1]

For other remarks on diseases, see W. E. Hiley, *The Fungal Diseases of the Common Larch* (1919).

Key to Larix in Cultivation.

Young shoots hairy, cones 3 or more in. long.—*L. Griffithii.*
Young shoots hairy, cones ¾–2 in. long.
  Leaves very long and slender up to 2 in.—*L. sibirica.*
  Leaves shorter, usually not more than 1½ in.
    Foliage glaucous, cone-bracts not exceeding scale.
      Leaves about 40 in bundle, cones ovoid, scales strongly reflexed.—*L. leptolepis.*
      Leaves about 40 in bundle, cones oblong, scales slightly reflexed.—*L. eurolepis.*
      Leaves 20–30 in bundle, cone-scales not reflexed.—*L. kurilensis.*

[1] *Trans. Roy. Scot. Arb. Soc.* XXXV, p. 73 (1921).

Foliage greenish, cone-bracts with mucro exceeding scales.
Leaves deeply keeled on both sides.—*L. Potanini.*
Leaves keeled beneath only.—*L. occidentalis.*
Young shoots glabrous, cones 1–1½ in. long.
Young shoots greyish, cone-scales not bevelled, leaves of long shoots up to 1¼ in. long.—*L. europœa.*
Young shoots shining brown, cone-scales variable in size, bevelled, leaves as in *L. europœa.*—*L. pendula.*
Young shoots bright reddish brown, leaves of long shoots 2¼–4 in. long.—*L. Principis-Rupprechtii.*
Young shoots glabrous, often glaucous, cones ½–⅔ in. long. *L. americana.*

Larix alaskensis, Wight.[1]

ALASKA LARCH.

Tamarack.

This larch is described (*loc. cit.*) as a small tree attaining a height of about 9 m. and a diameter of 20 cm.; leaf-fascicles at the ends of shoots 3–5 mm. long; *leaves* pale green, 5–20 mm. long, about 5 mm. broad, rounded on the upper surface, slightly keeled on the lower; *cones* borne at the ends of lateral branchlets, 3–5 mm. long, ovoid or short oblong, 10–15 mm. long, 9–12 mm. broad; *cone-scales* slightly longer than broad, the larger ones 8–10 mm. long, 7–9 mm. broad, rounded at the apex, abruptly contracted towards the base; *bracts* of the cone about one-third as long as the cone-scales, ovate, acute, without a projecting mucro; flowers not seen.

Judging from the description and figure, this larch is closely related to *L. americana*, and may be merely a geographical form of it distinguished by its usually shorter leaves, and the relatively large cone scales, which have shorter and broader bracts without a projecting mucro.

It is distributed from the Upper Kuskokwim River to the Yukon and Tanana Rivers, Alaska.

R. S. Kellogg, in an account of the Forests of Alaska,[2] says this larch grows sparingly in the river and creek valleys of the region named and is seldom more than 30 ft. high. It occurs with white spruce, white birch, balsam poplar, black cottonwood, black spruce, and aspen. In reference to the Alaska larch he says: "Naturally, it is impossible for timber to grow rapidly or to large sizes in soil which is perpetually frozen. On such sites the roots can penetrate only the overlying cover of moss and humus, and must spread out flat upon the frozen layer beneath. Rapid and thrifty growth has taken place only upon warm

[1] *Smithsonian Misc. Coll. L.*, pt. 2, p. 174 (1907).
[2] Forest Service Bull. (U.S.A. Dept. Agric.), 81.

slopes and in river valleys with sandy soil where the roots are able to go deeper." It is unlikely that the tree will have any value in Britain.

Larix americana, Michaux.

TAMARACK.

Larix americana, var. rubra, Loudon ; L. Fraseri, Curtis ; L. intermedia, Loddiges ; L. laricina, C. Koch ; L. microcarpa, Desfontaines ; L. pendula, Masters (not Salisbury) ; L. tenuifolia, Salisbury ; Abies microcarpa, Poiret ; Pinus laricina, Du Roi ; P. intermedia, Wangenheim ; P. microcarpa, Lambert. American Larch ; Hackmatack ; Black Larch ; White Larch.

A tree 50–80 ft. high, with a trunk 4–6 ft. in girth. *Bark* reddish-brown, 1–1¾ in. thick, peeling off in thin scales. *Branches* slender, horizontal, forming on old exposed trees an irregularly rounded head. *Young trees* narrowly pyramidal. *Young shoots* slender, without down, or with a few scattered hairs in the fissures of the bark ; covered with a bluish bloom, becoming bluish-grey at the end of the first year. *Terminal buds* rounded, short-pointed, dark red, shining, slightly resinous ; lateral buds very small, rounded, dark brown ; buds of short shoots small, surrounded by a circle of hairs. *Leaves* three-sided, very narrow, bright green, blunt, ½–1¼ in. long. *Male flowers* small, ovoid. *Female flowers* up to ½ in. long and ¼ in. wide ; *bracts* narrow, erect except for the points bending outwards, centre and points pale green, margins red. *Cones* ovoid, composed of few scales, each about ⅜ in. wide and ⅞ in. long, rounded, margins curving inwards. *Seeds* small with well-developed wings, shed within a few months of ripening. A peculiarity of the species is that the shoot is sometimes prolonged from the centre of the cone, a variation that accounts for the name *L. americana, var. prolifera* (*L. prolifera*, Malcolm).

L. americana is sometimes confused with *L. pendula*, from which it is distinguished by its uniformly smaller cones.

The tamarack is found wild in E. North America, where it extends from the Arctic Circle southwards to N. Pennsylvania and Cent. Minnesota, reaching an altitude of 4,000 ft. It appears to have been introduced in 1760, and was planted about that date at Whitton by the Duke of Argyll.

Wood heavy, hard, slow-growing, heartwood reddish-brown, sapwood narrow, yellow The timber shrinks a good deal if not carefully seasoned, is very durable in moist places or in contact with the soil, and is said to be less inflammable than many coniferous woods It is used in commerce for the construction of houses and other buildings, for ships, barges, and boats, telegraph and telephone poles, posts and rails, railway sleepers, and is suitable for paving blocks and other purposes. Lumbermen are said to recognize two varieties of wood, red and white. The

former has more heartwood than the latter and is stated to occur on colder and less favourable soils than the white. The roots are tough and pliable and have been used for weaving into baskets, etc.

The following strength-tests were made in the Canadian Government Laboratories :[1]

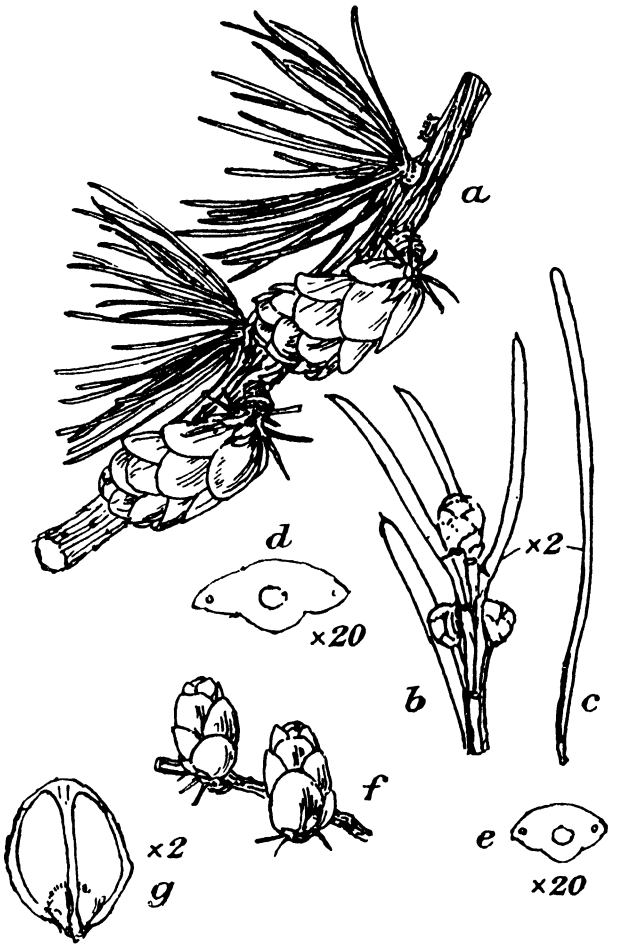

FIG. 63.—*LARIX AMERICANA.*

a, branch with two short shoots and cones; *b*, leaves and winter buds on long shoot; *c*, leaf from short shoot; *d*, *e*, sections of broad and narrow leaves; *f*, small variety of cone; *g*, cone-scale with two seeds.

Weight green (moisture 25 per cent., wood 75 per cent.), 40½ lb. per cubic ft.

Tension, strength across grain at elastic limit, 480 lb. per sq. in.

[1] *Cat. Empire Timber Exhib.*, 1920.

Compression, crushing strength with the grain, 3,480 lb. per sq. in.

Shearing, strength with the grain, 860 lb. per sq. in.

Bending, modulus of elasticity (stiffness), 1,240,000 lb. per sq. in.

Hardness, weight required to half-imbed a 0·444 in. steel ball, 390 lb. per sq. in.

The bark has medicinal properties, its action being alterative, diuretic, and laxative. It is recommended in cases of jaundice, obstructions of the liver, rheumatism, cutaneous disorders, etc.[1]

L. americana in a natural state [2] occupies both wet and dry soils, the best trees being found upon rich and light upland soils, whilst large numbers of smaller trees occur on wetter and heavier land. In swamps where water covers the surface of the soil, the tree only just manages to exist. In places subject to decided drought it is a failure. It is most plentiful in the swamps and silted lake-beds of northern regions, where it occurs in dense, extensive pure stands or with arbor-vitæ and black spruce. Being intolerant of shade, it must be able to dominate other species in mixed stands. The value of this larch in N. America lies in its ability to succeed under conditions unfavourable to other trees. In Britain it is occasionally seen in old collections of conifers, but has been neglected by modern planters and is seldom obtainable from English nurseries. It is less successful than other species, and can have little or no value as a commercial tree in Britain, though it might be useful as a first covering for wet, exposed land at a high altitude.

Larix Cajanderi, Mayr.

CAJANDER'S LARCH.

We do not know this species, but according to Elwes and Henry[3] it was discovered by Dr. Cajander in E. Siberia, where it occurs along the banks of the river Lena from the mouth of the Aldan at 68° N. lat. northwards to 72° N. lat., becoming here a stunted tree only 10–12 ft. high. It usually forms mixed woods with the Siberian spruce or with *Betula odorata*, assuming in wet soil a stunted habit; on unflooded land growing pure to a height of about 70 ft. Judging from the description, it is closely allied to, if not a variety of, *L. dahurica*. *Young branchlets* yellowish brown with scattered hairs, older branchlets becoming ashy grey. *Leaves* up to 2 in. long, showing when the bud opens a tuft of dense whitish pubescence which is absent in *L. dahurica*. *Cones* small, of about 20 scales, which gape widely when ripe and are broad and concave on the upper margin.

[1] Potter's *Cyclop. of Bot. Drug Prep.*, 278 (1915).
[2] Forest Service Circ. U.S.A. Dept. Agric., No. 89.
[3] Elwes and Henry, *loc. cit.* ii, p. 346 (1907).

Larix dahurica, Turczaninow.[1]

DAHURIAN LARCH.

Larix davurica, Trautvetter. L. Gmelinii, Gordon

A tree 60–80 or sometimes 100 ft. high. *Bark* brown on old trees. *Young shoots* without down or more or less clothed with reddish hairs. *Buds* of *long shoots* rounded, non-resinous, points of scales free, those of short shoots covered with down. *Leaves* ½–1 long, blunt and rounded at the apex, or narrowing to a short, blunt point, keeled below, stomata conspicuous on the under-surface. *Male flowers* globular, about ⅛ in. long. *Female flowers* not seen. *Cones* ¾–1 in. long; *scales*, few, woody, thin near the apex. *Seeds* small.

According to Wilson [2] this is the type of a group of E. Asiatic larches found in Siberia, Corea, Manchuria, etc., which vary considerably in the degree of hairiness of the young shoots, the length of the leaves, and the size of the cones. The large cones and long leaves of *L. Principis Rupprechtii* are found at one extreme, and the intensely hairy shoots, small leaves, and small cones of *L. kurilensis* and *L. olgensis* at the other. For convenience these three trees are kept separate from *L. dahurica* in this work, although collectors report that they are linked up by many intermediates. It is stated to have been introduced in 1827.

The *wood* of *L. dahurica* appears to be very similar to slow-grown wood of *L. europæa*, and to be of value for similar purposes.

It is little grown in Britain and is not well suited to our climatic conditions. Opening its leaves very early in spring, it is liable to injury by frost. No large trees of it are known in cultivation in this country.

Larix eurolepis, A. Henry.

DUNKELD LARCH.

Larix Henryana, Rehder.

A vigorous tree 40 ft. and upwards in height. *Young shoots* yellow, without down or slightly hairy, faintly glaucous. *Buds* light reddish-brown, without resin, terminal buds surrounded with acute or mucronate scales, axillary buds very slightly overlapped at the base by the subtending leaf-base. *Leaves* up to 1½ in. long, broader than in *L. europæa*, pointed or blunt, with a glaucous bloom and two bands of grey stomata beneath. *Female flowers* pink, as in *L. europæa*, but with the bracts more distinctly recurved, as in *L. leptolepis*. *Cone* conical as in *L. europæa*, but

[1] The larch, described as *L. dahurica* by Elwes and Henry, *loc. cit.* ii, 379 (1907), is mainly *L. pendula*, Salisbury.

[2] *Pl. Wils.* ii, p. 21 (1914).

paler coloured at maturity than the cone of that species; *scales* looser than in *L. europæa*, with the margins reflexed, but less so than in *L. leptolepis*, the points of the bracts projecting above the scales.

A hybrid between *L. leptolepis* and *L. europæa*, which first appeared at Dunkeld in Perthshire, the seed-bearers being ten specimens of *L. leptolepis* raised from seed received from Japan in 1884 and sown in 1885.[1] The flowers of these trees appear to be regularly pollinated by *L. europæa*, and seedlings are constantly raised. The following diagnostic characters are given by Prof. Henry and Miss Flood.[2]

L. europæa.	L. leptolepis.	L. eurolepis.
Twigs—glabrous, yellow, no wax	Twigs—pubescent or glabrous, red, much wax	Twigs—glabrous or very slightly hairy, yellow, slight wax
Buds—golden brown, no resin	Buds—red brown, resinous	Buds—light reddish-brown, no resin
Scales around terminal bud mucronate	Scales around terminal bud mucronate and acute	Scales around terminal bud mucronate and acute
Pulvini ending at base of axillary bud	Pulvini overlapping base of axillary bud	Pulvini slightly overlapping base of axillary bud
Bracts of young cones pink, straight	Bracts of young cones greenish, reflexed	Bracts of young cones pink, reflexed
Cones—conical, scales straight or incurved, bracts long, exserted, peduncle yellow	Cones—globose, scales much reflexed, bracts short, concealed, peduncle reddish	Cones—conical, scales slightly reflexed, bracts short, but a few exserted, peduncle yellow.

Under cultivation this larch grows with great vigour, soon outstripping both parents and being so far free from attacks by Chermes and fungi which are so destructive to European larch. One hundred acres of hybrid larch seedlings are said to have been planted at Dunkeld and Blair Athol.

Larix europæa, De Candolle. (Fig. 64.)

COMMON LARCH.

Larix decidua, Miller; L. decidua, var. communis, Henck. and Hochst.; L. pyramidalis, Salisbury; L. vulgaris, Fischer; Larix Larix, Karsten; Abies Larix, Poiret; Pinus læta, Salisbury; P. Larix, Linnæus. European Larch; Tyrolese Larch.

A tree 100–150 or more ft. high with a trunk 6–15 ft. in girth. *Bark* of young trees thin, greyish, of older trees brown, fissured

[1] *Trans. Roy. Scot. Arb. Soc.*, xxix, pp. 149–156 (1915).
[2] *Proc. Roy. Irish Acad.* xxxv, Section B, No. 4, p. 58 (1919).

and shed in small plates, sometimes very thick, at the base of old trees. *Branches* of young trees dense, short, compact; of old trees long, spreading; all drooping at the trunk with upturned points. *Young terminal shoots* grey or yellowish, furrowed, without down, those of the second year roughened by the cushion-

FIG. 64.—*LARIX EUROPÆA.*

a, two short shoots and two cones; *b*, young cone and long shoot (in May); *c*, part of shoot with leaf and leaf-bases, *d*, inner face of cone scale, showing young seeds; *e*, young cone scale and bract, side view; *f*, bract; *g*, mature cone scale and seeds.

like leaf bases of the previous year. *Short shoots* dark brown or almost black, marked with as many rings as they are years old, the younger rings downy. *Terminal winter buds* of long shoots globose, short-pointed, with many brown, pointed scales. *Lateral buds* shorter, blunter. *Buds of short shoots* small, rounded.

Leaves of long shoots up to 1¼ in. long, narrow, pointed or blunt, those of the short shoots 30–40 together, ½–1½ in. long, narrower and blunter than those of the long shoots, both kinds keeled below, soft, light green turning yellow in autumn. *Flowers* produced a little in advance of the leaves, during March at Kew, in April in later districts. *Male flowers* round, flattened, ⅕–⅖ in. long, ⅓ in. across, surrounded by thin bracts with fimbriated margins. *Female flowers* reddish or sometimes white, attractive, ⅓–½ in. long, the bracts more conspicuous than the scales, bright red or occasionally white, with a narrow, central green band ending in a long, slender tip, the upper part bending outwards. The inflorescence is surrounded by short green leaves, and the whole by a circle of thin brown, fringed scales. *Cone* ovoid, 1–1½ in. long, ¾–1 in. wide; *scales* rounded and entire above, striated, margin sometimes wavy, ⅓–½ in. long and broad, covered on the outer surface with soft brown down, almost concealing the bracts, of which the point ₁/₂–₁/₀ in. long can be seen. *Seeds* about ⅛ in. long, with a wing several times larger, up to ½ in. long and ⅓ in. wide, ripening the first year and shed in autumn or early the following spring, the empty cones remaining on the tree for an indefinite period.

The European larch is distinguished from the Japanese larch by its greyish bark, green, not glaucous-green leaves, and by its erect, not reflexed, cone-scales.

It is distributed through the Alps of Cent. Europe to N. Russia and Siberia, where it gives place to *L. sibirica*, a regionally distinct tree. *L. europæa* was introduced late in the sixteenth or early in the seventeenth century (before 1629). It was first planted extensively as a forest tree by the Duke of Atholl between 1774 and 1829. Michie[1] records that the first plants purchased at that time cost sixpence each and that it was only possible to procure 270,000 plants between 1774 and 1783. After 1870 the price fell to 35*s*. per thousand.

Wood hard, coarse-grained, durable even in contact with the ground, heartwood red or occasionally yellowish, sapwood yellow, narrow. The timber matures early, that of trees 40 years old being of excellent quality, commanding a regular average price of about 1*s*. per cubic foot. It is very extensively used for telegraph and telephone poles, railway sleepers, pit props, rustic work, ship and barge-building, house construction, piles, fencing and gates. Although less inflammable than many coniferous woods, it forms good heating fuel, but has the defect of throwing out sparks. It ranks high as a charcoal wood. In view of its great value for telegraph and telephone poles, a copy of a memorandum[2] on specifications for telegraph poles for the British Post Office is appended:

[1] *The Larch*, p. 57 (1885). [2] *Trans. Roy. Scot. Arb. Soc.* xxix, p. 91 (1915).

TELEGRAPH POLES FOR THE POST OFFICE. Memorandum to accompany Tender Form No. 264, for home-grown poles—Scots pine or larch. The full range of sizes included in the specification is:

Light poles	18 to 60 ft.	For details see page 6 of tender form.
Medium poles	18 to 60 ft.	
Stout poles	26 to 85 ft.	

The sizes of telegraph poles most commonly used in this country are:

Light.—22 to 30 ft. in length, not less than 5 in. in diameter at the top, and of a minimum diameter 5 ft. from the butt end of 6¼ in. for 22 ft., rising to 7¼ in. for 30 ft.

Medium.—24 to 34 ft. in length, 5½ to 6 inches minimum at top, 8 to 9¼ in. minimum at 5 ft. from butt. Also 36 and 40 ft. in length, 6 in. minimum at top, 9½ and 9¾ minimum at 5 ft. from butt.

Stout.—32 to 50 ft. in length, 7½ to 7¾ in. minimum at top, 11 to 13¾ in. minimum at 5 ft. from butt.

(All measurements are under bark.)

In the case of larch the specifications requirements will be modified as follows:

Light poles.—18, 20, 22, 24 ft., minimum diameter at top may be 4¾ in.
Medium poles.—All sizes minimum diameter at top may be ¼ in. less than specified.

Although larch poles and posts last longer than many coniferous woods when placed in the ground in a natural state, their life is greatly prolonged by creosoting the portion below and at least 1 ft. above ground, the bark being removed in all cases.

The bark has astringent, balsamic, and diuretic properties. It has been used in tanning and dyeing, and also in medicine. An oleo-resin known as *Venice* or *Larch Turpentine* is obtained by tapping, and an annual extraction of ½ lb. per tree can be made without injury to the tree.[1] It is of similar consistency to Canada balsam and possesses medicinal properties. Its use, however, appears to be confined to veterinary practice. A substance called Briancon Manna or Manna of the Larch[2] exudes in the summer from the leaves. It is a white saccharine substance and is found in the early morning in the height of summer as opaque crystalline oblong tears enclosing the leaves and without any well-marked odour, but having a sweet taste. It contains a peculiar sugar called Melezitose, and was formerly used in medicine. Ethyl alcohol[3] is obtained by distillation of the wood.

L. europœa is the most widely grown and probably the most valuable exotic tree in Britain. The general excellence of its timber has led to its being planted under every conceivable condition from sea-level to an altitude of 2,000 ft. in sheltered Scottish glens. There have naturally been many failures, but, on the other hand, where favourable conditions obtain, it has met with a

[1] Spon's *Encyclopœdia of the Industrial Arts*, v, p. 1691 (1882).
[2] Bentley and Trimen's *Medicinal Plants*, iv, No. 260.
[3] *Raw Materials Review*, Nov. 1922, p. 27.

Photo lent by Sir John Stirling Maxwell Bart

PLATE XIV. LARCH (*LARIX EUROPAEA*), AGE 53 YEARS, IN BRAEMORE WOOD, ULLAPOOL, SCOTLAND: ELEVATION 350 FEET.

greater measure of success than most other trees. It is perfectly hardy against winter frost, but is liable to suffer in districts where late spring frosts and bitter winds are experienced. The best results are obtained by planting in deep, fertile soil overlying sandstone or limestone, or in deep, porous, gravelly soils. Water-logged soil must be avoided; the tree is adversely affected by drought. It requires full light and a free circulation of air, and is usually planted in pure woods which may be underplanted with a shade-bearing tree when the larch is about half-grown. When planted as a mixed wood the companion trees should be shade-bearers, such as beech or silver fir.

Young plants are usually given permanent places when from 2–4 years old, and where the ground is loose notch planting is usually practised. It is advisable, however, whenever possible, to break up the ground and subsoil before planting. The trees in the earliest plantations formed by the Duke of Atholl were spaced 6 ft. apart, and they appear to have given satisfactory results Since that time, however, a good deal of planting has been done at 4 ft. apart each way. Whilst it is impossible to lay down hard-and-fast rules on the matter there appears to be little to be said for too close planting, especially at a time when both labour and plants are dear. On good soil, where growth is likely to be rapid and losses few, the plants may well be spaced 5 ft. apart; on poorer land, however, where more weaklings are likely to occur, closer planting would be an advantage. Planting operations may be carried on at any period during open weather between the fall of the leaves and the middle or end of March, the earlier the better, however, in most districts. Plantation trees usually grow very rapidly in height and the lower branches die whilst small. At this period the heads become thin and grass usually grows beneath the trees if under-planting is not practised. The full height may be reached at the age of 40–45 years, after which girth growth is more rapid. At 30–40 years of age, many trees are of telegraph-pole size, or larger, and it may be more profitable to fell trees at 40 years of age than to allow them to stand and mature at 80 years. At 20 years the trees have a large percentage of heartwood, and are suitable for fencing and pit-props. Even the early thinnings at 12 or 15 years are useful, particularly for rustic work and pergola poles.

All the diseases mentioned under the generic description attack the common larch, whilst young trees are often injured by the pine weevil (*Hylobius abietis*). Vigorous young trees have good recuperative powers after sudden injury, and trees killed almost to the ground by fire have been known to produce vigorous erect shoots from dormant buds near the ground. Michie[1] mentions a tree that grew on peat which, crowded by other trees,

[1] *Loc. cit.* p. 29.

had attained the height of 28 ft. and a girth of 4½ in. after 76 years' growth, but after the trees near it were cut down it grew rapidly and made as much wood in ten years as it had done during the whole of its previous existence. The fruiting stage of the fungus *Fomes officinalis* is collected from larch trunks in Switzerland, and from it agaracine is obtained, which is sometimes used in medicine in cases of phthisis.

From an æsthetic point of view the common larch has much to commend it, for not only are the delicate green leaves and bright-coloured cones beautiful in spring and summer, and the rich golden-yellow of the leaves charming in autumn, but the young shoots brighten up the landscape in winter and relieve the rather depressing greenery of pines, firs, and spruces.

Elwes and Henry, *loc. cit.* ii, 349 (1907).

Larix Griffithii, J. D. Hooker.

SIKKIM LARCH.

Larix Griffithiana, Carrière; Abies Griffithiana, Lindley and Gordon; Pinus Griffithii, Parlatore.

A tree up to 60 ft. high with a spreading head and long pendulous branchlets. *Bark* thick, brown. *Young shoots* downy, reddish brown the second year. *Terminal buds* conical, non-resinous, covered with hairy scales; lateral buds egg-shaped, non-resinous, downy; buds of short shoots downy. *Leaves* 1–1¼ in. long, light green, ending in a blunt point, deeply keeled below, stomata on each surface but most prominent beneath. *Male flowers* ⅜ in. long on short, stout stalks. *Female flowers* ovoid, bracts long, reflexed. *Cones* cylindrical, 2–4 in. long, 1–1¼ in. in diameter, violet-purple during growth, the short stout stalk twisted to bring the point of the cone upwards on the pendent shoot; *scales* four-sided, about 1 in. long and wide, furrowed, downy towards the base; *bracts* awl-shaped, the long pointed apex protruding beyond the scales. *Seed* about ⅛ in. long, with the wing about ½ in. long.

L. Griffithii differs from other larches by its long, weeping branchlets and large cones.

It was discovered by Dr. Griffiths, but was not recognized as distinct until Sir Joseph Hooker found it in Nepal in 1848. Of limited distribution, it occurs in E. Nepal, Sikkim, and Bhutan, at elevations of 8,000–12,000 ft., but is commonest at 9,500–11,000 ft., and is also found in the Chumbi Valley, Tibet.[1] In Bhutan it occurs with *Pinus excelsa* or in pure forest above it, or in small groups with an undergrowth of *Rhododendron*. It inhabits deep valleys, but prefers dry, rocky, ancient moraines and grassy slopes where drainage is good.

[1] Troup, *Silviculture of Indian Trees*, iii, 1157 (1921).

Larix Griffithii is only successful in the milder parts of Britain and does not succeed at Kew, but there is a tree 78 ft. high at Coldrennick in Cornwall,[1] and a fine specimen at Strete Raleigh near Exeter.

Larix kurilensis, Mayr.

KURILE LARCH.

Larix dahurica, var. japonica, Maximowicz.

A tree up to 70 ft. high, and sometimes 7–8 ft. in girth in its native country. *Bark* reddish-brown. *Branches* horizontal, branchlets short and dense. *Young shoots* downy, reddish-brown the second year. *Terminal buds* dark red, covered by a few long-pointed, resinous scales, the margins fringed with silky hairs. *Lateral buds* similar in shape, but smaller. *Buds of short shoots* rounded. *Leaves* short, ½–1 in. long, flat, rounded at the apex, 15–25 together on the short shoots; upper surface green, usually without stomata, under-surface distinctly keeled, with a conspicuous band of stomata on each side of the keel. *Male flowers* in very small round heads. *Female flowers* small. *Cones* short-stalked, ½–¾ in. long, and the same in width when expanded, composed of about 15 scales; *scales* about ⅓ in. long and wide, narrowing gradually to the apex, which is about $\frac{1}{16}$ in. wide, the edges curving inwards, slightly downy on the outer surface, gaping wide when ripe. *Seeds* small, about ⅛ in. long with a wing nearly ⅓ in. long.

L. kurilensis is closely allied to *L. dahurica*, and is often regarded as a variety of that species. It appears to differ chiefly in its denser branch system, shorter leaves, smaller cones and pointed cone scales, the apex of the scales being narrower than in any other larch.

It is found in the islands of Karafuto, Iturupp, and Shikotan N.E. Asia and is called Shikotanmatsu by the Japanese. It was discovered by Mayr and was introduced to Europe by him in 1888.

Wilson[2] states that it is also abundant in swampy places throughout Japanese Saghalien, where it forms pure forests or is mixed with other trees. The wood is hard, reddish in colour, and stands moisture for a lengthy period. It is consequently largely in demand for shipbuilding, public engineering, and household furniture.

Larix kurilensis is in cultivation at Kew, but grows slowly in comparison with several other species. The leaves appear very early and are liable to injury by frost. In the peculiarly trying spring of 1922 it suffered less than the various Siberian and Chinese species.

[1] *The Garden*, November 30, 1918.
[2] *Conifers of Japan*, 33 (1916).

Under the name of *L. dahurica*, var. *japonica*, Wilson[1] describes a form *ochrocarpa* which is said to differ from typical var. *japonica* by the pale yellowish-green colour of the cones.

Larix leptolepis, Murray. (Fig. 65.)

JAPANESE LARCH.

Larix japonica, Carrière; L. Kaempferi, Sargent; L. Sieboldi, Zuccarini; Abies Kaempferi, Lindley; A. leptolepis, Siebold and Zuccarini; Pinus Kaempferi, Lambert; P. Larix, Thunberg; P. leptolepis, Endlicher. Red Larch; Kara-matsu.

A tree 60–100 ft. high, with a trunk 6–12 ft. in girth in Japan. *Bark* of young trees reddish, brown in later life, with shallow fissures, shed in small plates or strips. *Branches* dense, longer and stronger than in the common larch. *Young shoots* glaucous, covered in varying density with soft, brownish hairs, or sometimes without hairs, furrowed, becoming in the second year reddish with a glaucous tinge. *Short shoots* stout, dark brown, the annual rings without down. *Terminal buds* of long shoots small, oblong or conical, pointed, resinous, covered by bright brown, loose, fringed scales, and surrounded at the base by soft hairs. *Lateral buds* short, broad, blunt. *Leaves* of long shoots up to $1\frac{1}{4}$ in. long, broader than in *L. europœa*, pointed or blunt; those of the short shoots 40 or more together, up to $1\frac{1}{2}$ in. long, both kinds glaucous-green, flat above, keeled below, turning yellow in autumn. *Flowers* appearing before the leaves at the same time as those of *L. europœa*. *Male flowers* oblong, shorter and narrower than in *L. europœa*, about $\frac{1}{4}$ in. long and $\frac{1}{8}$ in. wide when expanded, surrounded by thin, brown, fringed bracts. *Female flowers* about $\frac{1}{3}$ in. long and wide; *bracts* with a wide central triangular band of green or greenish brown, narrowly margined with pink, the green part ending in a sharp point, the apex bending outwards and more distinctly reflexed than in common larch. *Cones* $\frac{3}{4}$–$1\frac{1}{3}$ in. long and almost as broad; *scales* about $\frac{3}{5}$ in. long and wide, rounded, with the upper edge rolled back, giving the expanded cones a rosette-like appearance, each scale slightly downy and marked with longitudinal lines on the outer surface. *Bracts* scarcely exceeding the scales in length. *Seed* $\frac{1}{6}$–$\frac{1}{5}$ in. long, wing about twice as long.

L. leptolepis is distinguished from the common larch by its glaucous shoots, wider blue-green or glaucous leaves, and broader cones with reflexed scales.

This larch is found wild in Japan on the slopes of volcanic mountains at 4,000–6,000 ft., chiefly on Mount Euji, on Mount Asama, in the Azumi county of the Shinano Province, and also on Mount Nikko, but natural forests are rare elsewhere.[2] It was introduced to Britain in 1861 by John Gould Veitch.

[1] *Loc. cit.* [2] *Forestry of Japan*, 30 (1910).

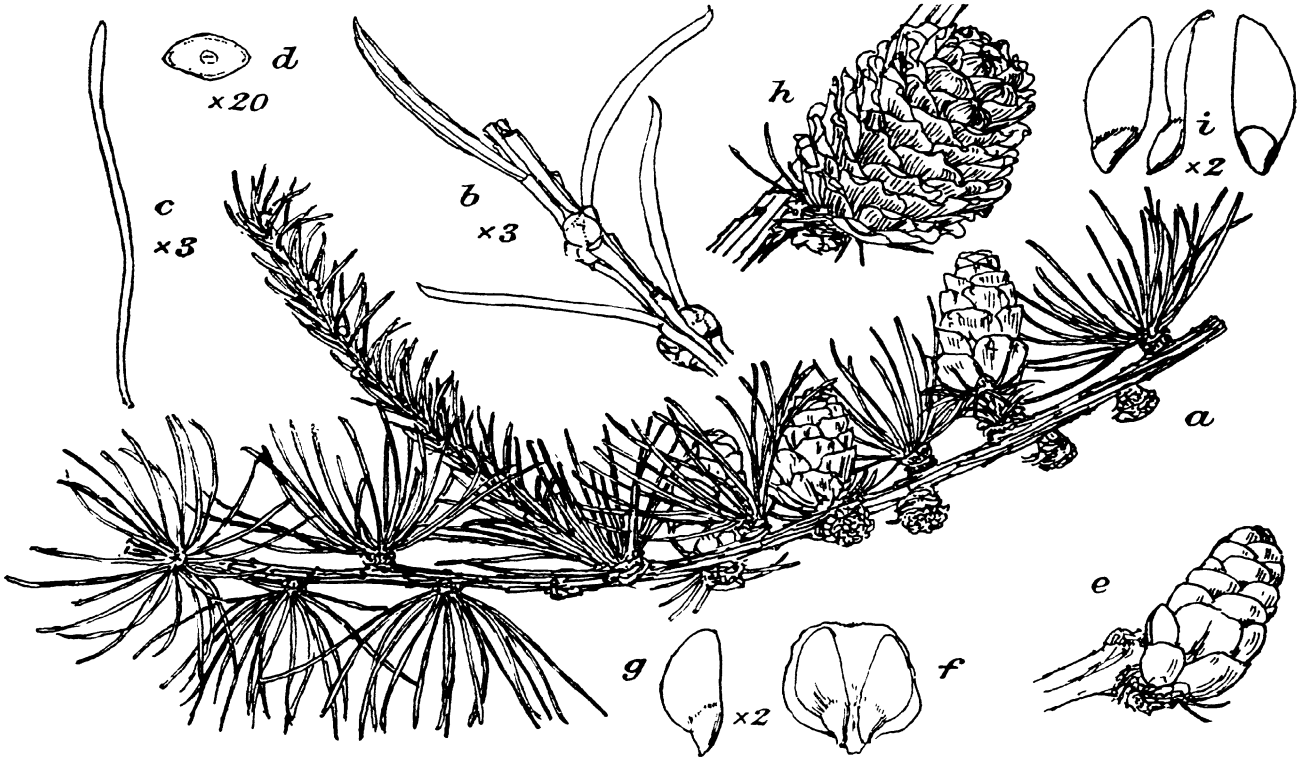

FIG. 65.—*LARIX PENDULA and L. LEPTOLEPIS.*

L. pendula.—*a*, spray with long and short shoots, three female and four old male cones; *b*, part of long shoot and winter buds; *c*, leaf from long shoot; *d*, section of leaf; *e*, cone; *f*, cone scale with two seeds; *g*—seed. *L. leptolepis.*—*h*, cone; *i*, seeds, outer side and inner view.

Mr. George Leven, forester to the Duke of Roxburgh,[1] considers that there are at least three types of Japanese larch which he describes as " fissure-barked," " flake-barked," and " smooth-barked," which can be picked out with comparative ease in a plantation. The fissure barked type is most common and most luxuriant, whilst the smooth-barked type is most liable to injury by *Chermes*.

The *wood* from mature trees is very similar in appearance to that of European larch It is hard, durable, and employed for house building, ships, telegraph poles, earthworks, etc.

As the Japanese larch has not attained maturity in this country, it is not possible to say at present how it will compare with European larch when grown under similar conditions, but from tests carried out on pit-wood of similar age it appears to be decidedly inferior.

A report on the comparative strength and durability of 13-year-old Japanese and European larch, carried out at Hodbarrow mine, Cumberland, in 1915, gives the following results :[2]

The pieces of larch were each placed on supports 4 ft. 6 in. apart and subjected to gradual pressure at the centre by means of a screw, having a pitch of $\frac{1}{2}$ in., turned by four men at the end of a lever :

Test No. 1.—Japanese larch, 6 × 5 in.
Broke at $2\frac{1}{4}$ turns—1 deflection.
Test No. 2.— English larch, 6 × 5 in.
Broke at $4\frac{1}{2}$ turns—$2\frac{1}{4}$ deflections.
Test No. 3.— Japanese larch, $7\frac{1}{4}$ in. diameter over bark.
Cracked at 6 turns—3 deflections.
Broke at 8 turns – 4 deflections.
Test No. 4.— English larch, $7\frac{1}{4}$ in. diameter over bark.
Cracked at 14 turns—7 deflections.
Broke at $15\frac{1}{2}$ turns—$7\frac{3}{4}$ deflections.
Test No. 5.—Japanese larch, $8\frac{3}{4}$ in. over bark.
Cracked at 6 turns—3 deflections.
Broke at 7 turns—$3\frac{1}{2}$ deflections.
Test No. 6.—English larch, $8\frac{1}{4}$ in. over bark.
Cracked at 12 turns– 6 deflections.
Broke at 16 turns—8 deflections.

In all the above tests the nature of the fracture was greatly in favour of the European larch ; the Japanese larch broke with a shorter fracture and did not show the toughness of fibre exhibited by the European larch. The trees tested were grown on the same ground and under the same conditions, whilst the tests were identical in each case.

Japanese larch grows more rapidly in a young state than

[1] *Trans. Roy. Scot. Arb. Soc.* xxxv, p. 118 (1921).
[2] *Trans. Roy. Scot. Arb. Soc.* xxix, p. 206 (1915).

European larch, and was for a long time thought to be immune from the attacks of larch canker fungus. There is ample proof, however, that it is not only attacked by this fungus, but also by other diseases that affect European larch. When plantations are made side by side the difference in the rate of growth in trees ten years old is very marked, the Japanese species being often half as tall again as the European species, with a correspondingly larger girth. There is a seventeen-year-old trunk of Japanese larch in the forestry museum at Kew, which is 43 ft. long, the base being 12 in. in diameter and the top $1\frac{3}{4}$ in. over bark. This tree was grown on the Duke of Buccleuch's estate in Dumfriesshire. The branch and leaf system of Japanese larch is heavier than in European larch, and the trees bear rather wider spacing; in fact, they might well be placed $5\frac{1}{2}$–6 ft. apart in good soil. The lower branches should not be cut off before they are dead unless some protective substance, such as coal-tar, be applied to the wounds. The Japanese larch forms a handsome decorative tree and is useful for groups in parks and mixed plantations. Several trees at Kew are forty or more years old. They are growing on poor, sandy soil and are similar in height and girth to European larch of the same age, near them. *L. leptolepis* is being planted in large numbers in Japan, and to meet the demand for young plants large quantities of seed are collected in the southern part of Honshu and in various parts of Shikoku and Kyushu.[1]

Larix Lyallii, Parlatore.

LYALL'S LARCH.

A tree up to 80 ft. in height and 12 ft. in girth in a natural state, but often less than 50 ft. high and 4 ft. in girth. *Bark* grey and scaling, or reddish brown and fissured on old trees. *Branches* short, irregular, brittle. *Young shoots* covered by a felt of short grey or buff hairs and encircled at the base by a ring of brown scales. *Buds* rounded, brown, densely covered with down. *Leaves* slender, stiff, pointed, quadrangular in section, prominently keeled on both surfaces, $\frac{1}{2}$–$1\frac{1}{2}$ in. long. *Male flowers* about $\frac{1}{3}$ in. long, short-stalked, yellow. *Female flowers* about $\frac{1}{2}$ in. long, with long-pointed bracts which bend outwards from the middle. *Cones* $1\frac{1}{4}$–2 in. long and $1\frac{1}{8}$ in. wide, very shortly stalked or sessile, pink when young. The bracts have long, slender points which, in the mature cone, extend well beyond the scales and eventually become reflexed. They are beautifully ciliated or fringed on the margins. *Cone-scales* slightly downy and reflexed. *Seeds* $\frac{3}{8}$–$\frac{7}{16}$ in. long, including the pale pinkish wing.

L. Lyallii, which has been regarded as an alpine form of *L. occidentalis*, is easily separated from other species by its

[1] *Forestry of Japan*, 73 (1910).

densely felted shoots, its four-sided leaves and long-pointed cone bracts.

It is a very local tree which was discovered by Dr. Lyall, surgeon to the British Columbia-Oregon Boundary Commission, 1858–1861. Essentially an alpine species, it occupies positions near the timber line at altitudes of 6,000–7,000 ft. in the Cascade Mountains and on the Galton Range, the largest size being attained in the Whitefish Range. In 1883 it was rediscovered by Mr. T. S. Brandyce, of the Northern Transcontinental Survey. Trees of this species most easily accessible to travellers may be seen above Lake Louise growing among *Picea Engelmanni* and *Abies lasiocarpa* within a few miles of the Canadian Pacific Railway.

The trees grow very slowly, and a section of wood preserved at Kew which is 7½ in. in diameter shows about 130 annual rings, the sapwood being less than ¼ in. wide and the bark ¼ in. thick.

Seedlings have been raised at Kew but have not grown well. A colder country than Britain appears to be necessary for its successful growth. A tree transplanted from the Rockies has lived at Dawyck for several years, the sole survivor of about a dozen Mr. Balfour planted ten years ago; it is not more than a foot high. Sections of those that succumbed, though not more than 1 or 2 ft. high, showed by their rings that they were at least forty years old.

Lyall in *Journ. Linn. Soc. Bot.* viii, p. 143.

Larix Marschlinsi, Coaz.

THE SWISS HYBRID LARCH.

This hybrid larch was raised in the forest garden of Tscharnerholz, near Morat, Switzerland, in 1901.

The mother-tree was a Japanese larch (*L. leptolepis*), and it is thought that the pollen was from the Siberian larch (*L. sibirica*), although there were trees of *L. europœa* near by. The seedling trees raised were very vigorous and are now growing at Marschlinus, Switzerland. By 1917 they had attained a height of 27–33 ft., with a girth of 24–26 in. at one foot above the ground. The reciprocal cross is said to have been made in Russia with a view of obtaining a tree less susceptible to disease than *L. sibirica*.

Schweiz, *Zeitschrift für Forstwesen*, lxviii, 12, fig. 3–4 (1917).
Henry and Flood in *Proc. Irish Acad.* xxxv, Sect. B, No. 4, p. 57 (1919).

Larix Mastersiana, Rehder and Wilson.

MASTER'S LARCH.

A tree 30–65 ft. high, with a trunk up to 6 ft. in girth. *Bark* greyish brown, irregularly fissured. *Branches* spreading horizontally, branchlets pendulous, without down or with a few scattered hairs. *Buds* ovate, blunt. *Leaves* pale green, ½–⅓ in.

long, short-pointed. *Cones* about 1¼ in. long, erect on short stalks, composed of numerous kidney-shaped or round scales. *Seed* about $\frac{1}{10}$ in. long with a wing ⅓ in. long.

According to the describers[1] this larch is closely related to *L. Griffithii*, which is distinguished chiefly by its very much larger cones, 2–4 in. long, with larger bracts which have a smooth, not papillose, epidermis, and a continuous hypoderm to the leaf.

L. Mastersiana is apparently a very local species, being known only from the petty tribal state of Wassu, China. In this small territory this larch is abundant, but in 1908 and 1910 it was being rapidly cut down in its more accessible localities. The timber is in demand for housebuilding and general constructive work and commands a high price at Kuan Hsien. Fortunately the region is extremely precipitous and there is little possibility of this interesting tree being exterminated.

Larix occidentalis, Nuttall.

WESTERN LARCH.

Pinus Nuttalli, Parlatore.

This larch attains greater dimensions than any other tree in the genus, being found up to 200 ft. high with a columnar trunk 12–15 ft. in girth. *Bark* thin, scaly, dark grey or brown on young and middle-aged trees, reddish brown, 3–6 in. thick, and deeply furrowed on old trees. *Young shoots* whitish, usually with long scattered hairs in the grooves, occasionally without hairs, light brown the second year. *Buds* round, resinous, with downy and fringed scales, the tips of the outer ones free; buds of short shoots covered with down. *Leaves* light green, 1–2 in. long, 14–40 together on the short shoots, rounded above, keeled beneath, stomata prominent, forming two white lines on each surface. *Male flowers* ¼–⅓ in. long, in short-stalked, cylindrical clusters. *Female flowers* ½–⅝ in long, the bracts brown or pinkish, with a long green midrib. *Cones* ovoid, 1–2 in. long by 1–1½ in. wide, on short, stout, scaly stalks ¼–⅓ in. long; scales ½ in. long, ⅓ in. wide, minutely downy on the outer side, upper margin thin and slightly recurved; *bracts* lance-shaped, with a long exserted recurved point. *Seed* and wing together ¼–⅓ in. long, the wing pale brown. The seeds are shed within three weeks of ripening. At Kew the flowers open about a fortnight later than those of *L. europœa*.

L. occidentalis is distinguished from *L. Lyallii*, another W.N. American species, by its less hairy shoots and by the seed-wings being brown, not pink as in *L. Lyallii*. Intermediate forms, however, are said to connect the two species.

[1] *Pl. Wils.* ii, 19–20 (1914).

L. occidentalis is found in the Columbian Basin between the Rocky Mountains on the east and the Cascade Range on the west; also north of the Blue Mountains of Oregon, at altitudes ranging from 2,500–6,000 ft. It is said to attain its greatest dimensions in Montana, where it is common. David Douglas discovered this species in April, 1826, at the Kittle Falls on the Columbia River. Seedlings were raised in the Arnold Arboretum in 1880, and young plants were received at Kew in 1881, which mark the introduction of this tree to Europe.

Wood very similar in appearance to European larch, of excellent quality, hard, strong, and durable in contact with the ground, and credited with being harder and stronger than either the E. American or European species. A report on the results of tests on green material shows :[1]

Weight, green (moisture 25 per cent., wood 75 per cent.), 40 lb. per cu. ft.

Tension, strength across the grain, 230 lb. per sq. in.

Compression, strength across grain at elastic limit, 560 lb. per sq. in.

Compression, crushing strength with the grain, 3,800 lb. per sq. in.

Shearing, strength with the grain, 920 lb. per sq. in.

Bending, modulus of rupture (breaking strength), 7,500 lb. per sq. in.

Bending, modulus of elasticity (stiffness), 1,350,000 lb. per sq. in.

Hardness, weight required to imbed a 0·444 in. steel ball, 460 lb. per sq. in.

The timber of the western larch is used for telegraph and telephone poles, railway sleepers, building material, flooring, ships and barges, posts and rails, and for firewood. As fuel it is reputed to be superior to all other American coniferous woods. The total stand of western larch timber in British Columbia is computed to be 3,152,000,000 board ft.[2] The annual cut is between 38,000 and 39,000 board ft.

In America a sweet manna-like substance exudes from the tree and is sometimes eaten by the Indians. A specimen of this substance, reddish brown in colour, is preserved at Kew. A whitish resinous exudation is found upon trunks and branches of young trees of *L. occidentalis* at Kew, but has not been noticed on other larches.

The original trees received at Kew in 1881 were planted in well-drained, poor, sandy soil and have grown at a similar rate to trees of European larch with which they were mixed. It is a remarkable fact, however, that whilst the European larch is often very badly attacked by *Chermes* the Western larch remains

[1] Tests by U.S. Dept. Agric.—*Timber Exhib. Cat.*, London, 1920.
[2] Whitford and Craig, *Forest Res. British. Col.* 241 (1918).

clean. Attempts have been made to make use of this species for silvicultural purposes in Britain, but as far as can be judged at present it cannot compete satisfactorily with either the European or Japanese species. Trial plantations have been started in several parts of the country,[1] but the results are not such as to warrant its being planted on a large scale. A small plantation was established at Kew in 1913, from plants raised from seeds sown in 1909. The young trees were placed 6 ft. apart each way. About 50 per cent. are now (1922) 18–25 ft. high, the largest being 15 in. in girth. The remainder range from weakly plants 3–4 ft. high to trees 15–18 ft. in height. Brambles have been allowed to grow in the centre of the plantation, and most of the best trees are to be found there. Grass has grown amongst the trees on the outskirts, and here well-developed trees are few in number. A small group of European larch planted with the Western larch are better developed. The older trees at Kew cone freely, but rarely produce fertile seed.

Bot. Mag. t. 8253 (1909).

Larix olgensis, A. Henry.[2]

OLGA BAY LARCH.

A small or medium-sized tree. *Young shoots* slender, brown, densely covered with reddish brown hairs, the remains of which may be found on older wood. *Branches* grey. *Buds* shining dark brown, those of the short shoots with a circle of reddish brown hairs at the base. *Leaves* short, slender, $\frac{1}{2}$–$\frac{3}{4}$ in. long, curved, rounded and blunt at the apex, upper surface rounded, lower surface prominently keeled with a stomatic line on each side of the keel. Resin canals present in the leaves of long shoots, rudimentary or absent in the leaves of short shoots. *Cones* $\frac{1}{2}$–$\frac{3}{4}$ in. long, composed of 20–30 scales, each nearly $\frac{1}{3}$ in. across, and with rounded and entire margins, the outer surface covered with dense, short down, the tips of the bracts protruding beyond the scales. *Seeds* about $\frac{1}{16}$ in. long with a wing $\frac{1}{4}$ in. long.

L. olgensis is closely related to *L. kurilensis*, and may be merely an unusually hairy form of that species, or, taken in a wide sense, a geographical form of *L. dahurica*. The cones of herbarium specimens at Kew are, however, larger than those of *L. kurilensis* grown at Kew.

The Olga Bay larch is found about Olga and Valdimar Bays, about 120 miles N.E. of Vladivostok, growing under very cold conditions, the average temperature being said to be 40° Fahr. and the average maximum temperature 68° Fahr. A dried specimen at Kew was collected in 1860 by Maximowicz, and further specimens were sent home from Olga Bay in 1911 by

[1] Henry in *Quart. Journ. Forest*, 161 (1922).
[2] *Gard. Chron.* Feb. 27, 1915, 109.

Captain (now Vice-Admiral Sir Lewis) Clinton-Baker, R.N. Seeds were procured about the same time, but the plants raised from them were weak and several were killed by the great drought of 1921, the survivors being injured by frost the following spring. It does not appear to be a suitable tree for Britain.

Larix pendula, Salisbury.[1] (Fig. 65.)

Weeping Larch.

L. americana, Michaux, var. pendula, Loudon; L. dahurica, Elwes and Henry (not Turczaninow); Pinus pendula, Aiton.

A tree 70–90 ft. high. *Bark* variable in character, resembling that of the European larch or peeling off in thin squarish plates like that of a cedar. *Young shoots* slender without down, usually pinkish at first, but becoming yellowish green with age. *Terminal buds* conical, resinous, short-pointed; axillary buds smaller and blunter. *Leaves* like those of *L. europæa*, but with the tips usually blunter than in that species. *Cones* variable in length of stalk, from $\frac{5}{8}$–$1\frac{1}{4}$ in. long, $\frac{1}{2}$–1 in. wide; *scales* bright brown, the margins bevelled and crenate, the outer surface often minutely downy at the base, bracts hidden. *Seeds* intermediate in size between those of *L. americana* and *L. europæa*.

This larch was first described by Aiton in 1789, and stated to be a native of Newfoundland. Pursh [2] states definitely that it occurs in low cedar swamps from Canada to Jersey, that it is quite distinct from *L. americana*, and that he never found the two trees growing together, but no other botanist or traveller seems to have seen east of the Rocky Mountains any larch except *L. americana*. Lambert's figure of *Pinus pendula*, published in 1803, and quoted by Pursh, shows a plant identical with the larch now known as *Larix pendula*, but for some years confused with *Larix dahurica*.[3] Lambert states definitely that this figure was made from specimens taken from the original tree in Collinson's garden at Mill Hill,[4] which had been moved from Peckham, where it was planted in 1739. In 1740 Miller[5] mentions this tree as "brought from America." Henry, in a recent paper on the origin of *L. pendula*,[6] maintains that the larch at Mill Hill was the result of a chance cross between *L. americana* and *L. europæa*, that all existing trees are descendants from it and show all possible combinations of the characters of the two species. The main basis of this argument rests on the assumption that from the time

[1] *Trans. Linn. Soc.* viii, 314 (1807).
[2] *Fl. Amer.* ii, 645 (1814). [3] Elwes and Henry, *loc. cit.*
[4] Cones from this tree are still preserved in the British Museum.
[5] *Gard. Dict. Abridg.* ii (1740).
[6] *Gard. Chron.* Sept. 18, 1915, p. 178.

of Michaux to the present day no American botanist has found any larch but *L. americana* in E. America. But the statements of Miller and Lambert that the original tree came from America in 1739 are quite clear, whereas, *L. americana* was not introduced until 1760. Henry's statement that it was in cultivation in 1739 is based on the reference to the Collinson tree, which he elsewhere allows to be *L. pendula*, and if these facts are correct there can be no question of hybridity. It would indeed be easier to assume that early deforestation had destroyed the American habitat of a distinct species now only known in cultivation.

The finest tree of *L. pendula* in the British Isles is at Woburn, and is 90 ft. high and over 7 ft. 6 ins. in girth. It was probably planted about 100 years ago. There are smaller trees at Stanage Park, Radnorshire; Beauport Park, Sussex; Royston, Yorks; Murthly; and at Kew.

Var. **repens**, Henry.[1]

A peculiar form with horizontally creeping branches. There is a plant at Henham, Cambridge, grafted on a European larch stock.

Larix Potanini, Batalin.

HUNG SHA (RED FIR).

Larix thibetica, Franchet; L. chinensis, Beissner.

A tree 20–70 ft. or sometimes 100 ft. high. *Bark* grey or grey-brown, rough and fissured on old trees. *Branches* short, horizontal. *Branchlets* slender, weeping, grey. *Young shoots* shining orange-brown or purple-brown, slightly hairy, glabrous before the end of the first year, older shoots grey. *Terminal buds* egg-shaped, resinous; *axillary buds* small, spreading, dark-brown, resinous. *Leaves* $\frac{3}{4}$–$1\frac{1}{8}$ in. long, prominently keeled on both surfaces, four-sided, apex pointed. *Cones* oblong or ovoid, reddish when young, violet-purple later, ultimately grey or greyish brown, without stalks, up to $1\frac{3}{4}$ in. long and 1 in. wide, apex blunt; *scales* numerous, rounded, often with a central notch; bracts usually longer than the scales, the long points protruding beyond them. *Seeds* about, $\frac{1}{8}$ in. long, wing $\frac{1}{4}$ in. long, and almost as wide.

L. Potanini can be distinguished from other larches, except *L. Lyallii*, by its four-sided leaves, and from *L. Lyallii* by its less hairy shoots. Its botanical characters place it between *L. Griffithii* and *L. Lyallii*.

Wilson[2] records it from the mountains of Shensi province westward to those of the Chino-Tibetan borderland. It is a common tree around Tatienz-lu at altitudes ranging from 7,500–11,000 ft. He further says,[3] that it is a strikingly handsome tree

[1] *Gard. Chron., loc. cit.*
[2] *Conifers of Japan*, p. 29 (1916).
[3] *Pl. Wils.* ii, p. 19 (1914).

and that it is the common larch of W. Szechuen, where it occurs at elevations of 7,500–11,000 ft. At its lower altitudes it is scattered in moist woods, more especially by the sides of streams, with other conifers and broad-leaved trees, becoming more abundant as it ascends and forming dense forests at the higher alpine regions. It is known to the Chinese as "hung sha" or "red fir," and is considered the most valuable coniferous timber in W. China.

Described in 1894, it was introduced ten years later by Mr. E. H. Wilson for Messrs. Veitch.

Young trees are making good progress in Britain and although it is too early to appraise this larch, it is more promising than any of the *L. dahurica* group. The foliage of young trees at Kew was seriously injured by frost in the spring of 1922.

Kew Bull. 1910, p. 174, with fig.

Larix Principis Rupprechtii, Mayr.

PRINCE RUPPRECHT'S LARCH.

This is a larch from Corea, Manchuria, and the extreme north-western corner of China, about which little is known in Britain. Young trees which have not yet coned are growing at Kew and show the following characters.

Young shoots without down, bright reddish brown. *Terminal buds* dark brown, glossy, with little or no resin, the points of the scales free; *axillary buds*, dark brown, glossy, pointed or blunt, longer and less closely pressed to the branch than in other larches. *Leaves* 2¼–4 in. long, $\frac{1}{16}$–$\frac{1}{13}$ in. wide on vigorous shoots, long-pointed, the upper surface rounded, keeled beneath.

Wilson[1] regards this tree as a large-coned form of *L. dahurica* and states:

"The typical form of *L. Principis Rupprechtii*, Mayr., as represented by the specimens from Wutai-shan, looks quite distinct from typical *L. dahurica*, but the specimens from Weichang, together with others from Manchuria, Amurland, and Korea, form a series which gradually merge unto typical *L. dahurica*. With *L. sibirica*, Ledebour, with which it has been compared, it agrees only in the size of its cones, but differs in their perfectly glabrous, more spreading and thinner scales not incurved on the margin, truncate or (particularly in the Weichang specimens) even emarginate at the apex, and in the more conspicuous bracts which are often, particularly in the lower part of the cone, more than half as long as the scales; in all these characters *L. Principis Rupprechtii* agrees with *L. dahurica*, and it seems therefore best to consider it as a variety of this species, distinguished by the more numerous scales. Purdom and also Meyer speak of this larch as forming forests on the northern slopes of Wutai-shan

[1] *Plantæ Wilsonianeæ*, ii, 21.

and in its neighbourhood, where, according to Meyer, the snow does not melt until well into May. Purdom remarks that in the Weichang region this tree is now becoming very scarce."

Larix sibirica, Ledebour.

SIBERIAN LARCH.

Larix intermedia, Lawson; L. archangelica; Lawson; L. rossica, Sabine; L. altarica, Nelson; L. europæa, var. sibirica, Loudon; L. decidua, var. rossica and sibirica, Regel; Pinus intermedia, Fisher; P. Ledebourii, Endlicher; Abies Ledebourii, Rupprecht. Russian Larch.

A tree 80–100 ft. high, with a trunk up to 12 ft. in girth in Siberia. Bark as in the European larch. *Young shoots* more or less hairy, occasionally without down. *Buds* rounded or conical, resinous, scales with ciliated margins. *Buds* of short shoots surrounded by a dense ring of hairs. *Leaves* 1–2 in. or more in length, slender, sharp-pointed, deeply keeled on the under-surface. *Flowers* very like those of *L. europœa*. *Cones* with fewer scales than in *L. europœa*; *scales* four-sided, as long as broad, outer surface finely striate, hairy, bracts hidden by the scales. *Seed* and wing up to ½ in. long.

The species is very similar to *L. europœa*, differing chiefly in its more slender leaves, which appear about ten days earlier in spring, and differently shaped cone-scales. It may, however, be a geographical form of the European tree.

It is found wild in N.E. Russia and W. Siberia, where it has a very wide distribution. The Duke of Atholl introduced it to Britain in 1806.

Wood very similar to slow-grown European larch, and useful for the same purposes. Siberian larch timber is said to have been used for piles in Dover Harbour Works.

Although efforts have been made to establish *L. sibirica* under forest conditions in Britain, little progress has been made owing to the very early breaking of the leaf-buds and the crippling effect of spring frost on the young shoots. In its native country there is very little spring or autumn, a short, sunny summer and a long, cold winter. In England the loss of a proper resting-period in winter appears to enfeeble the tree. In Siberia it is said to occur as small groups mixed with other trees rather than as a pure forest.

Writing of the Russian larch in 1854, Simmonds [1] says: "From the boiled inner bark, mixed with rye flour, and afterwards buried for a few hours in the snow, the hardy Siberian hunters prepare a sort of leaven with which they supply the place of common leaven when the latter is destroyed, as it frequently is, by intense cold. The bark is nearly as valuable as oak bark. From the inner bark the Russians manufacture fine white gloves, not

[1] *Commercial Products of the Vegetable Kingdom*, p. 376.

inferior to those made of the most delicate chamois, while they are stronger, cooler, and more pleasant to wear in the summer."

LIBOCEDRUS, Endlicher.

Evergreen trees with an aromatic odour, belonging to the tribe *Cupressineæ*, allied to *Thuya*. Widely distributed in W.N. America, S. America, China, Formosa, New Guinea, New Zealand, and New Caledonia, about 9 species being known. *Bark* thin, shed in long strips. *Branchlets* flattened, divided into fine spray. *Winter buds* hidden by leaves, as in *Thuya* and *Cupressus*. *Leaves* small and scale-like, those of the main branches larger and more distant than those on the lateral branchlets, closely pressed and overlapping. Juvenile leaves longer and more spreading than the mature leaves. *Male* and *female flowers*, usually on different branches of the same tree. *Male flowers* terminal, oblong with 6–20 stamens. *Female flowers* oblong, with 4 or 6 bracts with several pairs of persistent triangular scales at the base. *Cones* erect or pendulous, pointed; *scales* 4–6, oblong, woody, the upper pair or middle scales bearing 1 or 2 seeds each. *Seeds* with 2 wings, one broad and oblique, the other narrow or rudimentary.

Libocedrus chiefly differs from *Thuya* in its fewer cone-scales and unequally winged seeds.

Wood reddish brown or brown, with small but fairly numerous resin cells, fragrant with a spicy odour, durable, easily worked, finishes with a good surface. Suitable for building purposes where great strength is unnecessary, the indoor finish of houses, and other work.

These trees are unsuitable for forestry work in this country, though two species are often grown in gardens.

Key to Libocedrus.

I. Ultimate branchlets on mature trees tetragonal, bearing leaves all alike and uniform in size.
  Leaves spreading.—*L. tetragona.*
  Leaves closely pressed.—*L. Bidwillii.*

II. Ultimate branchlets of mature trees flattened and spreading.
  A. Median and lateral leaves equal in length.
    Leaves green on both surfaces.—*L. decurrens.*
    Leaves glaucous on the under-surface, with white stomatic bands.—*L. macrolepis.*
  B. Median and lateral leaves equal in length on mature trees; lateral leaves much longer than median leaves on young plants. Branchlets articulate.—*L. arfakensis.*
  C. Lateral leaves slightly longer than the median leaves.—*L. papuana.*

D. Lateral leaves much longer than the median leaves.
Median leaves minute, rounded at the apex, with a conspicuous gland.—*L. chilensis.*
Median leaves ovate, acute, mucronate, scarcely glandular.—*L. Doniana.*
Median leaves with a short triangular point; lateral leaves recurved and blunt at the apex, margins strongly recurved. *L. austro-caledonica.*

Libocedrus arfakensis, Gibbs.[1]

A tree 90–115 ft. high with a shapely bole and more or less conical head of branches in sheltered forests in New Guinea. *Bark* red and scaly. *Branchlets* articulate. *Leaves* of juvenile plants light green up to $\frac{1}{5}$ in. long, widening from the base upwards, attaining a width of about $\frac{2}{5}$ in. below the long, slender, spreading, apical point; the lateral pair larger than and almost overlapping the facial pair; leaves of mature plants dark green, shorter, narrow at the base, broad towards the apex which terminates in a short, blunt, non-spreading point. In some cases mature leaves, particularly on fruiting shoots, are small and scale-like. The narrow base and wide apex of the lateral leaves give the shoot its curious jointed character. The *male flowers* are about $\frac{5}{8}$ in. long from the points of short shoots. *Female flowers* appear on different branches of the same plant, and the cones are composed of 4 small pointed scales.

Native of the Arfak Mountains of New Guinea at elevations of 5,500–8,000 ft.

Libocedrus austro-caledonica, Brongniart and Gris.

A small symmetrical tree, never more than 20 ft. high, of narrow pyramidal outline, the branchlets Selaginella-like in appearance. *Leaves* arranged as in *L. Doniana*, but larger, the lateral pairs much larger than the median pairs, thick in texture, closely pressed and overlapping, the apex blunt and recurved, margins strongly recurved; median leaves ending in a short, triangular blunt point. *Cones* not seen.

Native of New Caledonia. Not in cultivation.

R. H. Compton, *Journ. Linn. Soc. Bot.* xlv, 434 (1922).

Libocedrus Bidwillii, J. D. Hooker.

PAHAUTEA.

Cedar.

A tree usually below 70 ft. high, resembling *L. Doniana*, from which it differs chiefly in its smaller size, smaller leaves and cones, and in the four-sided character of the ultimate branchlets. *Cones*

[1] *Phytogeo. and Fl. of Arfak Mountains*, 84–87 (1917).

usually ¼–⅓ in. long; *scales* 4, each with a curved spine on the back.

Found on the Ruahine Mountains of the North Island of New Zealand and in the Middle Island from the Nelson Mountains at 6,000 ft. elevation to Otago, where at Dunedin it descends to 2,000 ft. and at Haast's Pass to 1,000 ft. It is hardier than *L. Doniana*, but is reduced to a bush at the colder elevations or in wet, boggy ground.

Wood soft, brittle, durable, less generally useful than that of *L. Doniana*, but suitable for many kinds of carpentry.

This species is not known to be in cultivation in Britain.

Libocedrus chilensis, Endlicher. (Fig. 66.)

CHILEAN CEDAR.

Thuya andina, Poëppig and Endlicher; T. chilensis, Don.

A small tree up to 50 ft. high in Chile. Trunk short, with a narrow head of branches *Branchlets* slender, compact, the ultimate divisions closely arranged. *Leaves* in 4 ranks, scale-like, closely overlapping, the under-surface marked with a broad band of stomata; lateral pairs larger than, and almost covering the median leaves, which are rounded at the apex with a conspicuous gland. *Cones* solitary, terminating short branchlets; *scales* 4, the lower pair small and reflexed, the other pair ⅓–½ in. long, woody, with a minute boss near the apex. *Seeds* small with narrow wings, 1-2 to each fertile scale.

Allied to *L. Doniana*, from which it differs chiefly in its more plumose habit, finer spray, and by the absence of a spiny process on the back of each cone-scale.

Native of the lower slopes of the Andes of S. Chile to Valdivia, rising to an altitude of 3,500–4,500 ft. in the valley of the Rio Limay below Nahuel-Huapi, where trees 50–60 ft. high were found by Elwes. Seeds were originally sent to Messrs. Low, of Clapton, in 1847.

The fragrant and durable wood is used for general carpentry.

The Chilean cedar is fairly hardy and succeeds in many parts of the British Isles, the best results being obtained by planting it in deep, moist, but well-drained soil, either of a light loamy or peaty nature, in the warmer parts of the country where the atmospheric conditions are moist. Cuttings can be rooted by inserting them in sandy soil in a cold or slightly warmed frame in summer.

Libocedrus decurrens, Torrey. (Fig. 66.)

INCENSE CEDAR.

Heyderia decurrens, Koch; Thuya Craigiana, Murray; T. gigantea, Carrière (not Nuttall).

Bastard Cedar; Californian Post Cedar; Cedar; Juniper; Red Cedar; White Cedar.

A tree 100–150 ft. high, and up to 18 ft. in girth in North

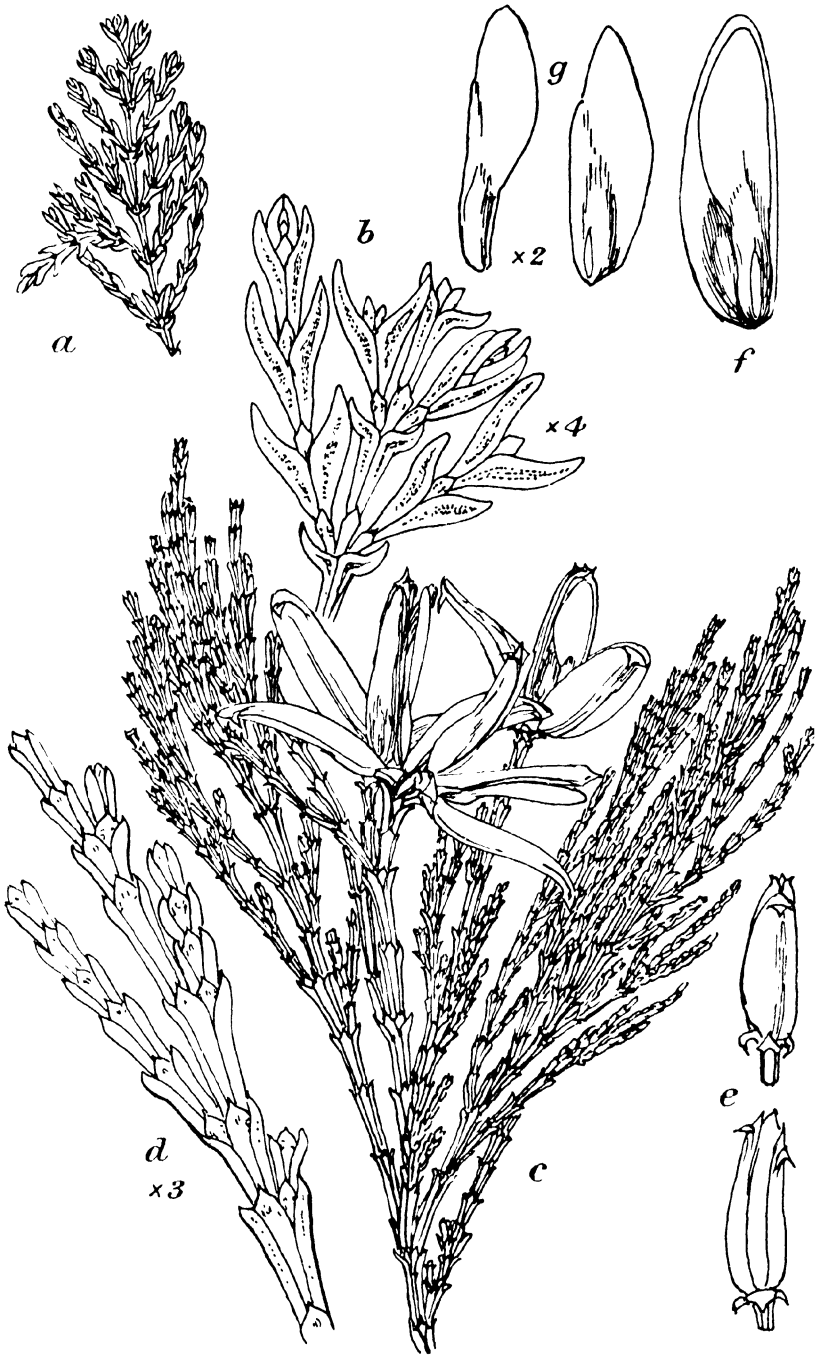

FIG. 66.—*LIBOCEDRUS CHILENSIS* and *L. DECURRENS.*

Libocedrus chilensis.—*a*, spray; *b*, branchlets. *L. decurrens*—*c*, spray with two expanded cones; *d*, branchlets; *e*, cones; *f*, cone-scale with seed; *g*, seeds.

America, with a straight trunk tapering from a broad base. *Bark* ¾–1 in. thick, cinnamon-red, deeply furrowed. Habit broadly pyramidal, but in cultivated trees the branches are usually short and the outline columnar. *Branchlets* flattened, divided into small sprays. *Leaves* dark green, in fours, equal in size, pressed closely to the branchlet except for the short, pointed tip, which is free ; those of the ultimate branchlets about ¼ in. long, those on the main shoots about ½ in. long, the lateral pair boat-shaped and overlapping the facial pair. *Cones* solitary, cylindrical, pendulous, ¾-in. long, ⅜ in. wide, reddish-brown or yellowish brown when ripe ; *scales* 6, the lowest pair short, barely ¼ in. long, triangular, reflexed, the middle pair oblong-lanceolate, fleshy when young, the length and width of the cone, with a minute reflexed point near the apex, concave on the inner side at the base with depressions for the seeds ; the upper pair erect, united into a thick woody partition which is crowned by 3 minute processes. *Seeds* 1–2 to each scale, each with an oblique wing about ¾ in. long, and a rudimentary second wing.

Var. **compacta.**

Differs from the type in its dwarf and more compact habit.

Var. **glauca.**

Leaves with a glaucous hue.

Var. **nana.**

Very dwarf and compact, suitable for the rock-garden.

Var. **variegata.**

Patches of golden leaves occur at irregular intervals about the branches. It is not very effective.

L. decurrens may usually be distinguished in cultivation by its stiff, columnar habit and dark green foliage. It is sometimes confused with *Thuya plicata*, but can be recognized by the less pungent odour of the bruised leaves and by the larger, cylindrical cones.

The incense cedar is found from Oregon along the western slopes of the Cascade and Sierra Nevada ranges to Mount San Pedro Martin in Lower California, mostly at altitudes of 3,000–8,500 ft. It was introduced to England in 1853.

Wood light, soft, fragrant, close-grained, durable in contact with the ground, light reddish-brown in colour with yellowish sapwood. The timber is used for general carpentry, indoor finish of houses, fencing, telegraph poles, furniture, laths, and shingles. As boxwood it should not be used for articles that absorb odour.

L. decurrens has no value as a forest tree in Britain, but its

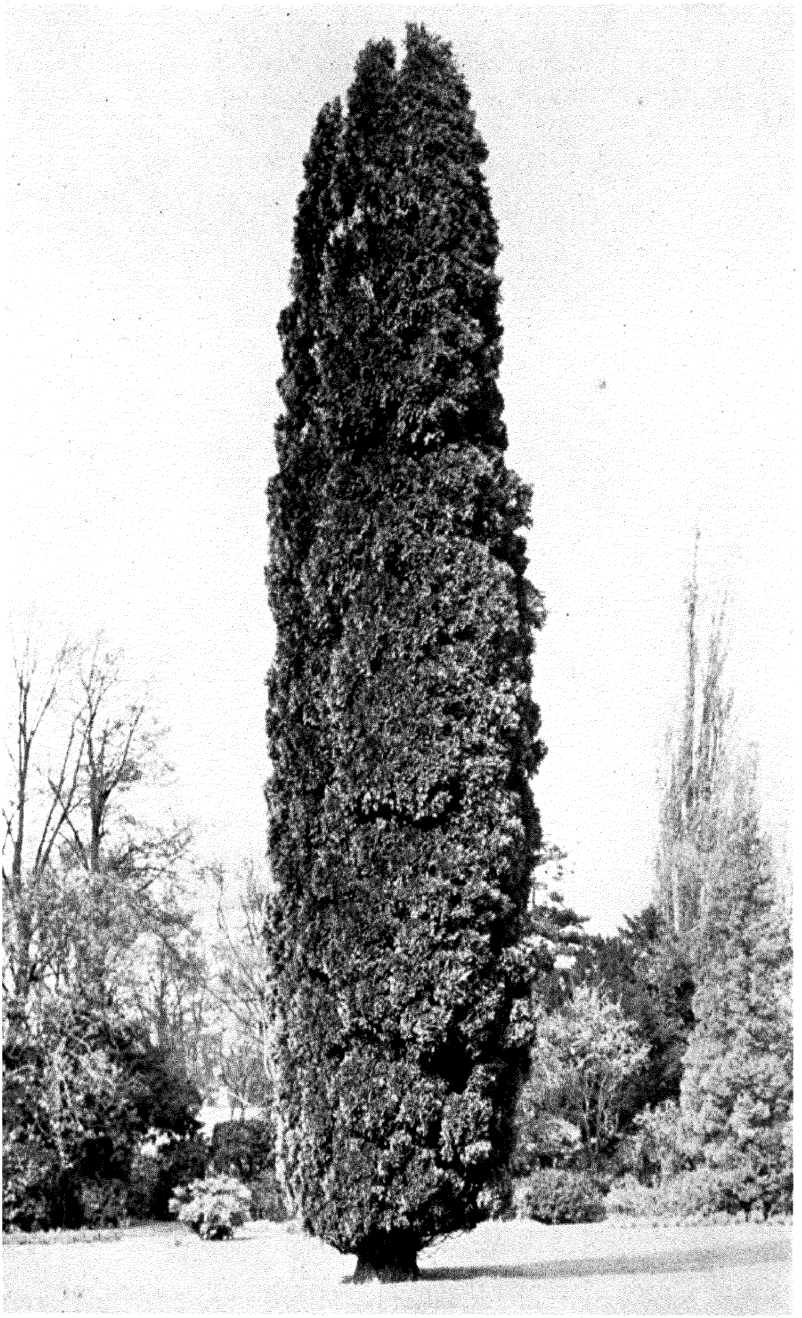

Photo. by J. F. Wallis.

PLATE XV. INCENSE CEDAR (*LIBOCEDRUS DECURRENS*) AT FROGMORE. 78FT. × 12FT. AT 1FT. FROM GROUND IN 1923; PLANTED IN 1857.

characteristic columnar outline and dark green foliage make it of considerable decorative value in gardens. It is perfectly hardy, even on moist, heavy soils where *Thuya plicata* is sometimes injured by frost. The best trees are found in deep, moist, but well-drained loamy soil where the climatic conditions are moist and free from impurities. It may be propagated by seeds and cuttings, the former being the better method.

Clinton-Baker, *Illust. Conif.* ii, 66 (1909).

Libocedrus Doniana, Endlicher.

KAWAKA.

A tree 60–100 ft. high, and 6–12 ft. in girth in New Zealand. *Bark* fibrous, flaking off in stringy patches. *Branchlets* flattened. *Leaves* in 4 rows and of 2 kinds, those in the lateral rows larger than the facial rows; young plants with lateral leaves about $\frac{1}{8}$ in. long, the facial leaves about $\frac{1}{30}$ in. long; on old branchlets they are more equal in size, adpressed and overlapping, the larger about $\frac{1}{6}$–$\frac{1}{8}$ in. long, the smaller about $\frac{1}{20}$ in. long. Cones $\frac{1}{3}$–$\frac{1}{2}$ in. long; *scales* 4, each with a spiny process springing from the back just above the centre. *Seeds* small, 1 to each fertile scale.

Allied to *L. chilensis*, but differing in its less plumose branching and in the spine-like process on the cone-scales.

Native of the Northern Island of New Zealand, and also found in the forests of the Bay of Islands.

Wood fine-grained, often beautifully marked, dark red in colour, durable, easily worked, and suitable for furniture, general building work, posts, shingles, and other purposes. It is, however, too scarce to be of much commercial value.

Hardy in the warmest parts of England, such as S.W. Cornwall, where it may be grown under similar conditions to *Cupressus Lawsoniana*.

Libocedrus macrolepis, Bentham and Hooker.

Calocedrus macrolepis, Kurz.

A tree up to 100 ft. high, with a broadly pyramidal head. *Bark* whitish, scaly. *Leaves* resembling those of *L. decurrens*, but larger and thinner in texture; those on the main shoots up to $\frac{1}{2}$ in. long, ending in a small spine, those of lateral shoots $\frac{1}{4}$–$\frac{1}{3}$ in. long, about $\frac{1}{8}$ in. wide, glaucous beneath, widening from base to apex (giving the shoot a jointed appearance), terminated by sharp teeth. *Cones* elliptical, $\frac{1}{2}$–$\frac{3}{4}$ in. long, on short four-sided, slender shoots up to $1\frac{1}{4}$ in. long; *scales* 6, resembling those of *L. decurrens*. *Seeds* usually 1 to each fertile scale.

Distinguished from *L. decurrens* by its wider branchlets and larger leaves which are glaucous beneath.

Native of the forests of S. Yunnan, China, occurring sparingly in ravines near watercourses at elevations of 4,000–5,000 ft. It is also found wild in Formosa. Introduced by Mr. E. H. Wilson, for Messrs. Veitch in 1899.

The wood is of better quality than that of most of the other species, and is said to be useful for many purposes in China and Formosa. The wood of buried trees is dug up, and is in demand for coffins.

L. macrolepis is scarcely hardy in Britain, but it may be planted with success in the warmer south and south-west counties of England.

Libocedrus papuana, F. v. Mueller.

A little-known species represented by a small specimen in the Kew Herbarium. It apparently belongs to the same group as *L. macrolepis*, the leaves being very similar in size, but less glaucous.

Native of Papua.

Libocedrus tetragona, Endlicher.

ALERCE.

Libocedrus cupressoides, Sargent; Thuya tetragona, Hooker; Pinus cupressoides, Molina.

A tree sometimes 160 ft. high, but usually less than half that height, with a narrow pyramidal habit and thin bark. *Leaves* of uniform size, in 4 ranks, giving the shoot a quadrangular outline; about $\frac{1}{16}$ in. long, closely pressed at the base, free at the tips. *Cones* $\frac{1}{3}$–$\frac{1}{2}$ in. long, borne on short shoots; *scales* 4, brown, lance-shaped, the lower pair very small, downy on the margins, each with a stiff curved spine on the back. *Seeds* small, usually 1 to each fertile scale, distinctly two-winged, the larger one broad and twice as long as the seed, the other short and narrow.

L. tetragona resembles *Fitzroya patagonica* in foliage, but in the former the leaves taper to the apex, whilst in the latter they are widest above. The cones are quite distinct.

Native of the western slopes of the Chilean Andes from latitude 35° southwards on the west end of Lake Nahuel-Huapi at 2,000–3,000 ft. altitude; also common in Patagonia and Tierra del Fuego. It was introduced by William Lobb in 1849, and a specimen of wood collected by him in Patagonia, preserved in the Kew Museums, is marked "used by the Cehilota for fencing, being the most durable wood in the country, tree 30–40 ft. high, seldom 1 ft. in diameter." Another section collected by W. Pearce is said to be part of a railway sleeper. In the Andes the tree delights in cold, moist, elevated positions. Elwes and Henry record a tree 15 ft. high in 1906, at Kilmacurragh, Co. Wicklow.

PICEA, Dietrich.

SPRUCES.

Spruce Firs.

Evergreen trees of large or medium size belonging to the tribe *Abietineæ*, and widely distributed in the temperate regions of the northern hemisphere, occurring in Europe, Asia Minor, the Caucasus, Siberia, China, Japan, the Himalaya, and N. America.

They are of pyramidal outline with tall, gradually tapering trunks which are sometimes prominently buttressed at the base. *Roots* shallow, with long, slender, tough rootlets. *Bark* usually thin and scaly, sometimes furrowed near the base of old trees, *Branches* whorled, usually small. *Branchlets* slender, the surface roughened by prominent, persistent, peg-like projections left by the fallen leaves. *Winter buds* usually dry, not resinous. *Leaves* needle-like, angled or flattened, persisting for several years (but falling readily from cut or dried specimens), with 1 or 2 resin ducts. *Male and female flowers* appearing in spring on different branches of the same tree in the leaf-axils of the previous year's shoots. *Male catkins* ovoid or cylindrical, erect or drooping, yellow or crimson in colour, composed of numerous spirally arranged stamens. *Female flowers* arising from the ends of the shoots, violet or purple in colour when growing, with numerous pointed or rounded scales bearing two ovules at the base of each. *Cones* pendulous, ripening during the first autumn when they open and liberate the seeds, but remain on the tree for some time after the seeds have fallen; *scales* persistent, with crenate, entire or lobed margins; bracts minute. *Seeds* small, with a well-developed wing. *Cotyledons* 4–15.

The spruces are distinguished from the firs by their woody, peg-like leaf bases, which persist on the shoot after the leaves have fallen, and by the pendulous cones which do not break up when ripe.

Thirty-eight species have been described, no less than 18 of these being confined to Cent. and West China. Some of the newer Chinese species are very difficult to separate. Most of them have been raised in English gardens from Wilson's seeds under a variety of names, and several, so far as we can judge from juvenile plants, appear to be identical. This may be partly due to the fact that the seeds have been mixed, but it is probable that when the trees in cultivation reach the coning stage, and become better known, the newer species will be considerably reduced in number. In the common spruce it is well known that individual trees often show considerable variation in habit, foliage, size of cones, and shape of cone-scales, and the same remarks apply to more than one Chinese species.

The genus is naturally divided into two groups, characterized as follows :—

1. **Eu Picea.**—Leaves more or less four-sided, with stomatic lines on all four surfaces.

2. **Omorica.**—Leaves flattened. Stomata usually on the inner surface only.

Wood soft, resonant, odourless, long-fibred, fine, medium- or coarse-grained, white or rarely pinkish, slightly resinous, resin ducts few and scattered, visible with a lens, heartwood and sapwood not well marked, knots often loose ; works well, takes glue well, and finishes with a satiny surface. Distinguished from fir (*Abies*) by the presence of resin ducts. *Applications* numerous, including general indoor joinery and carpentry, aircraft construction, boxes, scaffold poles, pit-props, sounding-boards for violins and other musical instruments, the tops of kitchen and dairy tables, matchwood, match-boxes, toys, carving, paper pulp, and, when split into shavings, for the manufacture of hats and baskets. " Burgundy pitch " is the refined resin of *P. excelsa* and " Swiss turpentine " is distilled from the leaves and branches. " Spruce " or " Spruce beer " is a fermented liquor made from an extract of the twigs and leaves of spruce mixed with treacle and other sugary products. The pliable roots have been twisted into ropes and fishing lines.

Spruces succeed in wet, cold, and shallow ground, and are suitable for places where pines will not grow. They withstand a good deal of exposure and are fairly good windbreaks. They bear shade well when young. When planted close together the small lower branches die and fall away naturally, the trees developing with long, slender, clean trunks. Under forest conditions spruces are usually spaced 3½ or 4 ft. apart. Isolated specimens may retain their lower branches until late in life. Spruces are unlikely to succeed on hot dry land or in the vicinity of smoky towns. Several species form handsome decorative trees, and they are employed for that purpose in parks and gardens. On low-lying land in exposed places the soft young shoots are sometimes injured by late spring frosts. The spruces are propagated by seeds which may be sown in pots or boxes, or, when large numbers of plants are needed, in well-prepared nursery beds during March or early April. Seedlings may stand two years in the seed-bed if not very close together, and must then be lined out in nursery borders. For forest work, permanent planting should be carried out when the plants are 9–12 in. high ; in gardens, specimens 3–4 ft. high can be used, provided they have been transplanted every alternate year while in the nursery. Well-grown, healthy trees should be selected as seed-bearers.

Spruces are sometimes injured by aphides. *Chermes abietis*, an aphis covered with a white, fluffy exudation, punctures the

partly developed leaves and lays its eggs in them, thus causing the leaf-bases to swell, enclosing the eggs, and later the larvæ, and producing small, pineapple-like galls. The only known means of coping with this disease on a wide scale is to fumigate all stock before removing it from the nursery. Decorative trees may be sprayed with paraffin emulsion once every 8–10 days over a period of 6 weeks from the time when growth begins in spring. Another pest is the spruce aphis (*Aphis abietina*), a small green fly, which causes the leaves to fall prematurely and eventually kills the plants. Regular spraying with a reliable insecticide is the only known means of checking this disease. Nursery stock should be fumigated with hydrocyanic gas before distribution. It is desirable that a sharp watch should be kept for this insect, as it is spreading rapidly in some parts of the country and doing much harm in plantations of Sitka spruce, not only amongst newly planted trees but in well-established plantations.

Note.—Great confusion has arisen owing to the different senses in which the names *Picea* and *Abies* have been used by different writers. By modern botanists the genus *Abies* is now made to include all the silver firs and *Picea* the spruces. In many nurseries and gardens, however, the arrangement proposed by Loudon and Gordon, of including spruces under *Abies* and the silver firs under *Picea*, is still followed; such an arrangement should be discontinued.

In the flat-leaved spruces, in which the stomatic surface is morphologically the upper one, the twisting of the leaves on their bases on the horizontal shoots in order to direct their upper surfaces downwards differs from the arrangement in *Abies*, *Tsuga* and *Pseudotsuga*, where the stomatic leaf surface is morphologically the under one.

Key to Picea.

Leaves flattened, stomatic lines on one surface only.
- Young shoots without hairs.
  - Leaves on lower side of shoot arranged in two lateral sets, exposing the shoot below.
    - Young shoots buff-coloured, becoming darker in second year; leaves bright green, silvery white beneath; slightly keeled on both surfaces.—*P. brachytyla.*
    - Young shoots pale buff, becoming red in second year. Leaves dark green, silvery white beneath, slightly keeled on both surfaces.—*P. jezoensis.*
    - Young shoots yellowish, showing darker in second year, deeply keeled on dorsal surface, almost convex on ventral white surface, needle-like, very prickly.—*P. sitchensis.*

Leaves somewhat radially arranged (spreading all round the shoot), but closely overlapping on the upper side of the shoot.

Young shoots slender, glabrous, yellowish grey ; leaves distinctly keeled on both surfaces and ending in a sharp point.—*P. morindoides.*

Young shoots hairy.

Shoots pendulous ; leaves greyish green, radially arranged, 1–1¼ in. long, convex on both surfaces.—*P. Breweriana.*

Shoots not pendulous ; leaves bright green, more crowded on upper side of shoot than below, ½–¾ in. long.—*P. Omorika.*

Leaves quadrangular or rhombic, stomatic lines on all four surfaces.

Leaves radially arranged (spreading all round the shoot), shoots usually glabrous.

Shoots pendulous, greyish ; buds large resinous, ½ in. long, pointed ; leaves slender, about 1½ in. long.—*P. Morinda.*

Shoots reddish brown ; buds small, resinous, ⅕ in. long ; leaves ⅜–½ in. long.—P. *Maximowiczii.*

Shoots reddish brown, glabrous, or with scattered glandular hairs ; buds conical, shining brown, resinous.—*P. Koyamai.*

Shoots reddish brown ; buds conical, acute, resinous, ¼–⅓ in. long ; leaves stiff, ½–¾ in. long.—*P. asperata.*

Shoots greyish, terminal bud dome-shaped, outer scales hairy ; leaves rigid, pointing forward, ¾–1¼ in. long.—*P. Schrenkiana.*

Shoots glaucous, becoming reddish brown ; buds with tips of scales reflexed ; leaves prickly, ¾–1¼ in. long.—*P. pungens.*

Shoots yellow ; buds shining reddish brown ; leaves stout, rigid, curved, spine-pointed.—*P. polita.*

Leaves on lateral branches overlapping on upper side of shoot, those below spreading outwards in two lateral sets,

Shoots glabrous or slightly hairy.

Shoots greyish or pale brown, usually glaucous ; leaves disagreeable in odour when bruised, about ½ in. long, stomatic lines equal.—*P. alba.*

Shoots pale brown or buff-coloured, not glaucous ; leaves ½–¾ in. long, stomatic lines unequal.—*P. bicolor.*

Shoots ashy or pearly grey ; leaves very narrow, needle-like, dark shining green up to about 1 in. long, stomatic lines inconspicuous.—*P. Wilsoni.*

Shoots reddish ; terminal bud conic, acute, non-resinous, outer bud scales keeled, minutely hairy ; leaves ¾–1 in.

long, bluntly pointed, with 2 to 3 stomatic lines on each side.—*P. excelsa.*

Shoots greyish yellow, glabrous or with minute hairs on the pegs from which the leaves arise; buds slightly resinous, with entire rounded scales.—*P. Albertiana.*

Shoots conspicuously hairy.

Terminal bud with awl-shaped outer scales equalling or exceeding the bud in length.

Shoots covered with short glandular hairs; foliage bluish or glaucous green, about ½ in. long.—*P. nigra.*

Shoots as in *P. nigra*; leaves yellowish or dark green, curved, ½–⅝ in. long.—*P. rubra.*

Shoots reddish with short non-glandular hairs, leaves slender, ⅓–½ in. long.—*P. Glehni.*

Terminal bud without awl-shaped scales or these do not equal the bud in length.

Shoots greyish or pale brown, often densely bristly; leaves sub-compressed, often bevelled at apex, ½–¾ in long, buds often resinous, stomatic lines unequal.—*P. likiangensis.*

Shoots pale brown, densely pubescent. Leaves ¼–½ in. long, dark shining green, blunt and bevelled at the tip.—*P. orientalis.*

Shoots greyish yellow with minute glandular hairs, smelling disagreeably when bruised, leaves ⅞–1 in. long.—*P. Engelmanni*

Shoots reddish brown with minute non-glandular hairs; leaves ⅗–¾ in. long, with 3–4 stomatic lines on each side.—*P. obovata.*

Picea alba, Link.

White Spruce.

Picea canadensis, Britton, Sterns and Poggenberg; P. nigra, var. glauca, Carrière; Abies alba, Michaux; A. canadensis, Miller; Pinus alba, Lambert; P. canadensis, Duroi (not Linnæus).

Canadian Spruce; Cat Spruce; Double Spruce; Single Spruce; Skunk Spruce; Spruce Pine.

A tree 70–100 ft. high, and 9–12 ft. in girth at its best in N. America, but usually 50–70 ft. high, and 3–4 ft. in girth, becoming shrubby at its northern limit. *Bark* thin, ¼–½ in. thick, greyish brown, scaly. *Branches* long, thick, bending downwards at the trunk, the points upturned. *Young shoots* slender, without down, or in the far north-western forms sometimes finely downy,[1] often glaucous, becoming dark yellowish brown or pale brown

[1] Sudworth, *The Spruce and Balsam Fir Trees of the Rocky Mountain Region*, p. 8, (1916).

in their second season, usually emitting, with the leaves, a fœtid, mouse-like odour when bruised. *Winter buds* up to ¼ in. long, with rounded, chestnut-brown scales. *Leaves* persistent for several years, crowded on the upper side of the shoot, pale green or glaucous, about ½ in. long, incurved, ending in an acute or roundish horny point; quadrangular in section, with stomata on all sides. *Cones* cylindric, blunt, 1–2½ in. long, and ½–¾ in. in diameter, green when growing, pale brown when ripe; *scales* few, loosely overlapping, roundish or oval, ⅓ in. broad, very thin and flexible, margin rounded or truncated. *Seed* ⅛ in. long with a wing ⅜ in. long, partly embracing the seed.

Var. **arctica,** Kurz.

Leaves thicker and cones smaller than in the type, the cone-scales being more rounded and the bracts of a different shape.

Var. **aurea.**

Leaves and shoots golden yellow.

Var. **cœrulea,** Carrière.

Habit densely pyramidal. Foliage conspicuously glaucous. Leaves pressed against the shoots. Often found as a seedling.

Var. **cœrulea Hendersoni.**

Like the last in habit. Young shoots horizontal, the older ones pendulous. A fine form.

Var. **compacta.**

Habit dwarf and compact.

Var. **echiniformis.**

Habit dwarf and compact. Leaves more spiny than in the type.

Var. **monstrosa.**

Branches loose and abnormal.

Var. **nana,** Loudon.

A bushy form of compact habit.

P. alba may generally be recognized without difficulty by its bluish, disagreeably smelling foliage. It is easily known from *P. nigra* and *P. rubra* by its usually hairless shoots, the different buds which have no awl-shaped outer scales and larger cones.

The white spruce has a wide distribution in Canada and the N. United States, reaching, according to Sargent, from Labrador

to Alaska and spreading southwards down the Atlantic coast to S. Maine, N. New Hampshire, Vermont, New York, Michigan, Wisconsin, and Dakota ; its most southerly limit being in Massachusetts. It is the most important timber tree in the forests of Cent. Alaska, and succeeds even where the soil is permanently frozen 2–3 ft. beneath the surface. It is said to have been introduced into Europe by Bishop Compton in 1700.

Wood creamy-white or straw-coloured, straight and even-grained, long-fibred, soft, easily worked, finishing with a satiny surface. It is used extensively for the indoor finish of houses, joinery and boxmaking ; selected qualities being employed for aircraft, for sounding boards for pianos and violins, and for organ pipes, but probably the largest quantity is consumed in the manufacture of paper pulp. It is one of the principal economic woods of Newfoundland and E. Canada, where, with the wood of *P. nigra* and *P. rubra*, it furnishes a large proportion of wood pulp. For this purpose the wood is reduced to cellulose either by a mechanical or chemical process, full accounts of which are given by Nelson Courtlandt Brown (*Forest Products, their Manufacture and Use*). The quantity of spruce wood used for pulp in N. America in 1916 is there given as 3,101,660 cords, and the yield of pulp from a cord of wood is stated to be 1,600–2,200 lb., manufacturers usually estimating a yield of about 2,000 lb. of air-dry pulp from spruce, the yield by the mechanical process being higher than by the chemical process. Spruce pulp in Newfoundland, Canada, and N.E. United States is used extensively in the manufacture of newspaper.

Strength tests conducted in the Forest Products Laboratory, Canada, and published in the *Empire Timber Exhibition Catalogue* (London, 1920), give the following results : --

Weight, green (moisture 25 per cent., wood 75 per cent.), 28½ lb. per cu. ft.

Tension, strength across grain, 300 lb. per sq. in.

Compression, strength across grain at elastic limit, 229 lb per sq. in.

Compression, crushing strength with the grain, 2,540 lb. per sq. in.

Shearing strength with grain, 630 lb. per square in.

Bending, modulus of elasticity (stiffness), 1,139,000 lb. per sq. in.

Hardness, weight required to half-imbed a 0·444 in. steel ball, 278 lb.

The wood of *P. alba*, *P. nigra*, and *P. rubra* appears to be often mixed in commerce. Canadian spruce is obtainable in four qualities and is shipped from Quebec, Montreal, and other ports. In 1916 [1] the total cut of spruce in the United States amounted

[1] Nelson Courtlandt Brown, *loc. cit.* 4–8.

to 1,250,000,000 board ft., and the standing spruce timber in the United States at that period was estimated at 60 billion board ft.

The white spruce occurs naturally on moist but well-drained land from sea-level to an elevation of 5,000 ft. Very wet or very dry land exerts a dwarfing influence. It is often found pure in extensive forests, but also occurs in mixed stands. *P. alba* withstands a good deal of shade in its earlier years, and suppressed trees make a good recovery when given additional light. A moderate crop of seed is borne every year with heavy crops every 5–8 years. Natural reproduction is said to be good[1] under mature spruce on damp moss over organic soil, and on moss-covered decayed logs and stumps. White spruce reproduces itself poorly on deep leaf-litter of broad-leaved trees.

P. alba is chiefly useful in Britain by reason of its great cold-resisting qualities, and is used sparingly in some parts of the N. of England and in Scotland for silvicultural work in cold, exposed positions at high altitudes, particularly for shelter. As a timber tree in Britain, however, it is inferior to *P. excelsa* and *P. sitchensis*. For ornamental purposes it is scarcely equal to European spruce, and is shorter-lived in England. In N. America its natural age is 250–300 years.

Clinton-Baker, *Illust. Conif.* ii, 34 (1909).

Picea albertiana, Stewardson-Brown.[2] (Fig. 67.)

A tree 160 ft. high in W.N. America. *Bark* fissured, at the base of old trunks thin and greyish, white higher up where it scales off in squarish plates. *Young shoots* light yellow or greyish, becoming darker with age; glabrous or with minute hairs on the pegs from which the leaves arise. *Buds* about $\frac{1}{5}$ in. long, ovoid, slightly resinous, with rounded scales, the terminal bud with long-pointed scales at its base. *Leaves* bluish green, spreading more or less round the shoot, but more crowded on the upper side, $\frac{1}{2}$–1 in. long, curved, shortly pointed, quadrangular in section, with 3–5 lines of stomata on each side. *Cones* cylindrical, 1–2$\frac{1}{4}$ in. long, about 1 in. wide when the scales are open, shining brown at maturity, with thin flexible fan-shaped scales which are flatter than those of *P. alba*, the upper margin entire, undulate or faintly toothed. *Seed* $\frac{1}{8}$ in. long with a wing $\frac{1}{2}$ in. long.

Var. conica, Bean.

Picea glauca, Voss, var. albertiana, Sargent, forma conica, Rehder.

A dense bush of narrow, conical habit, with slender, closely packed shoots which are yellowish grey at first and slightly

[1] Sudworth, *loc. cit.* 10. [2] Torreya, vii, 126 (1907).

hairy. *Leaves* slender, more or less curved, up to about $\frac{1}{2}$ in. long, tapering into a spiny point.

A most distinct and interesting pigmy conifer, first collected near Laggan, Alberta, in 1904, by J. G. Jack, and only recently introduced into cultivation.

P. albertiana is a somewhat critical species allied to *P. alba*, of which it may be a western form. It is distinguished by its resinous buds, occasionally hairy shoots, and different leaf arrangement.

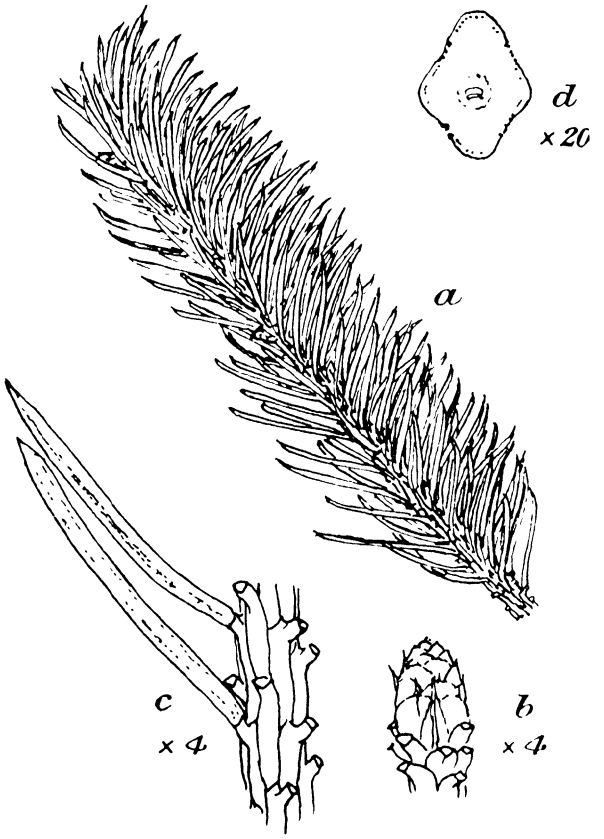

FIG. 67.—*PICEA ALBERTIANA*.

a, spray in profile; *b*, winter bud; *c*, portion of shoot and two leaves; *d*, section of leaf.

As a wild tree it extends from Wyoming and W. Montana to Alberta and British Columbia, and in the Rocky Mountains is found at elevations ranging from 3,000 to 5,000 ft. It attains larger dimensions than any other N. American spruce except *P. sitchensis*, and occasionally forms extensive forests.

It was introduced in 1906 by Elwes, who obtained seeds from Ottawa, and small plants have been distributed to various gardens in the country.

The timber does not appear to be separated from other species for commercial purposes.

The type will probably form a decorative tree in Britain, whilst the variety *conica* is suitable for the rockery.

Elwes and Henry, *loc. cit.* vi, 1385 (1912).
Var. *conica*, *Gardeners' Chronicle*, May 7 and 28, 1921.

Picea asperata, Masters. (Fig. 68.)

Picea montigena, Masters; *P. retroflexa*, Masters.

A tree up to 100 ft. high or more in Western China, resembling the common spruce in habit. *Bark* greyish chestnut and rough, peeling off in thin, irregularly shaped flakes. *Young shoots* pale shining yellowish brown, deeply grooved, changing to grey as they become older, mostly glabrous in cultivated plants, but occasionally hairy in native specimens. *Winter buds* conical, $\frac{1}{4}$-$\frac{1}{3}$ in. long, often swollen at the base, the upper scales sometimes recurved at the apex. *Leaves* spreading all round the shoot quadrangular, stiff and prickly, $\frac{1}{2}$–$\frac{3}{4}$ in. long. *Cones* 3–5 in., long, fawn grey when ripe, becoming chestnut brown with age. *Scales* variable in shape, rounded, truncate or rhombic at the summit.

Var. *notabilis*, Rehder and Wils., is a name applied to those forms in which the cone scales are gradually narrowed or abruptly contracted at the apex.

Var. *ponderosa*, Rehder and Wils., differs in its much larger cones.

According to Wilson, this is the common quadrangular-leaved spruce of N.W. Szechuen, W. China, and is especially abundant in the department of Sungpan Ting, where extensive forests occur.

The following five plants appear to be closely allied to *P. asperata*, but we have not seen them in cultivation.

Picea aurantiaca Masters and *P. Neoveitchii* Masters, of which we have seen native specimens, appear to be closely allied if not identical with *P. asperata*.

Picea gemmata, Rehder and Wilson. A Chinese spruce which is said to differ from P. *asperata* in its densely hairy shoots, its broader cone-scales, and also in its bark. Recorded from W. Szechuen.

Picea heterolepis, Rehder and Wilson. This spruce is also found in W. Szechuen. It is described as having bright, orange-brown, hairless shoots, elongated buds with loosely overlapping,

reflexed scales, and two-lobed cone-scales. It is closely related to if not identical with P. *asperata*, which grows in the same region.

Picea Meyeri, Rehder and Wilson. A square-leaved spruce

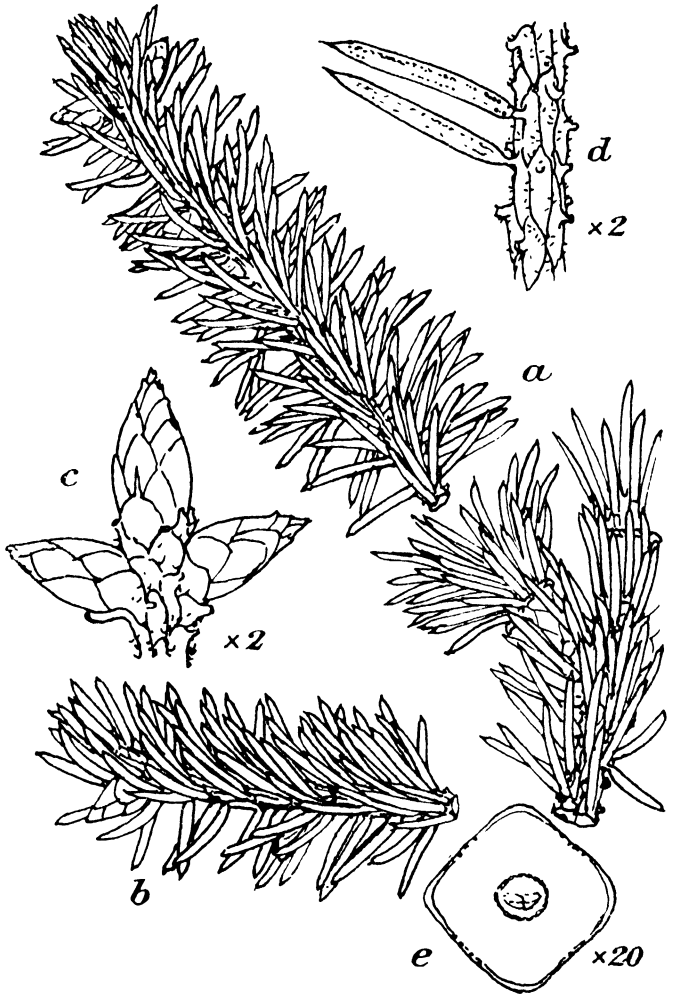

FIG. 68.—*PICEA ASPERATA*.

a, spray from above, *b* from side; *c*, winter buds; *d*, under-side of leaves and shoot; *e*, section of leaf.

from Shensi, a specimen of which has been kindly sent us by Mr. E. H. Wilson. It is very like the plant named *P. gemmata*, but has curved, non-pungent leaves and smaller cones.

Pl. Wils. ii, 24 (1914).

Picea bicolor, Mayr.

ALCOCK'S SPRUCE.

Picea Alcockiana, Carrière; Abies Alcoquiana, Veitch ex Lindley (in part).

A tree attaining 80 ft. high in Japan. *Bark* grey or grey-brown, breaking into small scales *Branches* slender, horizontal, often slightly ascending, forming a tree with a broadly pyramidal crown. *Young shoots* whitish at first, becoming light brown or buff-coloured in the second year, and eventually darker in colour. Weak lateral shoots often without hairs, but terminal shoots more or less hairy. *Buds* ovoid or conic, about $\frac{1}{5}$ in. long, with obtuse, closely overlapping scales. *Leaves* arranged like those of *P. excelsa*, $\frac{1}{2}$–$\frac{3}{4}$ in. long, stiff, quadrangular in section, mucronate, with 5 or 6 white lines of stomata on each of the two upper sides and two narrower bands of about 2 lines each on the lower sides. *Cones* ovoid-cylindric, stalkless, 3–4 in. long, 1–1$\frac{1}{4}$ in. wide, pale reddish purple when growing, becoming brown when ripe; *scales* obovate to rhombic, appressed or more or less reflexed at the apex, which is broad or rounded and toothed. *Seed* $\frac{1}{5}$–$\frac{1}{4}$ in. long, wing $\frac{3}{5}$ in.

Var. **acicularis**, Shirasawa and Koyama.[1]

Distinguished from typical *P. bicolor* by its densely crowded, long, linear and mostly incurved, bluish-white leaves, and by its entire smooth and not undulated cone-scales. It is found in the region of Mount Shirane, Cent. Japan.

Var. **reflexa**, Shirasawa and Koyama.[2]

Habit very similar to that of typical *P. bicolor*, but the tips of the cone-scales are reflexed. It is found in the region of Mount Shirane, Cent. Japan, at elevations of 4,500–6,000 ft.

As a native tree this spruce occurs in the mountains of Cent. Japan, where it was discovered in 1861 by John Veitch, who named it after Sir Rutherford Alcock, his companion on the expedition, but unfortunately the specimens collected at the time included the leaves of *P. jezoensis* and the cones of *P. bicolor*, and Lindley's original description of *Abies Alcoquiana* covers both species. Seeds were also sent out under this name, which accounts for *P. jezoensis* being often called *P. Alcoquiana* in gardens.

P. bicolor does not appear to be of much economic importance in Japan, as it is rather scarce and confined to regions where timber extraction is difficult. The wood, however, is probably mixed with that of *P. jezoensis*.

[1] *Gard. Chron.* Aug. 14, 1915, p. 98.
[2] *Gard. Chron., loc. cit.*, p. 99.

It is of no value for commercial planting in Britain, but is sometimes found in gardens and in scientific collections. Plant in moist, loamy soil where clean atmospheric conditions prevail.

Wilson, *Conifers of Japan*, p. 42 (1916).

Picea brachytyla, Pritzel. (Fig. 69.)

Picea ascendens, Patschke; P. complanata, Masters; P. pachyclada, Patschke; P. Sargentiana, Rehder and Wilson; Abies brachytyla, Franchet.

A tree 35–80 ft. high, pyramidal in habit when growing in woods, but commonly round-headed in more open country. *Bark* pale grey or grey brown, smooth on young trees, but becoming dark grey and patchy on old trunks. *Branches* relatively long and horizontally spreading, ascending at the tips. *Branchlets* pendulous. *Young shoots* slender, pale brown or buff-coloured, shining, glabrous, or occasionally hairy, becoming darker with age. *Buds* numerous, small, ovoid, about $\frac{1}{8}$ in. long, with rounded, chestnut-brown, closely-pressed scales. *Leaves* crowded and closely overlapping on the upper side of the shoot, those on the lower side spreading outwards in two opposite ranks and exposing the shoot; often rigid, green to yellowish green, $\frac{1}{2}$–$\frac{3}{4}$ in. long, flat, but slightly ridged on each surface, conspicuously bluish white beneath with two broad bands of stomata; apex bluntish or with a sharp, horny point. *Cones* cylindric-oblong, $2\frac{1}{2}$–$3\frac{1}{2}$ in. long, greenish, tinged with purple when growing, dull brown when mature; *scales* broad and rounded at the summit (*forma latisquamea*) or more or less narrowed to a blunt, wavy apex (*forma rhombisquamea*). *Seeds* $\frac{3}{16}$–$\frac{1}{4}$ in. long with a slightly longer wing.

This handsome spruce, which may be recognized among the flat-leaved species by its pale brown shoots, numerous chestnut-brown ovoid buds, and leaves glaucous white beneath, occurs over an extensive area in W. Hupeh and W. Szechuen, from 5,000–7,500 ft. alt.; but has been ruthlessly cut for its timber, and is now much rarer than formerly.

We are unable to make out any satisfactory differences between the Chinese species of the Omorica section, enumerated by Rehder and Wilson,[1] and they are accordingly here treated as a single species, exhibiting two types of cone-scale as indicated above. A careful study of the native specimens which have been compared with cultivated plants raised from Chinese seed shows that the characters relied upon to distinguish the species, including the hairiness of the shoots, length of leaves and shape of cone-scales, are in no way co-related and invariably break down when a sufficient number of examples are examined. In an extensive area of common spruce (*P. excelsa*) quite as much variation can be seen in habit, foliage, size of cones, and size and shape of cone-scales.

[1] *Pl. Wils.* ii, 33–35 (1916).

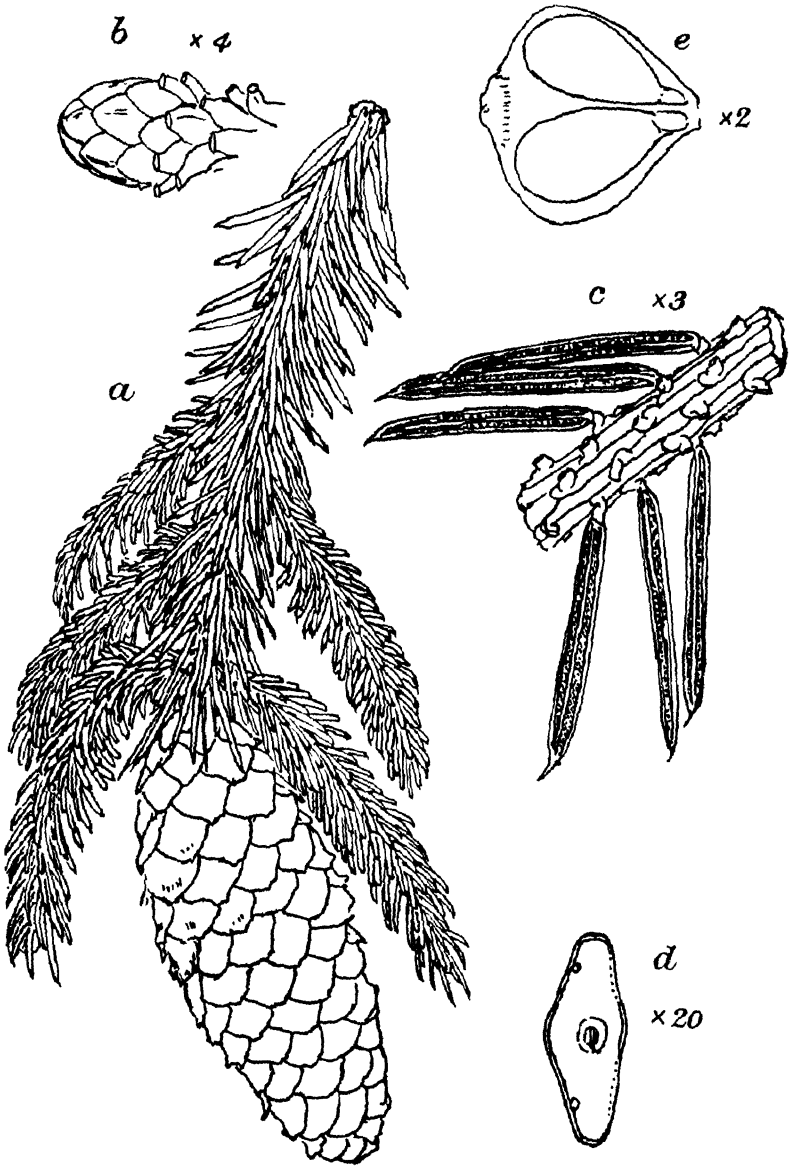

FIG. 69.—*PICEA BRACHYTYLA.*

a, spray with cone; *b*, winter bud; *c*, under-side of shoot and leaves; *d*, section of leaf; *e*, cone scale and seeds.

Picea Breweriana, Watson. (Fig. 70.)

BREWER'S WEEPING SPRUCE.

A tree 80–120 ft. high, with a girth of 6–9 ft. and a trunk much enlarged at the base. *Bark* grey and flaky, resembling that of

a larch. *Habit* remarkably distinct, the narrow crown ending in a spike-like point which bears short, upcurving branches. *Lower branches* with a downward tendency; branchlets pendulous, slender, and whip-like, 6–8 ft. long and about the thickness of a

FIG. 70.—*PICEA BREWERIANA*.

a, spray from above, *b* from side; *c*, winter bud; *d*, under-side of shoot and leaf; *e*, section of leaf, showing two resin canals.

lead pencil. *Buds* dome-shaped, obtuse, about $\frac{1}{8}$ in. long. *Young shoots* with greyish hairs. *Leaves* flattened, spreading all round the shoot, about 1–$1\frac{1}{4}$ in. long, convex on both surfaces, blunt or slightly pointed; dorsal surface dark shining green, ventral surface with lines of stomata on each side of the midrib. *Cones*

oblong, narrowed at each end, 2½–5 in. long, ¾–1 in. broad, green when young, purple before ripening, russet brown when mature; *scales* broadly ovate, ultimately reflexed, with entire, rounded margins; bracts minute, concealed, oblong, toothed on the upper margin. *Seed* with a wing about three times its length.

P. Breweriana may be distinguished among the flat-leaved spruces by its markedly weeping habit, hairy shoots, and leaves convex on both surfaces. It is the rarest of all the spruces, being confined to a few isolated localities in the Siskiyou Mountains of N.W. California and S.W. Oregon, extending, according to Jepson, from N. Trinity County through the Siskiyous northward to the mountains south of Rogue River and westward to the Oregon coast range.

This beautiful tree was probably discovered in 1863 by Professor Brewer, of Yale University, after whom it is named, but it was not described until found again some twenty years later by Mr. T. Howell, an Oregon botanist.

P. Breweriana has been in cultivation since 1897, when a small plant was sent to Kew from the Arnold Arboretum. In 1905 it was 2½ ft. high. At the present time (1923) it is 14½ ft. high, and the branches are 11½ ft. across near the base. It first bore cones in 1920. Mr. F. R. S. Balfour brought home from S.W. Oregon in 1908 a number of wild lifted plants, some of which he has since distributed to various gardens. At Dawyck in Tweeddale he has several of these trees, which thrive extremely well. Although it is more vigorous than some of the better-known species it is a slow-growing though perfectly hardy tree, thriving in good, moist, loamy soil. The Kew plant is growing in light, loamy soil containing a little peat.

Wood soft, close-grained, compact, light brown, shining, and the heaviest of the spruces, but the timber is too scarce to be of any economic value.

Jepson, *Silva of California*, 111 (1910); Sudworth, *Trees of the Pacific Slope*, 84 (1908).

Picea Engelmanni, Engelmann.

ENGELMANN SPRUCE.

Abies alba, Torrey; A. Engelmanni, Parry; A. nigra, Engelmann (not Link); Pinus commutata, Parlatore; P. Engelmanni, Engelmann.

Arizona Spruce; Balsam; Mountain Spruce; White Pine; White Spruce.

An alpine spruce attaining in N. America a height of 150 ft. and a girth of 15 ft., but generally of much smaller dimensions, with a narrow spire-like crown. *Bark* reddish, resinous and scaly. *Young shoots* greyish yellow, with minute scattered hairs. *Buds* conical, about ⅛ in. long, with rounded scales. *Leaves* similar to those of *P. excelsa* in arrangement, grey-green or blue-

Photo by I. B. S. Balfour, Esq.

PLATE XVI. *PICEA BREWERIANA* IN THE SISKIYOU MOUNTAINS, OREGON.

green in colour, soft to the touch and flexible, $\frac{7}{8}$–1 in. long, ending in a sharp horny point, with a peculiar fœtid odour when bruised, four-sided, with several stomatic lines on each side. *Cones* ovoid-cylindric, variable in size, $1\frac{1}{2}$–3 in. long, $\frac{3}{4}$–1 in. wide, green tinged with crimson when fully grown, becoming eventually shining brown ; *scales* thin with toothed margins. *Seed* about $\frac{1}{10}$ in. long, with a wing three times that length.

Var. **Fendleri,** Henry.

A variety based on a tree in the spruce collection in the Kew Pinetum. It differs from *P. Engelmanni* in having pendulous young branchlets and slender leaves, 1–$1\frac{1}{8}$ in. long, which spread equally round the shoot. This tree is similar to *P. Morinda* in habit and leaf-arrangement, but the buds and shoots are quite distinct.

Var. **glauca.**

Leaves glaucous with a rich blue-green colour.

Var. **microphylla,** Hesse.

A shrub bearing shorter leaves than those of the typical form.

P. Engelmanni resembles *P. alba* in the peculiar odour of the foliage, but the latter species has usually glabrous shoots and more rigid leaves. It is also like *P. pungens* in foliage, but the leaves in that species are prickly and the shoots without down.

It has a wide distribution in W.N. America, occurring at altitudes varying from 3,000–11,500 ft. in the Rocky Mountains from Alberta and British Columbia to Arizona and New Mexico, and westward to the Cascade Mountains of Washington and Oregon, often forming pure forests. The species was discovered in 1862 on Pikes Peak, Colorado, by Dr. Parry, and introduced into England in 1864, but is apparently rare in cultivation.

Wood straw-coloured, soft, rather weak, straight-grained, easily worked, finishing with a fine satiny surface, rather like that of *P. alba*, but obtainable in larger dimensions. It is sometimes mixed with wood of *P. sitchensis*, but is inferior in strength and is recognized by its lighter colour and by there being no distinct difference between sapwood and heartwood, as in the Sitka spruce. In British Columbia alone in 1918 the available timber of this species was estimated at 56 billion board ft.[1]

The following results of tests on green material were made by the U.S.A. forest officers :[2]

" Weight, green (moisture 25 per cent., wood 75 per cent.), $25\frac{3}{4}$ lb. per cubic ft.

" Tension, strength across the grain, — lb. per square in.

[1] Whitford and Craig, *Forests of British Columbia*, 200 (1918).
[2] Cat. Emp. Timb. Exhib., Lond. (1920).

"Compression, strength across grain at elastic limit, 290 lb. per square in.

"Compression, crushing strength with the grain, 1,980 lb. per square in.

"Shearing, strength with the grain, 590 lb. per square in.

"Bending, modulus of rupture (breaking strength), 4,200 lb. per square in.

"Bending, modulus of elasticity (stiffness), 830,000 lb. per square in.

"Hardness, weight required to half imbed a 0·444 in. steel ball, 245 lb."

It should be compared with white spruce rather than with Sitka spruce, and may be used for similar purposes. Considerable quantities of timber are available from British Columbian and Western U.S.A. ports. It will probably afford one of the great sources of pulpwood in the future.

The bark is said to be rich in tannin and to be exploited to some extent for tanning purposes.

Engelmann's spruce is of no commercial importance in Britain, but is sometimes cultivated in gardens, the glaucous-leaved form being most popular. It succeeds best in districts where the atmospheric conditions are moist, and where the soil is loamy and never becomes dry. It is liable to injury by both *Chermes abietis* and *Aphis abietina*, which see under the generic description.

P. Engelmanni is being planted in Switzerland for protective work at high elevations. Near Pontresina, at 8,000 ft. and higher, it is giving better results than native trees. It might be worth trying under forest conditions in the Scottish Highlands above the natural tree limit. At lower elevations in its native country this species is usually confined to north slopes and valleys where the soil is constantly moist; at higher altitudes it is more generally distributed, but only where the ground is moist. It is found in pure stands and in mixed forests; withstands a good deal of shade and makes a good recovery after many years of suppression. Good seed-years occur triennially and the seed is said to possess a high rate of germination.

Sudworth, *The Spruce and Balsam Fir Trees of the Rocky Mountain Region*, 10–14 (1916).

Picea excelsa, Link. (Fig. 71.)

COMMON SPRUCE.

Abies excelsa, De Candolle; A. Picea, Miller; A. rubra, Bauhin; Picea vulgaris, Link; Pinus Abies, Linnæus; P. excelsa, Lambert (not Wallich); Picea Abies, Karst.

European Spruce; Norway Spruce; Spruce Fir; Violin Wood; White Deal (in part); White Fir; White Pine.

A tall tree attaining in Cent. Europe a height of 200 ft. and a girth of 15–20 ft. In Britain it often becomes 120 ft. or more

high, with a girth of 10–12 ft. *Bark* thin on young stems, on old trees thick with small, thin surface scales. *Branches* short. *Young shoots* reddish brown or orange red, glabrous or with minute scattered hairs. *Buds* conic, acute, about ¼ in. long,

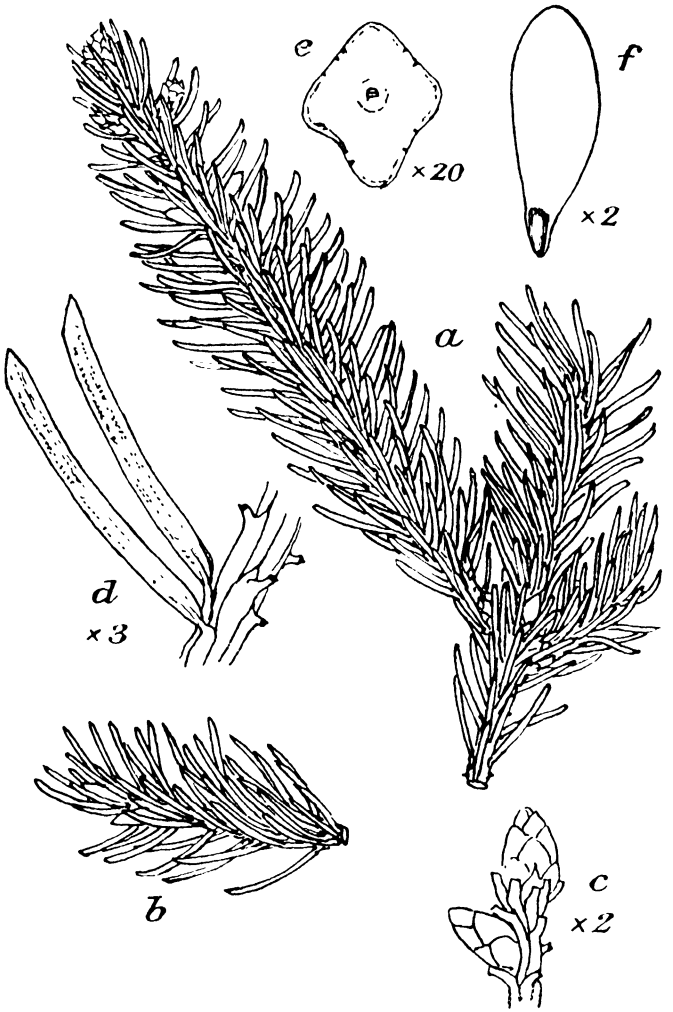

FIG. 71.—*PICEA EXCELSA.*

a, spray from above, *b* from side; *c*, winter buds; *d*, under-surface of shoot and leaves; *e*, section of leaf; *f*, seed.

with reddish-brown scales. *Leaves* persistent for several years, those on the upper side of the shoot more or less overlapping and pointing forwards, those on the lower side spreading right and left, and exposing the shoot; rhombic in section, ½–1 in. long, stiff, straight or curved, ending in a blunt, horny point; with

two or three stomatic lines on each side. *Cones* pendulous, cylindric, variable in size, about 4–6 in. long, turning brown when ripe in autumn, opening and releasing the seeds the following spring, and falling during the subsequent summer or autumn; *scales* thin and flexible, variable but often rhomboid in shape, 1–1¼ in. long, ⅝–¾ in. wide, truncate and toothed at the apex; bract about ⅕ in. long, lanceolate, toothed at the tip. *Seed* ⅙ in. long, wing ⅔ in. long.

Many varieties of the common spruce have been described.[1]

Var. **acuminata,** Beck.

Cone-scales suddenly narrowed into a long, recurved, undulate point. Found in the Jura, the Alps, E. Prussia, and S. Sweden.

Var. **argenteo-spica,** Hesse.

Young shoots creamy-white.

Var. **aurea,** Carrière.

Leaves yellowish-white, shining.

Var. **chlorocarpa,** Purkyne.

Cones green before ripening.

Var. **Clanbrassiliana,** Carrière.

A dwarf compact globose bush usually not more than 5–6 ft. high. *Buds* conspicuously red in colour. *Leaves* only ¼–½ in. long. Said to have been first found near Belfast at the end of the eighteenth century and introduced into England by Lord Clanbrassil. Common in cultivation, but apparently never producing cones. Var. **Gregoryana** is rather similar in habit.

Var. **columnaris,** Carrière.

Of narrowly columnar habit. *Branches* short, horizontal, clothed with dense short branchlets and foliage. Long known in cultivation and found wild in several Swiss localities.

Var. **corticata,** Schröter.

Bark thicker than usual and furrowed like that of a pine.

Var. **eremita,** Carrière.

Habit slender, pyramidal; branches usually pointing upwards at an acute angle with the stem. *Shoots* short, stout; buds large; leaves thick, sharp-pointed. Vars. **Dicksoni** and **gigantea** are very similar.

[1] Beissner (*Handbuch der Nadelholzkunde*, ed. 2, 1909) describes 70 varieties and forms of this variable tree. See also Hornibrook, *Dwarf and Slow-growing Conifers*, pp. 83–122 (1923).

Var. **erythrocarpa**, Purkyne.

Cones dark violet before ripening.

Var. **europæa.**

Cone-scales gradually narrowed to a truncate, emarginate or toothed apex. This constitutes the typical form which is widely spread in Central Europe.

Var. **finedonensis**, Gordon.

Leaves pale yellow, changing to bronze colour.

Var. **globosa**, Berg.

Branches many, close, dividing into numerous branchlets, forming a globose or conical bush. Vars. **globosa nana** and **dumosa** are very similar. All are suitable for the rockery.

Var. **monstrosa.**

SNAKE-BRANCH SPRUCE.

A form destitute of all branches, consisting of a single thick stem with thick rigid leaves. Vars. **Cranstoni** and **denudata** are very similar in character.

Var. **mutabilis**, Carrière.

Young shoots creamy yellow, changing to green by the end of the season.

Var. **nana.**

A dwarf compact cushion-like plant often less than 12 in. high.

Var. **pendula**, Jacques and Herincq.

P. excelsa inversa, Beissner.

A curious form with weeping branches hanging closely against the stem and sometimes trailing on the ground. Var. **inverta** is of similar habit, but the weeping character is even more pronounced.

Var. **pumila glauca.**

A dwarf plant with glaucous leaves.

Var. **pygmæa.**

A very dwarf and compact plant, often only 6–12 in. high.

Var. **pyramidata**, Carrière.

Almost fastigiate in habit, the branches ascending at a sharp

angle with the stem. Found in Central Europe and sometimes seen in cultivation.

Var. **strigosa**, Christ.

Resembling a larch in habit, with numerous, slender, horizontal branches. Found in Switzerland.

Var. **tabulæformis**, Carrière.

A prostrate plant with slender branchlets spreading horizontally over the ground. It is said to have originated from a cutting taken from a witch's broom found on a typical tree.

Var. **triloba**, Ascherson and Graebner.

Scales of the cones three-lobed at the apex. A rare tree found in the Harz Mountains.

Var. **tuberculata**, Schröter.

A sport in which the lower part of the trunk is covered with corky excrescences. Examples have been found in Switzerland, Austria, and Germany.

Var. **variegata**, Carrière.

Leaves variegated with pale yellow.

Var. **virgata**, Caspary.

Snake Spruce.

Stem producing very few branches, which are elongated, straight or curved. Leaves spreading all round the shoot. Found in Norway, Sweden, Bohemia, etc.

The common spruce may generally be known from all the other square-leaved species by the reddish brown colour of the shoots, which are often without hairs, and by the bluntly pointed leaves.

P. excelsa is a native of Europe, where it has a very wide distribution, ranging from the Pyrenees, Alps, and Balkans, northwards to S. Germany and E. Prussia, to Scandinavia, and eastwards through the Carpathians and Poland to W. Russia. It is common in Switzerland, reaching an altitude of 6,000 ft. It is known to have been in cultivation since 1548, and is one of the commonest and hardiest of conifers.

Wood light in weight, soft, straight-grained, long-fibred, elastic, cream-coloured or white, easily worked when free from knots, finishing with a satiny surface ; knots black or dark brown, very hard, frequently loose and troublesome under the plane. Boulger[1] gives the following results of strength tests :

[1] *Woods of Commerce*, p. 277 (1908).

" When green 64·7 lb. per cubic ft., when dry 28–32 lb. per cubic ft. Coefficient of elasticity 715 tons per square in. Coefficient of bending strength 3·77 tons per square in. Tensile strength (tenacity along the fibre), 5·5 tons per square in. Crushing strength along the fibre, 2–2·86 tons per square in. Shearing resistance along the fibre, ·27 tons per square in. Stress required to indent it, $\frac{1}{20}$ in. transversely to the fibres, 500 lb. per square in."

It is used extensively for general joinery and carpentry, indoor finish of houses, the cheaper kinds of furniture, boxes, scaffold poles, pit-props, wood paving when creosoted, sounding-boards for violins and other musical instruments, toys, carving, matches, wood chip for hats, fruit and flower baskets, match-boxes, etc., and for paper pulp. Its adaptability for washing and scrubbing, and its clean appearance, makes it a popular wood for the tops of dairy and kitchen tables and dressers. A considerable quantity of wood is produced in Britain, and there are large imports from Norway and Russia.

Burgundy pitch is the purified resin extracted from this tree. Longitudinal incisions about 1½ in. wide and deep are made in the trunks, and the exuding resin is collected, melted, and purified. It is used in medicine for plasters and enters into the composition of a varnish. Burgundy pitch is prepared in Norway, Finland, Germany, Austria, and Switzerland.

Spruce beer, referred to in the generic description, is partly made from an essence prepared from the young shoots and leaves of this tree. The following recipe for spruce beer is taken from Spons' *Encyclopœdia of the Industrial Arts*, ii, 424. " Essence of spruce ½ pint, pimento and ginger (bruised) of each 5 oz., hops ½ lb., water 3 gallons. Boil the whole for 10 minutes, then add 12 lb. of moist sugar, and 11 gallons of warm water ; mix well, and when luke-warm add one pint of yeast. After 24 hours fermentation, place in bottles." Spruce beer is diuretic and antiscorbutic ; it is an agreeable drink in summer, and was at one time considered to be particularly useful during long sea voyages.

The common spruce is the conifer chiefly used for Christmas trees, and there is a large trade in young trees for this purpose. Overgrown nursery stock may often be disposed of in this way.

P. excelsa is extensively planted under forest conditions in this country, but it should only be used on thin or wet soils where more valuable species fail. The best results are usually obtained from rather dense pure plantations. The tree stands considerable shade, and unless planted closely retains its lower branches for many years. Planting may be carried out at distances of 3–3½ ft. apart each way, and thinning must be practised with great care until the trunks have been cleaned to a considerable height. After additional head-room has been given sup-

pressed trees quickly recover. On low-lying wet land young trees are liable to injury from spring frosts. As an ornamental tree it is less picturesque than the Scots pine. Its principal value in Britain is for silvicultural purposes, but good timber can only be obtained by very careful management.

The numerous dwarf forms are useful for the rock-garden, but some of the taller varieties are simply monstrosities. In 1913 the forest garden at Adlisberg, Switzerland, contained a very interesting group of abnormal seedlings of the common spruce. At that time the plants were 13 years old and all had originated from the seed of one tree, which had a normal leader but a curious bunchy branch system. The seedlings were of three types. About 16 per cent. were of normal habit with single trunks; about 31 per cent. had developed several trunks from the base; whilst 53 per cent. had formed dense, round, cushion-like plants of heights varying from a few inches to a few feet. There were minor variations which made it possible to select forms which would probably represent almost all the named garden varieties.

The dwarf varieties can be increased by cuttings of short shoots dibbled into sandy soil in a cold frame or under a hand-light in July, whilst the larger ones are usually grafted on stocks of the type indoors in March.

The common spruce and its varieties are very liable to injury by *Chermes abietis*, and both young and old trees are often disfigured by cone-like galls.

Elwes and Henry, *loc. cit.* vi, 1337 (1912).

Picea Glehni, Masters.

GLEHN'S SPRUCE.

A tree attaining in Japan 100 or more ft. in height, with a trunk 10–15 ft. in girth. *Bark* distinct from all the other species, reddish brown or chocolate in colour, dividing into thin flakes which turn grey as they fall off. *Branches* short, slender, forming a narrow crown. *Branchlets* reddish brown, with dense hairs often confined to the furrows. *Buds* small, ovoid or conical, resinous, with closely overlapping scales, the terminal bud surrounded with a ring of awl-shaped scales. *Leaves* crowded, arranged like those of the common spruce, $\frac{3}{8}$–$1\frac{1}{2}$ in. long, ending in a short, horny point, compressed, quadrangular in section, with lines of stomata on all 4 sides. *Cones* cylindrical, $2\frac{1}{2}$ in. long, 1 in. in diameter, shining brown when ripe, with roundish scales slightly toothed on the upper margin and minute bracts. *Seeds* with a wing $\frac{3}{5}$ in. long.

Recognized by its reddish shoots, which are often hairy only in the furrows.

A native of S. Saghalien and N. and E. Yezo. In the eastern part of the island it forms pure forests, but never becomes a very large tree and is rare elsewhere. It was discovered in Saghalien in 1861 by Glehn, who accompanied Schmidt on an expedition to E. Asia, and was introduced by Maries for Messrs. Veitch in 1877, but only small plants are known in cultivation in England.

The economic uses of *P. Glehni* appear to be confined to the local use of the timber.

Under cultivation it grows more slowly than the common spruce and is probably better adapted for high land than for low elevations where the resting period is short.

Wilson, *Conifers of Japan*, 40 (1916).

Picea jezoensis, Maximowicz. (Fig. 72.)

YEZO OR HONDO SPRUCE.

Picea ajanensis, Fischer; Abies Alcoquiana, Lindley (in part).

A tree 100–150 ft. high and up to 20 ft. in girth in Japan, assuming, when well developed, a pyramidal or spire-like habit, the branches being more or less deflexed, with the ends upturned. *Bark* grey, scaling off in circular plates, deeply and irregularly fissured in old trees. *Young shoots* glabrous, shining, pale buff, brown or reddish brown in the second year, becoming slightly darker in their third season and eventually showing a greyish tinge. *Buds* broadly conic, with ovate, resinous, shining scales. *Leaves* crowded and overlapping on the upper part of the shoot, those below spreading in two opposite ranks, curving upwards and exposing the shoot; thin, flattened, bevelled off at the apex into a short point, slightly keeled on both surfaces; ventral surface silvery white with two broad bands of stomata; dorsal surface dark green. *Cones* crimson when young, leather-brown when ripe, cylindrical, 2–3 in. long by 1 in. in diameter; *scales* narrowly oblong with toothed margins; bracts minute, concealed. *Seed* with a wing two or three times its length.

This tree has a very wide distribution in N.E. Asia and Japan, and is the only flat-leaved spruce of that region. It extends from Ajan on the sea of Okhotsk through the coast districts of Amurland to Corea and Manchuria, where it reaches its southernmost limit. The finest trees are found in the moist forests of Yezo, the northern island of Japan.

P. jezoensis was introduced into cultivation in 1861 by J. G. Veitch, and owing to a mixture of seed was subsequently distributed under the names of *P. ajanensis* and *P. Alcockiana*.

It may be distinguished from the other flat-leaved spruces by the pale shoots and dark green leaves, which are crowded on the upper side of the shoot, and bluish or silvery white on

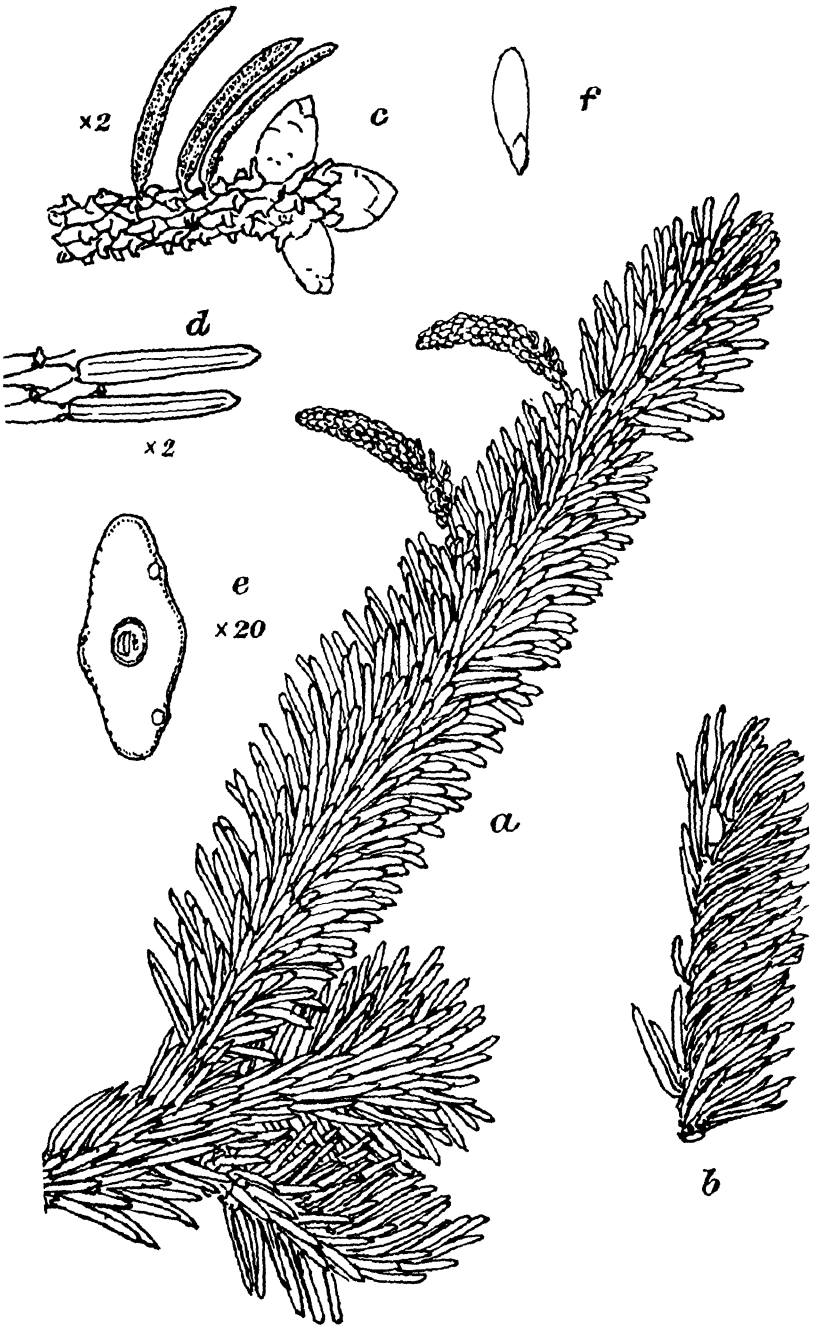

FIG. 72.—*PICEA JEZOENSIS.*

a, spray with two stamen catkins; *b*, spray from side; *c*, winter buds and under-side of shoot; *d*, leaves and shoot from upper side; *e*, section of leaf; *f*, seed.

the lower surface. In Hondo, the main island of Japan, there is a form which Mayr has separated as a species under the name of *P. hondoensis*. This is said to have the young leaves tinged with red and the shoots of the second year red in colour, but Wilson, who has lately made a careful study of *P. jezoensis* in its native habitats, and has examined many specimens from widely separated localities, is unable to recognize more than one species. There appear to be two forms in cultivation, however, which may be characterized as follows :

Var. **typica.**

Young shoots yellowish brown or yellowish grey. Leaf-cushions slightly swollen. *Leaves* acute, slender, dark green on the dorsal surface. Rare in cultivation.

Var. **hondoensis,** Rehder.

Picea ajanensis, var. microsperma, Beissner. P. hondoensis Mayr

Shoots light reddish brown. Leaf-cushions much swollen. *Leaves* shorter and more curved, obtuse, dull green on the dorsal surface. This is the form usually found in cultivation in Britain.

Wood light, soft, long-fibred, creamy white ; used for general joinery, boxes, paper pulp, and other purposes in Japan, where it forms an important forest tree.

In Britain it is confined to gardens and to scientific collections of trees, where it grows slowly and is not a general success. It has no qualifications to recommend it for commercial planting here.

Bot. Mag. t. 6743 (1884) ; *Gard. Chron.*, March 20, 1920, p. 139 ; Wilson, *Conifers of Japan*, 44 (1916).

Picea Koyamai, Shirasawa.

KOYAMA'S SPRUCE.

A small tree scarcely exceeding 60 ft. in height, with a trunk up to 4 ft. in girth. *Bark* grey-brown, lightly fissured, scaling off in paper-like, oblong flakes. *Branches* dense, slender, horizontal, eventually turning upwards and forming a spire-like or pyramidal crown like that of the common spruce. *Young shoots* reddish brown, slightly glaucous, becoming pale grey with age, glabrous or with scattered glandular hairs which are more conspicuous in the furrows. *Buds* conical, shining brown, resinous. *Leaves* crowded, dark green, often somewhat glaucous, stout, straight or slightly curved, $\frac{1}{4}$–$\frac{1}{2}$ in. long or more, quadrangular in section, acute or obtuse at the apex with lines of stomata on all surfaces. *Cones* cylindrical, 2–4$\frac{1}{2}$ in. long, pale green when young, pale shining brown when ripe ; *scales* broad and rounded with finely toothed margins.

Distinguished from the other Japanese species by its resinous conical buds and glandular hairy shoots.

This interesting addition to the conifers of Japan was made by Mr. Mitsua Koyama, who found it in 1911 on the slopes of the mountain Yatsuga in Central Hondo, which is the only known locality. Wilson, who has since visited the place, states that there is only one small grove, consisting of about 100 trees at an altitude of between 3,000–5,000 ft., and that on account of its rarity the species is in danger of extirpation. Young plants are in cultivation in Britain.

Wilson, *Conifers of Japan*, 39 (1916); *Gardener's Chronicle*, Aug. 14, 1915, p. 98.

Picea likiangensis, Pritzel. (Fig. 73.)

Abies likiangensis, Franchet [1]; Picea Balfouriana, Rehder and Wilson; P. likiangensis, var. rubescens, Rehder and Wilson.[2]

A tree 50–100 or more ft. high, with a mast-like trunk up to 10 ft. in girth. *Bark* thick, deeply furrowed. *Young shoots* pale brown, reddish brown or greyish, sparsely or densely bristly or occasionally without hairs, the pulvini or peg-like leaf-bases twisted more or less horizontally. *Buds* ovoid or conic, more or less resinous. *Leaves* on the upper side of the shoot pointing forwards and more or less densely overlapping; those on the lower side spreading in two opposite ranks, quadrangular, compressed, up to $\frac{3}{4}$ in. long and slightly keeled on both surfaces, apex acute, ending in a horny point; stomatic lines few, unequal. *Cones* ovate or ovate-oblong; *scales* flexible, rhombic, ovate in shape, narrowed above to a rounded or acute apex, margin undulated, those of ripe cones more or less spreading, sometimes horizontal. *Seeds* about $\frac{2}{5}$ in. long, including the obovate wing.

Var. **purpurea.** (Fig. 74.)

P. purpurea, Masters.

Leaves shorter and more crowded, about $\frac{1}{2}$ in. long, closely pressed to the upper side of the shoot, which is often densely hairy. *Cones* somewhat smaller.

Native of W. Szechuen, China, where it occurs in forests and open country at 9,000–12,000 ft. altitude.

Young plants of this spruce variously named, *P. likiangensis*, *P. purpurea*, or *P. Balfouriana*, are now to be found in collections, but they do not seem to us to represent more than one species. No two specimens are alike in the degree of hairiness of the shoots, which often varies in amount on the same plant, and in length and direction of leaves there is also considerable variation. The

[1] *Journ. de Bot.* xiii, 257 (1899).
[2] *Pl. Wils.* ii, 31 (1914).

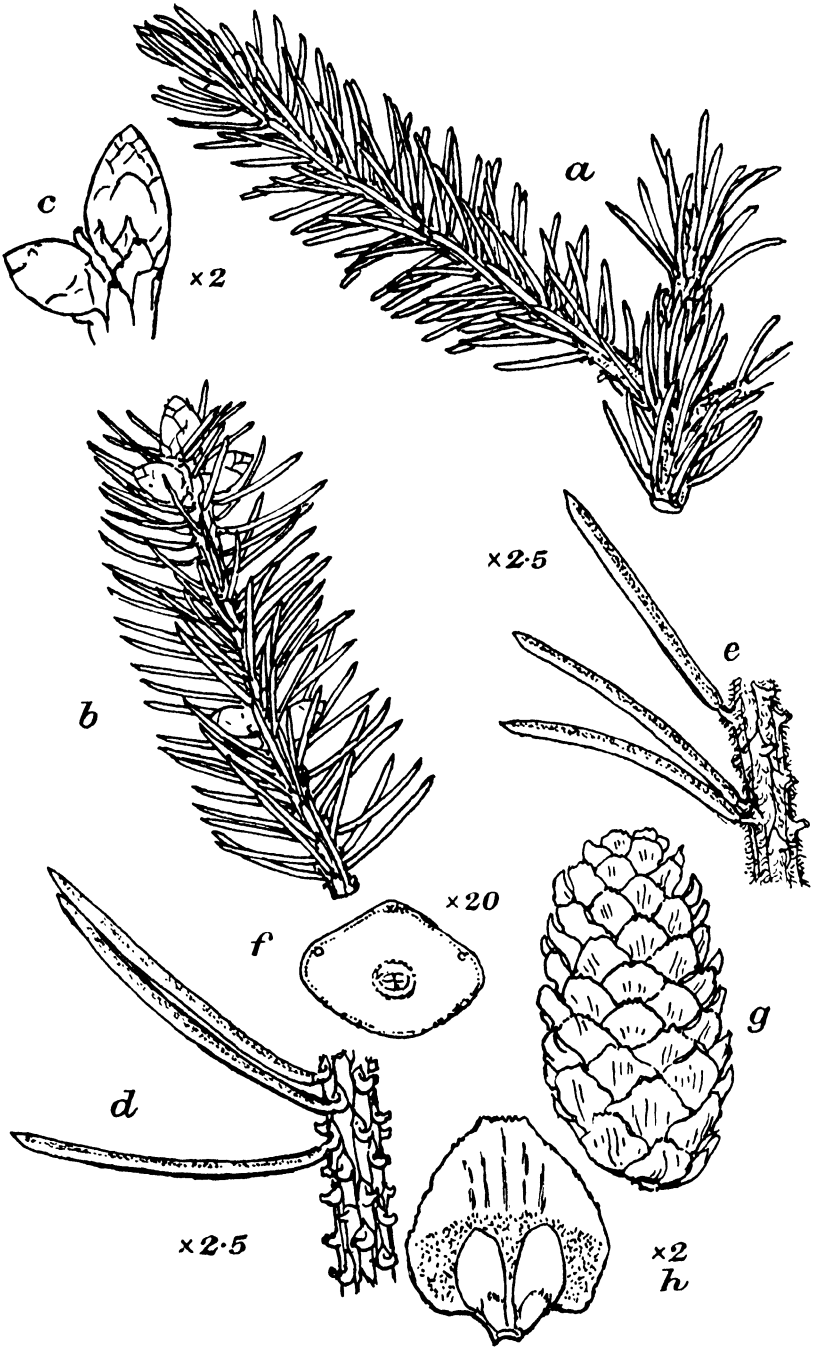

FIG. 73.—*PICEA LIKIANGENSIS.*

a, *b*, spray; *c*, winter buds; *d*, under-side of leaves and glabrous shoot; *e*, under-side of a pubescent shoot; *f*, section of leaf; *g*, cone; *h*, cone-scale with seeds.

same remarks apply to native specimens, quoted under numbers in the *Plantæ Wilsonianæ*, which we have carefully examined. The characters based on the size of the cones and shape of the cone-scales are equally unreliable and appear to us to be largely due to conditions of growth.

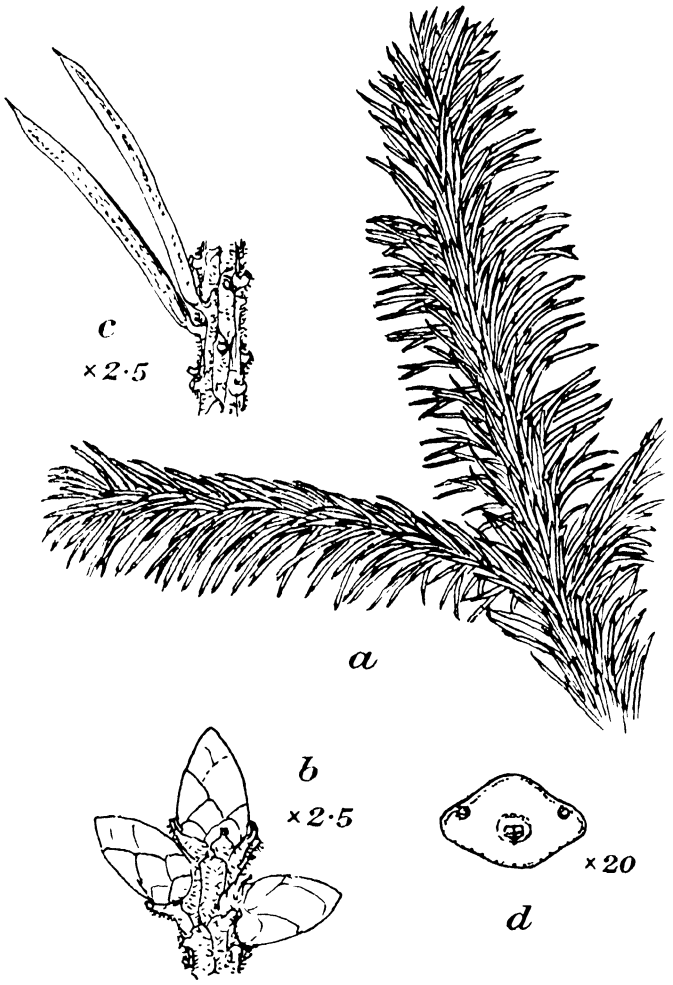

FIG. 74.—*PICEA LIKIANGENSIS*, var. *PURPUREA*.
a, spray; *b*, winter buds; *c*, under-side of leaf and shoot; *d*, section of leaf.

P. likiangensis may generally be recognized by its sub-compressed, overlapping leaves and more or less hairy shoots.

P. hirtella, Rehder and Wilson, of which we have seen no living specimens, is closely allied to if not identical with *P. likiangensis*. It is not in cultivation.

Picea Maximowiczii, Regel.

MAXIMOWICZ'S SPRUCE.

Abies Maximowiczii, Neumann; Picea obovata, var. japonica, Beissner.

Usually a small, densely branched tree, 40–50 ft. high, of pyramidal outline, but occasionally 150 ft. high, with a trunk 15 or more ft. in girth. *Bark* greyish brown or light grey, rough and fissured. *Branches* many and slender, horizontal and ascending. *Young shoots* reddish brown, glabrous at first, becoming paler with age. *Buds* conical or ovoid, about $\frac{1}{5}$ in. long, with resinous scales. *Leaves* spreading at right-angles to the shoots, pointing slightly forwards, $\frac{3}{8}$–$\frac{1}{2}$ in. long, quadrangular in section, dark green, tipped with a short, blunt point, with lines of stomata on all four surfaces. *Cones* cylindrical, $1\frac{3}{4}$–2 in. long, pale green when young, shining brown when ripe; *scales* with rounded entire margins.

Distinguished by its short, spreading leaves and resinous buds.

P. Maximowiczii, a rare and little known spruce, is a native of Japan, where it occurs in two remote localities in the central island. It was discovered on Mount Fujyama by Tschonoski, a Japanese collector, in 1861. It has since been re-discovered on the Yatsuga-dake, a high mountain on the border of Kai and Shinano provinces in Cent. Japan, by Koyama, from 3,600–5,000 ft. altitude, where, according to Wilson, it is fairly common as a low, bushy tree.

This species is sometimes found in collections but is uncommon and not very suitable for cultivation in Britain. The best results may be expected on moist, rather light soils, in the cooler parts of the country.

Clinton-Baker, *op. cit.* iii, 68 (1913); Wilson, *Conifers of Japan*, p. 38 (1916).

Picea Morinda, Link. (Fig. 75.)

WEST HIMALAYAN SPRUCE.

Picea Smithiana, Boissier; Abies Khutrow, Loudon; A. Smithiana, Forbes; Pinus Khutrow, Royle; P. Smithiana, Lambert.

A tall stately tree of pendulous habit, attaining in the Himalaya a height of 200 or more ft. and a girth of 20 ft. *Bark* brownish grey with shallow furrows and rounded or squarish scales. *Branches* conspicuously drooping. *Young shoots* pale brown or greyish, shining, without hairs. *Buds* spindle-shaped, $\frac{1}{2}$ in. long, with reddish brown, closely overlapping scales; the terminal bud with awl-shaped scales at its base. *Leaves* spreading all round the shoot, incurved, pointing forwards, long and slender, about $1\frac{1}{2}$ in. long, dark green, tapering to a fine, horny point, quadrangular in section, with about two lines of stomata on all four sides. *Cones* cylindric, but tapering at each end, 4–7 in. long, $1\frac{1}{2}$–2 in. wide, bright green when growing, bright brown

when ripe ; *scales* smooth and shining, broadly obovate, narrowed at the base ; margin entire ; bract rudimentary. *Seeds* dark brown, with the wing about $\frac{2}{3}$ in. long.

The pendulous habit and long dark, incurved leaves, tapering to a sharp point, are unlike those of any other *Picea*.

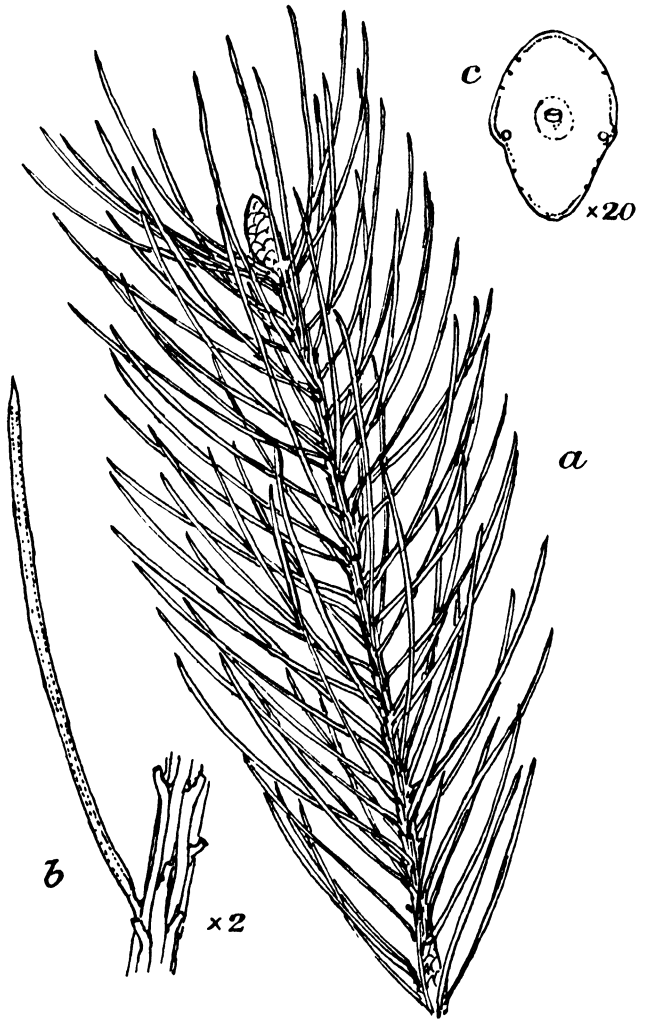

FIG. 75.—*PICEA MORINDA*.
a, branchlet with winter bud ; *b*, under-side of leaf and shoot ; *c*, section of leaf.

P. Morinda is found throughout the W. Himalaya from Afghanistan to Nepal, from 7,000–12,000 ft. elevation. It forms mixed forests with *Abies Pindrow* and is often a very fine tree, though of sombre aspect.

Dr. Govan of Cupar first raised trees in Britain in 1818, at Hopetoun House near Edinburgh.

Little is known of the wood in the British Isles, but from small specimens it appears to be very like that of *P. excelsa*. It can, however, be procured in larger sizes. Its economic uses are similar to those of common spruce, and it is in great request in India for matches and for paper pulp. In a wild state it is said to suffer seriously from heart-rot.

P. Morinda is only grown for ornamental purposes in Britain. It forms a handsome specimen, its long weeping branchlets giving it a very distinct appearance. It is quite hardy and is easily raised from seeds. Under natural conditions it withstands moderate shade but requires more light than most of the spruces. Troup[1] says that young plants are not so readily eaten by goats as are young plants of the blue pine. Like other spruces it requires moist soil and grows best under cool and moist climatic conditions.

Picea morindoides, Rehder.

SIKKIM SPRUCE.

Picea spinulosa, Henry; Abies spinulosa, Griffith. East Himalayan Spruce.

One of the tallest of the spruces, attaining a height of over 200 ft. in the Himalaya. *Branches* pendulous, like those of *P. Morinda*. *Bark* rough, scaling off in small, squarish plates. *Young shoots* slender, glabrous, yellowish in colour at first, but becoming grey with age. *Buds* ovoid, about $\frac{1}{4}$ in. long, pale brown, slightly resinous, with obtuse scales. *Leaves* more or less irregularly arranged round the shoot, crowded and closely overlapping on the upper side, flattened, $\frac{3}{4}$–$1\frac{1}{4}$ in. long, keeled on both surfaces, tipped with a sharp point, dorsal surface green, ventral surface with two white lines of stomata. *Cones* cylindric, blunt, 2–$3\frac{1}{2}$ in. long and about 1 in. wide, green with a purple margin to the scales when young, shining brown when ripe; *scales* roundish, tapering at the base, with a finely toothed margin. *Seed* $\frac{1}{5}$ in. long, with a wing about $\frac{1}{2}$ in. long.

Distinguished from *P. sitchensis*, which it somewhat resembles, by its radially arranged leaves.

The Sikkim spruce is the only species occurring in the E. Himalaya, where it was discovered about 1841 by Griffiths in Bhutan, 150 miles east of the Sikkim frontier at 8,500–10,000 ft. altitude. It has since been found in the Lachen and Chumbi valleys of Sikkim. In the former valley trees of immense height have been found, one fallen specimen measuring 220 ft. from the roots to where it had broken off.

P. morindoides was introduced into cultivation by Sir George

[1] *Silviculture of Indian Trees*, iii, pp. 1143–1154 (1921).

King, who sent seeds to Europe about 1878. Very few trees are known in the British Isles, and it appears to be more tender than *P. Morinda*. There are good specimens at Castlewellan, Leonardslee, Menabilly and Chetley Place, Liphook; but in some places it has possibly been passed over for *P. Morinda*, which it much resembles in habit and with which it was formerly confused.

Wood very similar in appearance to that of *P. Morinda*, but said to be harder and heavier.

If seeds were obtained from a high elevation, the resulting plants would probably be hardier than those now growing in this country. At present it is found to give the best results in the warmer parts of the country, where the soil is good and moist.

R. S. Troup, *Silviculture of Indian Trees*, iii, p. 1154 (1921); *Bot. Mag.* t. 8169 (1907); Elwes and Henry, *op. cit.* vi, 1392 (1912).

Picea morrisonicola, Hayata.

A Formosan species found on Mount Morrison by Torrii in 1900. It is described as having glabrous shoots. *Buds* ovoid conic, with ovoid, obtuse, scarious scales. *Leaves* linear, four-sided, ¼–¾ in. long, apex acute, stomatiferous. *Cones* oblong-cylindric, 2 in. or more long, deflexed; *scales* ovate-orbicular, tapering at the base, rounded-truncate and sub-entire at the apex. *Seed* with a wing 1 cm. long.

Allied to *P. Glehni* but differs from it in having non-hairy shoots.

Hayata, *Journal of the College of Science*, Tokyo, xxv, 220 (1908).

Picea nigra, Link. (Fig. 76.)

BLACK SPRUCE.

Picea Mariana, Britton, Sterns and Pogg.; Abies alba, Chapman; A. americana, C. Koch; A. arctica, Hort.; A. denticulata, Michaux; A. Mariana, Miller; A. marylandica, Hort.; A. nigra, Poiret; Pinus Mariana, Duroi; P. nigra, Aiton. Blue Spruce; Bog Spruce; Double Spruce; He Balsam; Red Spruce; Swamp Spruce; Spruce Pine.

A tree attaining in N. America a height of 50–75 ft. and a girth of 6–9 ft., but often of much smaller dimensions. *Bark* reddish brown, scaly. *Young shoots* brownish, with short, dense, glandular hairs. *Buds* ovoid, surrounded by awl-shaped, fringed scales. *Leaves* arranged like those of the common spruce, crowded, bluish or glaucous green, about ½ in. long, quadrangular in section, ending in a horny point, with 1–4 lines of stomata on each side. *Cones* persisting several years after shedding the seed, ovoid, short-stalked, about 1 in. long, green tinged with purple or deep purple when growing, reddish brown when ripe; *scales* broadly ovate or rounded, with toothed margins. *Seeds* ⅛ in. long, with pale brown wings ½ in. long.

Var. **Doumetii,** Carrière.

A dwarf, shrubby form of densely conical habit. Leaves very crowded, thin and sharp-pointed.

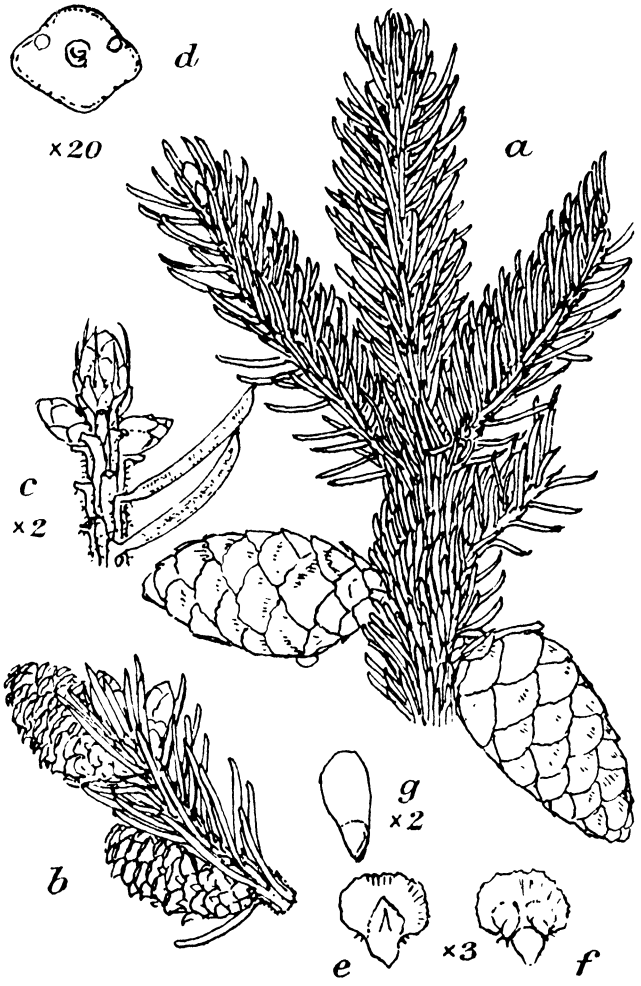

FIG. 76.—*PICEA NIGRA.*

a, spray with two mature cones; *b*, two young cones; *c*, winter buds and shoot from beneath; *d*, section of leaf; *e*, young cone-scale and bract; *f*, inner side of cone-scale, showing ovules; *g*, seed.

Var. **ericoides.**

This forms a rounded bush with short, slender leaves about $\frac{1}{3}$ in. long. It is of very slow growth.

Var. **fastigiata.**

A dwarf, columnar form with slender leaves.

P. nigra is recognized without difficulty by its densely hairy

shoots, awl-shaped outer bud-scales and glaucous-green foliage. The characters which separate it from *P. rubra* are described under the latter species.

The black spruce is found over nearly the whole of the Dominion of Canada, being a common tree in all the eastern provinces and Newfoundland. It crosses the Rocky Mountains into Alaska and spreads southwards in the United States to Pennsylvania, N. Virginia, Wisconsin, and Michigan. In British Columbia its western limit is said to be between Teslin and Atlin lakes and to the east of Telegraph Creek, on Stikine River.[1] In British Columbia it is usually found as a stunted tree less than 25 ft. high, in cold, swampy places. It has a more northerly distribution than *P. rubra* and is often a tree of swampy and boggy places, but in the northern part of its range it is often found in drier situations, such as the stony slopes of hills.

The economic properties of the black spruce are identical with those of *P. alba*. The wood, however, is regarded as being rather stronger when at its best, but it is usually smaller and is in less general use. In commerce the wood of *P. nigra* appears to be mixed with that of *P. alba* and *P. rubra*, but for special purposes it is desirable that they should be separated. The chief use of black spruce is for the manufacture of paper pulp.

P. nigra succeeds in Britain, but grows more slowly than *P. alba*, and its use is limited to decorative planting and to scientific collections. It is less liable to insect attacks than either European or Sitka spruce. In N. America it occurs both as pure forests and as mixed stands. The largest trees and the best stands occur in moist but well-drained alluvial soils.

Picea obovata, Ledebour.

SIBERIAN SPRUCE.

Abies obovata, Loudon.

A tree of somewhat similar habit and dimensions to the common spruce, and by some botanists united with it. *Young shoots* reddish brown, clothed with minute, scattered, glandular hairs. *Buds* conic, about $\frac{1}{5}$ in. long with closely pressed rounded scales, the terminal bud with a ring of long-pointed scales at the base. *Leaves* similar to those of *P. excelsa*, $\frac{2}{5}$–$\frac{3}{5}$ in. long, bluntly pointed, quadrangular in section, with 3 or 4 stomatic lines on each side. *Cones* 3–4 in. long, $1\frac{1}{4}$–$1\frac{1}{2}$ in. wide, cylindrical, shining brown when ripe; *scales* numerous, thin, flexible, fan-shaped with entire or toothed margins; bracts $\frac{1}{5}$ in. long, toothed at the apex. *Seed* $\frac{1}{6}$ in. long, brownish black, with a narrow wing $\frac{3}{4}$–$\frac{3}{5}$ in. long.

[1] Whitford and Craig, *Forests of British Columbia*, p. 201 (1918).

Photo by F. J. Wallis

PLATE XVII. ORIENTAL SPRUCE (*PICEA ORIENTALIS*).

Var. **alpestris**, Henry.

Bark greyish white. *Leaves* ½–⅔ in. long, stout, very glaucous. Cones 3–5 in. long, with scales rounded and entire on the upper margin.

Var. **fennica**, Henry.

Leaves dark green; cone scales with their upper margins rounded and finely toothed.

This species is distinguished from *P. excelsa* by its hairy shoots and shorter leaves. The two species are apparently connected by intermediate forms.

It is the most widely distributed of the spruces, occurring over a vast area in E. Europe and Asia, where the climatic conditions are very severe. It is found in N. Scandinavia, Lapland, Finland, N. and E. Russia, Siberia, Kamtschatka, and Manchuria, occasionally forming extensive forests.

We have no large trees of this spruce in England. Seedlings were raised at Bayfordbury, Herts., in 1908, from Siberian seeds, and small plants labelled *P. obovata* are occasionally seen in collections.

The uses are similar to those of *P. excelsa*, which see.

It appears to require a longer resting period than is possible in Britain.

Elwes and Henry, *loc. cit.* vi, 1359 (1912); Clinton-Baker, *Illust. Conif.* ii, 42 (1909).

Picea Omorika, Bolle. (Fig. 77.)

SERVIAN SPRUCE.

Pinus Omorika, Pancic.

A tree with a remarkably slender trunk and a spire-like crown, attaining in its native habitat a height of over 100 ft. and a girth of only about 4 ft. *Bark* of trunk reddish brown, scaling off in plate-like layers. *Branches* short in proportion to the height of the tree, the lower ones drooping but turning upwards at the ends, the upper ones horizontal or ascending. *Young shoots* light brown, hairy. *Buds* ovoid-conic, acute up to about ¼ in. long, with red-brown scales, the outermost scales ending in long awl-shaped points. *Leaves* more or less horizontally arranged, those on the lower side of the shoot curving downwards, those on the upper side of the shoot overlapping and pointing forwards, flattened, ½–¾ in. long with a short, acute or obtuse tip, convex and shining on the dorsal surface with two white lines of stomata separated by a prominent midrib on the ventral surface. *Cones* ovoid-conic, about 1½–2 in. long, bluish-black when young, dark brown when ripe, horizontal or pendulous, with roundish, convex scales. *Seed* small, about ⅛ in. long, wing ⅓ in. long.

P. Omorika has a restricted distribution, being only known to occur on both sides of the river Drina, which forms the boundary

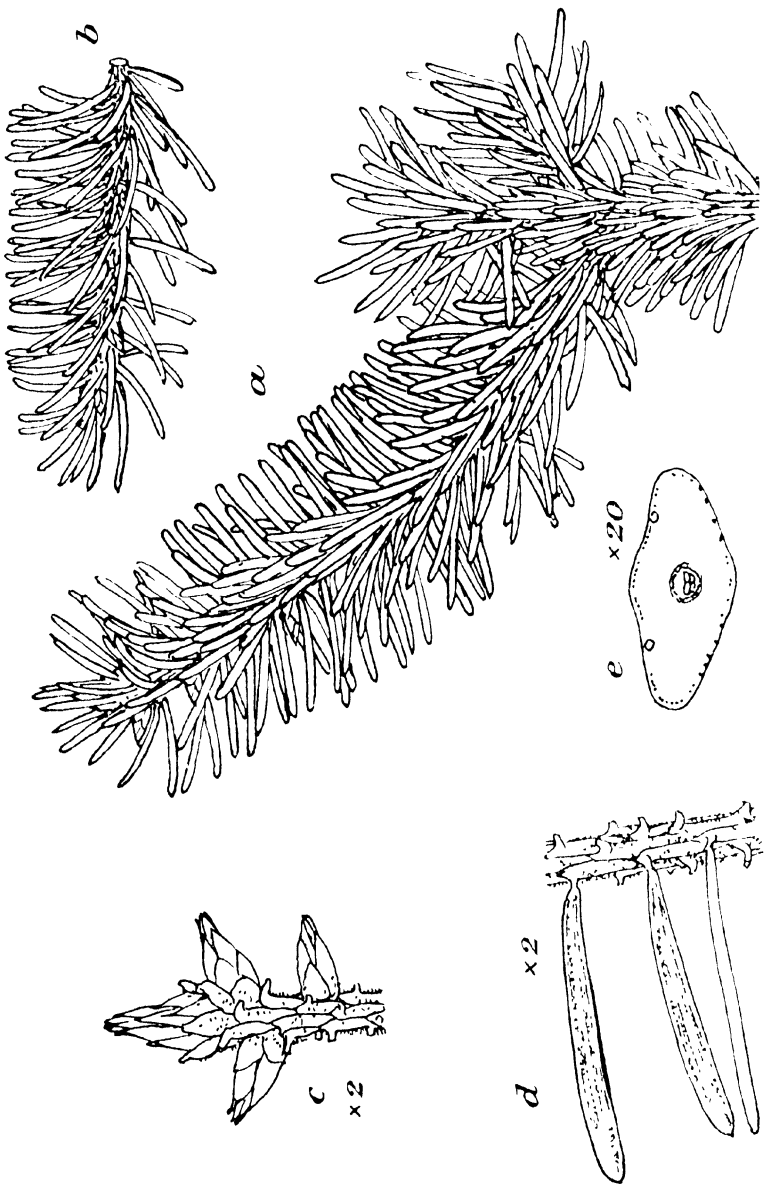

FIG. 77.—*PICEA OMORIKA*.

a, spray from above, *b*, from side; *c*, winter buds, *d*, under-side of shoot and leaves; *e*, section of leaf

between Servia and Bosnia. It was discovered in S.W. Servia in 1875 by Dr. Pancic. It grows on limestone rocks at 2,700–5,300 ft. altitude, sometimes forming pure woods. This species was introduced to Kew in 1889, where it succeeds better than any

other spruce in spite of the enervating conditions of a hot dry soil and an impure atmosphere.

Wood close-grained, compact, yellowish, easily worked, finishing with a good surface, and suitable for the same purposes as *P. excelsa*.

The Servian spruce may be grown in Britain under similar conditions to *P. excelsa*, and in a young state makes better progress at Kew than that species. It is an excellent ornamental tree and is worth planting under forest conditions, provided seed can be procured at a rate that will allow young plants to be produced at the same price as Sitka spruce.

Elwes and Henry, *loc. cit.* i, 78 (1906); Clinton-Baker, *Illust. Conif.* ii, p. 43 (1909).

Picea orientalis, Carrière. (Fig. 78.)

ORIENTAL SPRUCE.

Abies orientalis, Poiret; A. Wittmanniana, Hort.; Pinus orientalis, Linnæus.

A densely branched tree of pyramidal habit, attaining in the Caucasus 180 ft. in height and 12 ft. in girth. *Bark* of trunk brown, eventually exfoliating in thin scales. *Young shoots* slender, pale brown, densely hairy. *Buds* conic, acute, with chestnut-brown scales. *Leaves* arranged on the shoot like those of the common spruce, overlapping above, pointing forwards and concealing the shoot; those below spreading right and left and leaving the shoot bare; very short, $\frac{1}{4}$–$\frac{1}{2}$ in. long, quadrangular in section, dark green, shining, bevelled, blunt or rounded at the apex, with one to four lines of stomata on each surface. *Cones* narrower than in the other species, cylindric, but tapering at each end, short-stalked, 3–4 in. long, $\frac{3}{4}$–1 in. wide when closed, purple when growing, brown when ripe; *scales* obovate, tapering at the base, $\frac{1}{2}$–$\frac{3}{5}$ in. wide, the upper margin rounded and entire. *Seed* blackish, $\frac{1}{5}$ in. long, with a wing $\frac{1}{2}$ in. long.

Var. **aurea-spicata**, Beiss.
Var **aurea**, Hort.
Foliage yellowish
Var **nana**, Carriere.
Habit dwarf, compact.
Var. **pygmæa**, Hort.
Habit dwarf, compact, carpet-like.

The Oriental spruce is a very distinct species, easily recognized by its pale brown hairy shoots and short, blunt, glossy leaves.

As a native tree it is widely spread in the mountain ranges of Asia Minor, Armenia, and the Caucasus, at altitudes varying from

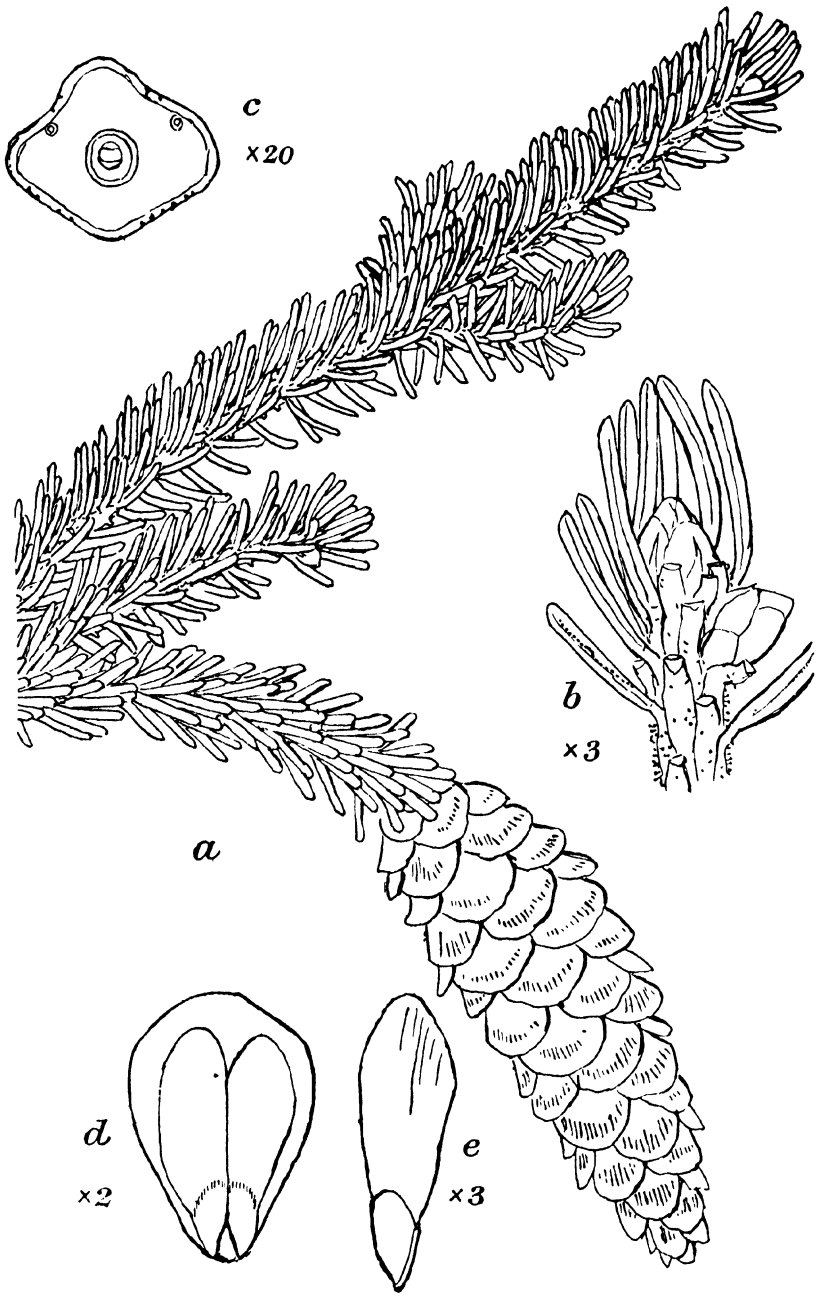

FIG. 78.—*PICEA ORIENTALIS.*

a, spray with cone; *b*, winter buds; *c*, section of leaf; *d*, cone-scale and seeds; *e*, seed.

2,500–7,500 ft. It appears to have been introduced into England in 1839 and has proved one of the most successful conifers in cultivation.

Wood similar in appearance and uses to *P. excelsa*. It does not appear to be of any economic importance in N.W. Europe, but takes the place of *P. excelsa* in the E. Mediterranean region. Young trees are used for Christmas trees in common with *P. excelsa*.

As a cultivated tree in Britain it gives excellent results, but is usually planted more for ornamental than for commercial purposes. It might well be grown under forest conditions, however, particularly in the warmer parts of the country where the results might be expected to equal those of common spruce. It is less susceptible to insect attack than *P. excelsa*. The dwarf forms are excellent plants for rock-gardens.

Elwes and Henry, *loc. cit.* vi, 1362 (1912).

Picea polita, Carrière. (Fig. 79.)

TIGER-TAIL SPRUCE.

Abies Torano, Siebold; A. polita, Siebold and Zuccarini.

The tallest of the Japanese spruces, sometimes attaining a height of 130 ft. but usually only about half that size, with a girth of 3–9 ft. *Bark* rough, pale grey, lightly furrowed, breaking into small irregular-shaped flakes. *Branches* numerous, horizontal, forming a tree of pyramidal outline. *Young shoots* stout, yellowish brown, shining, without hairs. *Buds* ovoid, with obtuse, reddish brown, closely pressed scales. *Leaves* spreading all round the shoot, $\frac{3}{4}$–$\frac{7}{8}$ in. long, with their tips pointing upwards, stout, curved, sickle-like, four-sided, but slightly compressed in section, ending in a spine-like point, stomata on each surface. *Cones* ovoid or cylindrical, stalkless, 3–4 in. long, $1\frac{1}{2}$ in. wide, shining yellowish-green when growing, reddish brown or cinnamon-coloured when mature; *scales* roundish with the upper margin rounded and minutely toothed; bracts minute. *Seed* $\frac{1}{3}$ in. long, with a wing $\frac{7}{8}$ in. long.

The stout, stiff, sickle-shaped leaves, ending in prickly points, resemble those of no other spruce.

As a native tree, *P. polita* is confined to the main island of Japan, where, according to Wilson, it is distributed from the Nikko region southwards, being apparently always found in volcanic soils of recent formation. It is nowhere common except at the northerly end of Lake Yamanaka, where there is a pure forest growing on an old lava flow. This spruce is much cultivated in Japan for decorative purposes. It was introduced into cultivation by John Gould Veitch in 1861.

The use of the wood is confined to local purposes, the species being too scarce for exploitation.

P. polita grows well but slowly in British gardens, where it forms a dense pyramidal tree of considerable beauty. It succeeds

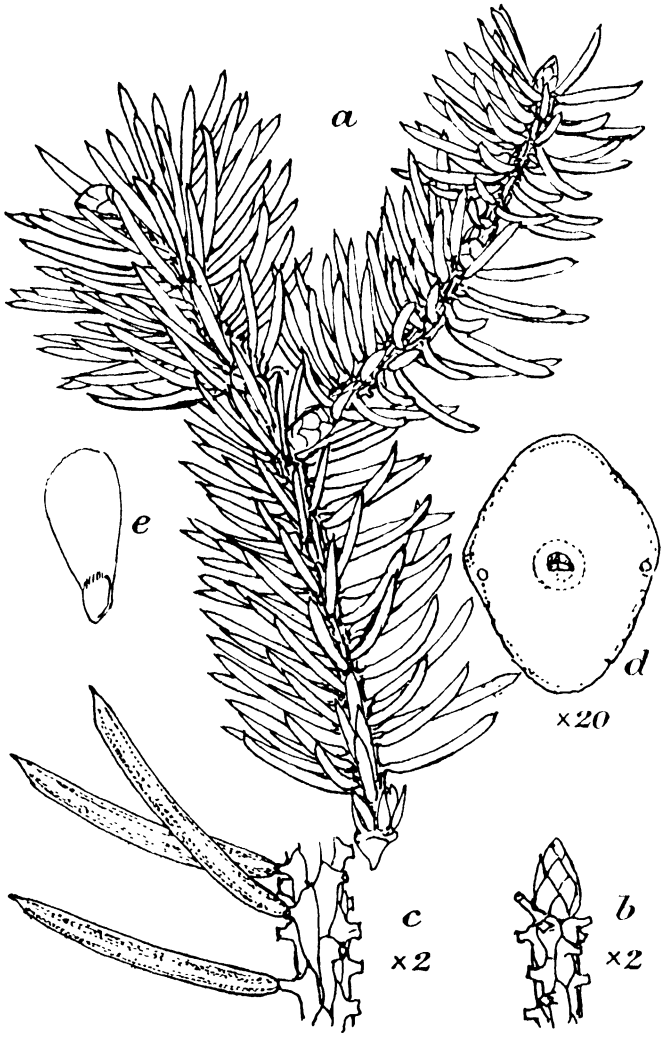

FIG. 79.—*PICEA POLITA*.

a, spray; *b*, winter bud; *c*, under-side of spray and leaves; *d*, section of leaf; *e*, seed.

in moist loamy and peaty soils and is one of the most popular of the rarer species for decorative garden work.

Wilson, *Conifers of Japan*, 36 (1916); Clinton-Baker, *Illustrations of Coniferæ*, ii. 45 (1909).

Picea pungens, Engelmann.

BLUE SPRUCE.

Picea commutata, Hort.; P. Parryana, Sargent; Abies Parlatorei, Hort.

Balsam; Colorado Blue Spruce; Parry's Spruce; Prickly Spruce; Silver Spruce; Spruce; White Spruce.

A tree attaining in N. America 80–100 ft. high, with a trunk up to 9 ft. in girth. *Bark* brownish grey, 1 in. or more thick, deeply furrowed and scaly on old trunks. *Young shoots* stout, without hairs, glaucous at first, becoming orange-brown with age. *Buds* ovoid or broadly conic, $\frac{1}{4}$–$\frac{5}{8}$ in. long, with scales reflexed at the apex. *Terminal bud* with keeled, long-pointed scales at the base. *Leaves* spreading more or less all round the shoot, but more crowded above than below, stout, rigid, incurved, and very prickly, $\frac{3}{4}$–$1\frac{1}{4}$ in. long, varying in colour on different trees, dull green, bluish or silvery white, four-sided, with about six stomatic lines on each side. *Cones* cylindrical but slightly narrowed at each end, 2–4 in. long, green with a reddish tinge before ripening, pale shining brown when mature, remaining on the trees till the autumn of the second season; *scales* numerous, longer than broad, thin, tough, and flexible, narrowing towards the toothed apex; bract much shorter than the scale, acuminate, fringed at the upper edge. *Seeds* $\frac{1}{8}$ in. long, half the length of the wing.

Var. **argentea**, Waterer.

Foliage silvery. Leaves longer and more slender than in the type.

Var. **glauca**, Beissner.

Foliage conspicuously glaucous, especially when young.

Var. **Kosteriana**, Masters.

Branches pendulous, foliage bluish.

Var. **prostrata**, Beissner.

Of prostrate habit.

Var. **tabuliformis**, Beissner.

A dense, low bush, usually with a flattened head.

Var. **viridis**, Regel.

Foliage dull green.

P. pungens may be known by its spreading, prickly leaves, glabrous shoots, and reflexed points of the bud scales. The leaves are usually more rigid than in *P. Engelmanni*, which it resembles to some extent.

This spruce is a native of Colorado, E. Utah, New Mexico and Wyoming, usually growing on the banks of streams or rocky ledges at 6,000–10,000 ft. elevation. It was discovered on Pikes Peak in Colorado in 1862 by Dr. Parry and was shortly afterwards introduced into cultivation. Cuttings were obtained from America in 1877 by Waterer, who planted them in his nursery at Knap Hill.

Wood soft, weak, close-grained, creamy white to pale brown, knotty, the best qualities finishing with a satiny surface; about equal to *P. alba* in quality. Used locally, but of little commercial importance, and said to be the least useful of the American spruces.

P. pungens is grown in Britain for decorative purposes, but is often disappointing. The blue or glaucous-leaved forms are very popular and are strikingly handsome when young, but they are difficult plants to keep in health and many lose their colour and fail after attaining the height of 6–12 feet. Even young plants 2–4 ft. high in nurseries sometimes go wrong and suddenly lose their leaves when in apparently good health. This premature leaf-fall is often due to the presence of *Aphis abietina*; but, being an alpine tree, it also probably misses the long winter's rest to which it is accustomed in a natural state, and becomes enfeebled by our milder and more enervating climate. Although *P. pungens* is constantly planted at low elevations throughout the country, it appears to be better adapted to high ground and may be expected to be a more satisfactory tree in mountainous districts than in the low country of S. England. From a batch of seedlings it is usually possible to select both green and glaucous-leaved forms. The most distinct varieties are obtained by grafting, but var. *glauca* can be raised from seeds.

Sudworth, *The Spruce and Balsam Fir Trees of the Rocky Mountain Region*, 14–17 (1916).

Picea rubra, Link.

Red Spruce.

Picea nigra, var. rubra, Engelmann; P. rubens, Sargent; Abies nigra, var. rubra, Michaux; A. rubra, Poiret; A. rubra, var. arctica, Lindley and Gordon; Pinus americana, Gaertner.

Black Spruce; Blue Spruce; Double Spruce; He Balsam; Spruce Pine.

A tree attaining in N. America a height of 70–80 ft. and a girth of 6–9 ft. *Bark* of trunk reddish brown and scaly. *Branches* slender, spreading, often covering the trunk to the base and forming a tree of conical habit. *Young shoots* reddish brown, very hairy. *Buds* ovoid-conic, more or less concealed by the upper leaves, with long awl-shaped points to the outer scales. *Leaves* crowded, mostly on the upper side of the shoot, yellowish or grass-green, more or less incurved and twisted, ½–⅝ in. long,

blunt or short-pointed at the apex, with 2–4 stomatic lines on each surface. *Cones* ovoid cylindric, narrowing abruptly to a stalk-like base, 1½–2 in. long, ¾ in. broad, green or purplish when growing, shining brown when ripe, usually deciduous in the second year ; *scales* ⅔ in. long, the upper margin entire or toothed. *Seeds* mottled dark brown, ⅛ in. long with a wing about ⅔ in. long.

Forma **vegeta**, Rehder.

This differs from the type in the long, slender branches which are entirely without branchlets. It was found at the base of Mount Hopkins, Massachusetts, as a single tree from which grafts were taken and propagated at the Arnold Arboretum. It has a parallel form in the European snake spruce, *P. excelsa*, var. *virgata*. [See *Rhodora*, ix, p. 110 (1907)].

P. rubra is distinguished from all the other spruces by its crowded, incurved, grass-green leaves, peculiar bud-scales, and hairy shoots.[1] It is allied to the black spruce, which has similar shoots and bud-scales, but the foliage is glaucous-green and almost straight.

The red spruce is found wild in Nova Scotia, Prince Edward Island, the valley of the Saint Lawrence and the N.W. United States. Extensive forests of it occur in New York, where in the Adirondacks it reaches 4,500 ft. altitude. It extends through the Alleghany Mountains to Pennsylvania and N. Carolina.

Wood very similar to that of *P. alba* and used for similar purposes.

It is not common in Britain, but a good specimen exists at Stanage Park, Radnorshire, the seat of Mr. C. Coltman Rogers.

Picea australis, small, is closely allied to *P. rubra*, from which it is said to differ in its young shoots being glabrous, or hairy only in the furrows, and in its smaller cones, which are rarely 1 in. long, and fall immediately after shedding their seeds.

It is a native of Virginia and N. Carolina.

Small, *Flora, S.E. United States*, 30 (1903).

Picea Schrenkiana, Fischer and Meyer.

SCHRENK'S SPRUCE.

Picea obovata, var. Schrenkiana, Carrière ; Abies Schrenkiana, Lindley and Gordon.

A large tree, 100 or more ft. high in its native country, where it often assumes a narrowly pyramidal or columnar habit. *Young shoots* grey, glabrous or with scattered hairs. *Buds* ovoid or dome-shaped with obtuse scales, the terminal bud surrounded

[1] We have seen forms of *P. excelsa* with very hairy shoots, but the buds of the latter species are quite distinct.

by long-pointed, hairy scales. *Leaves* spreading more or less all round the shoot, dark shining green, resembling in appearance those of *P. Morinda*, but shorter, dense, and pointing forward on the upper side of the shoot, those on the lower side less numerous and spreading, ¾–1¼ in. long, rigid, tapering to the sharp-pointed apex, obscurely quadrangular in section with about 3 stomatic lines on each side. *Cones* cylindric, blunt, 3–4 in. long by 1–1¼ in. wide, dark shining brown; *scales* numerous, closely overlapping, longer than broad, with the upper margin wavy. *Seed* ⅛ in. long, with a wing ½ in. long.

Resembling *P. Morinda* in foliage, but the branchlets are not pendulous, and the leaves are shorter and less regularly arranged round the shoot.

This spruce is widely distributed in Cent. Asia, especially in Russian Turkestan, where it forms large forests at from 4,500–10,000 ft. elevation. It extends eastward through Chinese territory along the Thianshan Mountains. It was first found in 1840 in Soongaria by Schrenk, after whom it was named.

P. Schrenkiana was introduced into cultivation in the late seventies of last century, but has never become common, and we have seen no plants above 12 ft. high in English gardens.

Although the wood of this spruce appears to be very similar to that of *P. excelsa*, the inaccessibility of the forests and their long distance from the coast prevent the successful exploitation of the timber.

It is unsuitable for general cultivation in Britain.

Elwes and Henry, *loc. cit.* vi, 1364 (1912); Clinton-Baker, *loc. cit.* ii, p. 48 (1909).

Picea sitchensis, Carrière. (Fig. 80.)

SITKA SPRUCE.

Picea Menziesii, Carrière; P. sitkaensis, Mayr; Abies Menziesii, Loudon; A. sitchensis, Lindley and Gordon; Pinus Menziesii, Douglas; P. sitchensis, Bongard.

Great Tideland Spruce; Menzies Spruce; Silver Spruce; Tideland Spruce; Western Spruce.

A tree attaining a height of 160–180, or occasionally 200 ft., and a trunk-girth of 24–36 ft. or more above the buttressed base in W.N. America, but ordinarily 100–125 ft. high, with a trunk 9–18 ft. in girth. Exposed trees are of broadly pyramidal outline, but those grown close together under forest conditions have gradually tapering trunks clear of branches for 40–80 ft. In Alaska it is much smaller, often becoming shrubby in habit. *Bark* dark purple or reddish brown, with thin exfoliating scales. *Young shoots* light brown or buff-coloured, without hairs. *Buds* ovoid, with obtuse scales. *Leaves* flattened, rigid, standing out all round the shoot, ½–¾ in. long, ending in sharp, horny points which render the leaves prickly to the touch,

dorsal surface bright green, deeply keeled; ventral surface with two broad white bands of stomata. *Cones* oblong, cylindrical, 2–4 in. long, light brown when mature; *scales*, thin, papery, oblong or oblong-oval, with unevenly toothed margins; *bracts*

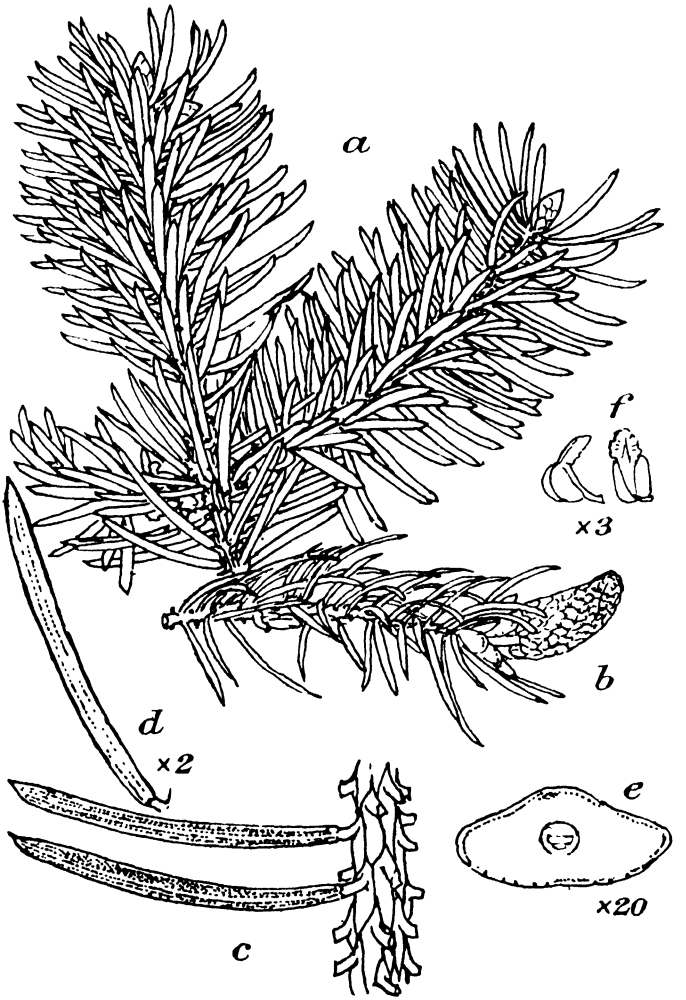

FIG. 80.—*PICEA SITCHENSIS.*

a, spray; *b*, branch ending in male catkin; *c*, shoot and leaves, from beneath; *d*, leaf from above; *e*, section of leaf; *f*, stamens.

lanceolate, about half as long as the scales. *Seed* with a wing three or four times its length.

P. sitchensis may be distinguished from the other flat-leaved spruces by its stiffly spreading, prickly leaves, which are strongly keeled on the dorsal surface, and blue-green in colour.

The Sitka spruce extends further north-west than any other N. American conifer, its westerly limit being the east end of Kadiak Island. It extends through the coast region of Alaska, British Columbia, W. Washington, Oregon, southwards to N. California, rarely extending inland more than 50 miles. It was first found in 1792 at Puget Sound by Archibald Menzies, the distinguished traveller after whom it was first named by Lindley, but was not in cultivation until introduced by Douglas in 1831.

Wood light in weight, straight-grained, long-fibred, strength value very high in comparison to weight; soft, easily worked, finishing with a fine, smooth, satiny surface, sapwood cream-coloured, heartwood a little darker or sometimes pinkish; shrinkage small, even. The most valuable of all spruce woods, and obtainable in large dimensions; planks up to 30 ft. long and 30 in. wide, and narrower planks up to 40 ft. long. It is used for building construction, aircraft, general joinery, and all the other purposes of spruce, including pulp for paper manufacture. Its combined qualities of strength and lightness render it peculiarly suitable for aeroplane construction, and during the war the timber, which had previously been scarcely known in England, was in great demand and became one of the most widely used woods for this purpose. Large quantities were imported from British Columbia and U.S. ports under the name of silver spruce, a trade name which at first included other woods, probably *Picea Engelmanni* and *Tsuga Albertiana*, but was later restricted to *P. sitchensis*.

Tests made on green material by the Canadian Forest Products officials are given in the *Catalogue of the Empire Timber Exhibition* (London), 1920, as follows:

Weight, green (moisture 25 per cent., wood 75 per cent.), 29 lb. per cubic ft.

Tension, strength across the grain, 299 lb. per square in.

Compression, strength across grain at elastic limit, 288 lb. per square in.

Compression, crushing strength with the grain, 2,574 lb. per square in.

Shearing, strength with the grain, 625 lb. per square in.

Bending, modulus of rupture (breaking strength), 5,454 lb. per square in.

Bending, modulus of elasticity (stiffness), 1,413,000 lb. per square in.

Hardness, weight required to half imbed a 0·444 in. steel ball, 352 lb.

Compared with the wood of *P. Engelmanni*, it is much stronger, and each species should therefore be marketed under distinct names.

P. sitchensis gives excellent results under cultivation in

Photo lent by Sir John Stirling Maxwell Bart

PLATE XVIII. SITKA SPRUCE (*PICEA SITCHENSIS*) AGE ABOUT 18 YEARS, AT DRUMLAURIG, MORTON MAINS, SCOTLAND.

Britain, thriving from sea-level in the mildest parts of the country up to a considerable elevation in exposed parts of the Scottish Highlands. Under mild climatic conditions it sometimes grows very fast, forming leading shoots 4–5 ft. long in a single season. It succeeds in sandy soil quite close to high-water mark and also in wet, boggy land at altitudes of 1,000–1,400 ft. Planted in places where European spruce has failed it is growing vigorously and is giving good results on cold bogland in exposed places in W. Scotland where cold weather is experienced until late spring. Sir John Stirling Maxwell is using it extensively at Corour at an elevation of 1,400 ft. to plant very wet bogland where there have been failures with other trees. On this estate, under the Belgian or raised-turf system of planting, it is growing well and forming shoots 12 in. or more long each year. Two of the best plantations in N. Britain were, in 1923, on Mr. H. J. Baird's estate in Kincardineshire. The larger of the woods, extending to 83 acres, lay on north and north-west slopes at elevations of 700–800 ft. The soil is deep peat, and at planting-time was so wet that deep, open drains had to be made at frequent intervals. In this case a mixture of Sitka spruce, common spruce, Scots pine, and Douglas fir was planted. The other was a pure plantation of about 12 acres at an elevation of 900 ft. Planting in both cases was carried out in 1878, and when one of us saw the trees in 1912 the Sitka spruce averaged 50 ft. in height and the larger ones contained 16–18 cubic ft. of timber. In the bigger plantation Sitka spruce had gained the ascendancy over other species, many of which had been suppressed. The smaller plantation had not been thinned, and most of the trees were of rather small girth.

Ornamental specimens exceeding 100 ft. in height exist in Britain. In British Columbia the best trees are found at the lower elevations in rich valley bottoms, and commercial timber is rarely found at a greater altitude than 1,000 ft. It forms less than 7 per cent. of the merchantable timber of the coast forests, although single trees have been known to contain from 8,000–10,000 board ft. and occasionally 15,000 board ft. of timber. Seed of high germinating quality is produced in abundance and reproduction is good in moist soils rich in vegetable matter. Young trees withstand a good deal of shade. Unless grown close together the branches live for a considerable time and the wood becomes knotty. In British Columbia Sitka spruce is sometimes seriously harmed by a bark beetle, *Dendroctomus obesus*, Mannh.; it is the host of one generation of *Chermes cooleyi*, Gillette, which also attacks Douglas fir and is referred to under the description of that tree. In Britain it is sometimes injured by the green fly, *Aphis abietina*: see generic description.

Sudworth, *Trees of the Pacific Slope*, p. 81 (1908); Whitford and Craig, *Forests of British Columbia*, 199 (1918).

Picea Wilsoni, Masters.[1] (Fig. 81.)

P. Watsoniana, Masters.

A small tree, about 40 ft. high in China, with slender, horizontal branches of more or less equal length from the base to the top of the tree. *Young shoots* pale brown or buff-coloured, shining,

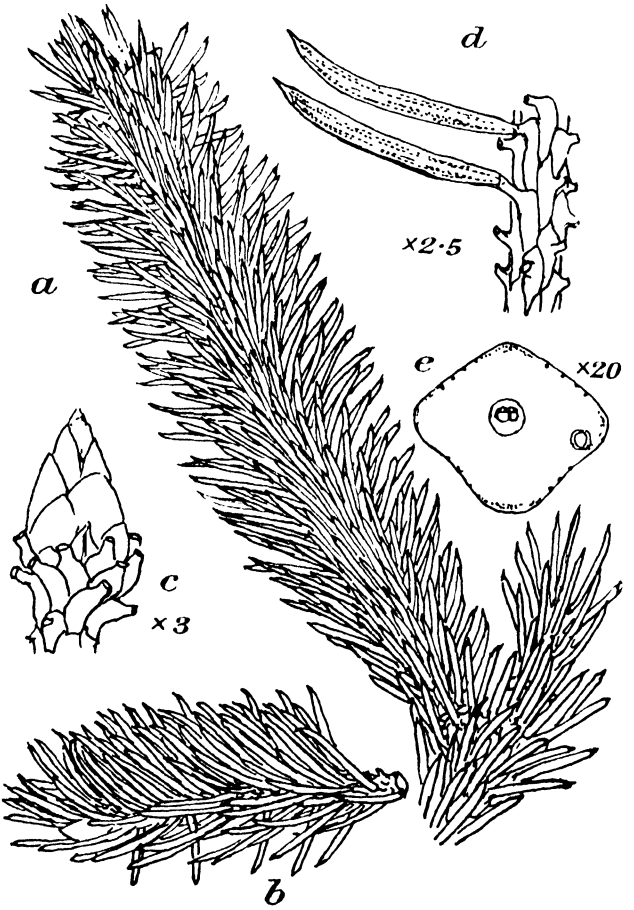

FIG. 81.—*PICEA WILSONI.*

a, spray from above, *b*, from side; *c*, winter bud; *d*, under-side of shoot and leaves; *e*, section of leaf.

furrowed, becoming grey with age. *Winter buds* ovoid, up to about ⅓ in. long, with chestnut brown scales *Leaves* densely clothing the shoot above, but spreading in two lateral sets below at right-angles to the shoot, quadrangular, dark shining green, up to 1 in. long, very narrow, slightly curved with 3–4 lines of stomata on each surface. *Cones* small, about 2 in. long, falling from the tree soon after they are ripe; *scales* pale brown,

[1] *Gard Chron.* Ser. 3, xxxiii, 133, fig. 55, 56 (1903).

glabrous, with rounded, entire or irregularly toothed margins.

Frequent on the mountains of N.E. Hupeh, China, between 4,800–7,500 ft. altitude, and also occurring in N.W. Szechuen.

Young plants in collections differ from all the other Chinese spruces in cultivation by their very narrow, dark shining green, sharp-pointed leaves.

Pl. Wils. ii, 27 (1914).

PINUS, Linnæus.

Pines.

The true pines are evergreen resin-yielding trees, belonging to the tribe *Abietineæ* and widely distributed in the northern hemisphere from the limit of tree growth on the plains of N. Europe, Asia, and N. America, to the sub-tropical regions of N. Africa, the Canary Islands, Asia Minor, Burma, the Philippine Islands, Central America, Florida, the Bahamas, and British Honduras. In tropical countries they are usually found at sub-tropical or warm temperate altitudes, rarely on the plains.

Young to middle-aged trees are usually of pyramidal habit with horizontal branches disposed in regular whorls, but mature trees may have flat, round, or spreading crowns. The trunks of isolated trees are usually large at the base and taper rapidly as they advance in height, the lower branches being retained throughout life. Forest-grown trees lose their lower branches early and mature with long, clean, columnar trunks with little taper but smaller at the base than those of isolated specimens. In a few species the production of more than one leading shoot is fairly common.

Bark usually thick, rough, and deeply furrowed, but in some species thin and scaly. The long shoots produced in spring either form a single internode [1] consisting of (*a*) a leafless base which often bears the staminate flowers, (*b*) a longer upper portion bearing foliage and ending in a terminal bud surrounded by a whorl of smaller buds, one or more of which may be replaced by pistillate flowers (young cones), or the long shoot consists of two, or rarely more, internodes,[2] each with a leafless base, a leaf-bearing portion, and a whorl of buds. Some species are liable to produce occasional shoots bearing juvenile leaves until advanced in age. Such shoots often appear from adventitious buds. The terminal buds vary in character in different species as regards the shape and character of their scales, which may be resinous or non-resinous.

Leaves of three kinds: (*a*) *Primordial* leaves borne on seedling plants, solitary, spirally arranged, linear lanceolate, and toothed; (*b*) *Scale* leaves bearing in their axils the short shoots, triangular

[1] Termed uninodal pines by Shaw, *Genus Pinus*.
[2] Multinodal pines of Shaw.

lanceolate entire or fringed in margin, and soon deciduous, except the basal portion; (*c*) *Adult* leaves, needle-like, persistent 2 or more years, borne in clusters usually of 2, 3, or 5, according to species, sometimes more in luxuriant plants, margin often minutely toothed, the section semi-circular in the two-leaved species, triangular in three- to five-leaved species; fibro-vascular bundle branched or simple; resin canals 2 or more, varying in position.[1] Sheath enclosing the leaf-bundles persistent; deciduous or partly so. The leaves when bruised emit a pungent odour owing to the liberation of an oleo-resin rich in oil of turpentine.

Male and female flowers appearing on the same tree and borne during late spring and early summer. *Male flowers* yellow or reddish, produced in groups of cylindrical cones round the base of the young shoot; their presence in winter being noticeable by a distinct swelling around the base of the bud. The male flower consists of numerous overlapping, stalkless, two-celled anthers, with a crest-like roundish connective. *Female flowers* in cones usually terminal or subterminal, but occasionally borne at irregular intervals on the young shoots, composed of two series of scales, very minute bracts which disappear in the ripe cone and large ovuliferous scales, each of the latter bearing two pendulous ovules. The scales open to receive the wind-distributed pollen in the first year and close immediately afterwards, actual fertilization of the ovule, i.e. the arrival of the pollen tube at the embryo sac, not occurring until May or June of the following year, when the cone rapidly increases in size, usually ripening at the end of the second year, but in *P. Pinea* and *P. leiophylla* not maturing until the third autumn. The male flowers shrivel and fall soon after the dispersal of the pollen. Mature cones very variable in outline, symmetrical or oblique, the scales thin, or thick and woody. Exposed part of each scale thickened and showing the apex of the growth of the first year as a terminal or dorsal protuberance or scar called the umbo, which is often provided with a prickle or stout hook. The cones of most species open their scales when ripe and release the seeds, but in a few species the scales remain closed and the seeds are liberated by the cones falling and rotting or by squirrels and other animals in search of food. In some species the cones remain on the trees unopened for many years, the scales ultimately separating when scorched by forest fires.

Seeds nut-like, the kernel being surrounded by a shell (testa) of varying hardness. In many species each seed is furnished with a wing which aids in dispersal, but in other species the wing is rudimentary or absent.

The *wood* is fairly uniform in character, with the early (spring)

[1] The resin canals may be:—1. Marginal against the hypoderm; 2. Internal against the endoderm; 3. Medial in the green tissue; 4. Septal, touching both endoderm and hypoderm.

and late (summer) wood well marked. The medullary rays are numerous but fine. Heartwood and sapwood are well defined, particularly in the species known as "hard pines," where the heartwood is much darker than the sapwood. In the "soft" or "white pines" the dividing line is also well defined, although the colour is paler and more uniform. Newly worked wood has a resinous odour which varies in intensity according to species. It is very inflammable, so much so that wood of some species has been used for torches.

Many of the pines yield timber of vast economic importance which is used for innumerable purposes, including the construction of bridges and viaducts, house-building, railway sleepers, and street paving blocks, furniture, pattern-making, toys, carving, box-boards, paper pulp, etc. When used in contact with the ground, however, the wood should be treated with creosote or some other preservative.

Several species yield (by tapping) an oleo-resin which by distillation furnishes turpentine and rosin. The wood is subjected to distillation by two distinct methods, destructive or dry distillation, and steam distillation. By the former method the wood is calcined in retorts in the absence of air. As the various gases or vapours are given off they pass by special openings into a copper condenser. The crude distillate is then refined and yields light and heavy tar oils, turpentine, pitch, pyroligneous acid, etc. The residue of the wood is withdrawn as charcoal. A smoke deposit furnishes lampblack, and various gases are available for fuel. Roots and waste wood can be profitably dealt with by this means. An average cord of wood (128 cubic ft.) of *P. palustris*, in the United States, yields 7 gallons of turpentine, 2 gallons of pine oil, 32 gallons of tar oils, 41 gallons of tar and pitch, and 39 bushels of charcoal.[1] In steam distillation the wood is reduced to small chips before placing in the retort; it is then treated with steam for several hours, which removes most of the turpentine and oils. The steam and oil are then passed into a condenser and thence into a separator. After various processes, turpentine, pine oil, and rosin are obtained. An improvement on the steam extraction of these products is the use of a solvent such as naphtha, benzol, gasoline, etc.[2] Pine-leaf oil is procured by distillation of the leaves of certain species. This is chiefly used for medicinal purposes. The leaves are sometimes reduced to fibre which is used for weaving into medicated underclothing, for the manufacture of coarse matting resembling coco-nut matting, for surgical dressings, and for stuffing upholstery, mattresses, etc.[3] The

[1] Brown, Nelson Courtlandt, *Forest Prods., their Manuf. and Use*, 229 (1919).
[2] *Loc. cit.* 231.
[3] *Pine-needle Fibre.* Dipl. and Cons. Rep., Ann. Ser. (State of Oregon), Nos. 2,570, p. 9, and 2,666, p. 23 (1900).

water used in the reduction of the leaves to fibre is used for medicinal baths.

The seeds of a number of species are an important article of food, whilst the inner bark and sapwood have also been used for food in times of scarcity by the North American Indians.

The variable quality of the timber, not only of different species but of the same species of pine, makes comparison of the economic properties difficult, but for general purposes they may be grouped as follows, taking the first-named species in each group as the standard of quality :

Timber: Hard Pines.

Grade A.

Pinus palustris.
,, *caribœa.*
,, *canariensis.*

Grade B.

Pinus sylvestris.
,, *resinosa.*
,, *Thunbergii.*
,, *densiflora.*
,, *Laricio.*

Grade C.

Pinus mitis.
,, *ponderosa.*

Grade D.

Pinus Pinaster.
,, *Pinea.*

Grade D—*continued.*

Pinus halepensis.
,, *radiata.*
,, *muricata.*
,, *Tæda.*
,, *glabra.*
,, *longifolia.*
,, *contorta*, var. *Murrayana.*

Grade E.

Pinus Banksiana.
,, *contorta.*
,, *virginiana.*
,, *Coulteri.*
,, *Sabiniana.*

Timber: Soft Pines.

Grade A.

Pinus Strobus.
,, *monticola.*
,, *Lambertiana.*
,, *koraiensis.*

Grade B.

Pinus Cembra.
,, *excelsa.*
,, *Peuke.*

Grade C.

Pinus parviflora.
,, *flexilis.*

Pines from which Turpentine and Rosin are obtained.

Europe.

Pinus Pinaster.
,, *sylvestris.*
,, *Laricio.*
,, *halepensis.*

India.

Pinus longifolia.
,, *excelsa.*
,, *Merkusii*
,, *Khasya.*

Pines from which Turpentine and Rosin are obtained (*continued*).

N. AFRICA.

Pinus halepensis.

N. AMERICA.

Pinus palustris.
,, *caribœa.*
,, *mitis.*
,, *ponderosa.*

Pines with Edible Seeds.

EUROPE.

Pinus Pinea.
,, *Cembra.*

CHINA.

Pinus Armandi.

SIBERIA.

Pinus Cembra.

N. AMERICA.

Pinus cembroides.
,, ,, var. *edulis.*
,, ,, var. *monophylla.*
,, ,, ,, *Parryana.*
,, *Sabiniana.*
,, *Torreyana.*
,, *Coulteri.*

INDIA AND AFGHANISTAN.

Pinus Gerardiana.

Cultivation.— Pines are naturally light-loving trees, and although a few species withstand partial shade for several years they are suppressed sooner or later if full light is not available. Most of the species require well-drained soil, but a few, notably *P. Tæda*, succeed on wet land. Several species thrive in the pure sand of dunes near the sea, others in gravelly soil or amongst rocks where soil is scarce, on poor ground that has gone out of cultivation, in good loam and in peat; whilst a few may be grown on clayey soil. Certain species are unsuitable for limy soil, but others, such as Austrian pine, thrive in soil of a calcareous nature. Some withstand a good deal of exposure and are amongst the best of all trees for affording shelter in wind-swept areas. The species that can be successfully grown in the British Isles require well-drained land, and it is useless planting them in wet places or in sour soil. Pure atmospheric conditions are essential, and it is useless planting pines in the neighbourhood of smoky towns or near large chemical works.

As some species are very widely distributed it is necessary when collecting or purchasing seed to give attention to the country and altitude where the seedlings are to be grown. Thus, seeds of a species distributed longitudinally for 500 miles if collected at the most southerly limit may produce trees that are too tender to be grown at the most northerly extreme of distribution, and trees raised from seeds collected at a low altitude may be tender in a country with a more northerly latitude, whereas seeds from

a higher altitude on the same mountain may produce trees that are perfectly hardy in a more northerly country. At the same time seeds taken from trees growing in a very cold region and planted in a much warmer country may not give good results, owing to the restricted resting period causing premature activity in spring, when late frosts and cold winds cripple the young shoots. Seeds of *P. sylvestris* ripened in Scotland produce plants more suitable for the British Isles than those matured in N. Russia or at a considerable elevation in the Alps. It is also wise to take seeds from well-grown trees rather than from indifferent specimens. Cones that do not shed their seed readily may be assisted by the judicious application of fire-heat. When purchasing seed, new seed only should be taken, for although that of certain species may be kept in cold storage for several years and maintain a fair germination percentage, new seed is always the best. The more oily the seeds the sooner do they lose their vitality.

In raising large numbers of seedlings, the seeds should be sown out of doors in March or early April, in beds 4 ft. wide separated by narrow paths, after thorough preparation of the soil, the seeds being covered by about ½ in. of light soil made moderately firm. Protection from mice and birds must be provided, and when the seedlings appear they must be shaded (if necessary) from hot sun. Small quantities of seed may be sown in pots or boxes in cold frames, but plants so raised must be lined out in nursery borders at an early date. Seedlings may be left for one or two years in the seed-beds according to their size and closeness. They must then be lined out in nursery borders for one or two years before planting in permanent places. The roots must not be allowed to become dry between lifting and planting. All pines are impatient of root disturbance, and when started in nurseries they should be transplanted to permanent places when not more than 12 in. high unless they can be given individual attention afterwards ; even then it is not wise to defer permanent planting until after the plants are 2 ft. high. The planting time varies according to climatic conditions. Where mild and moderately moist weather is experienced during winter, planting may be carried out at any period between the middle of September and the middle of April. Where dry spring weather prevails planting is best done in autumn or early winter, but where severe weather is experienced and growth begins late in spring, planting may be delayed until May or early June. Deep planting must be avoided, the top roots being just covered with soil.

The preservation of the terminal shoot from injury is important, for an interruption of the terminal axis may result in the suppression of the tree. Well placed, vigorous trees may produce several leading shoots from adventitious buds after an injury

to the original leader. In such cases an early removal of superfluous shoots is necessary to prevent permanent injury to the trees. Weakly trees, however, rarely recover from a serious injury to the leader. In a few species the production of more than one leading shoot is characteristic, and in such cases it is unnecessary to restrict the trees to a single leader. Lower branches of forest-grown trees are killed from lack of light, and they usually fall naturally; any that remain after the trees begin to increase rapidly in girth, however, should be removed to prevent knotty wood. Ornamental trees may be pruned when necessary during summer or winter, but they do not respond so readily to branch-shortening as do broad-leaved trees, and it is often better to remove branches outright than to shorten them. Lower branches of isolated trees must be removed gradually to prevent too great an area of trunk being suddenly exposed to bright sun.

Numerous diseases due to insect or fungus agency attack the pines. Some are of little more than local importance and are easily dealt with, but others cause widespread destruction. A few of the most destructive insects are :—*Hylobius abietis*, Linnæus (Pine Weevil) and *Hylastes ater*, Payk., which destroy young plants. The larvæ feed on dead wood such as old stumps and roots, but the mature insects feed on the bark of young trees and sometimes ruin whole plantations. Correct cultural methods and logs of young Scots pine wood placed about the plantations as traps are the most effective means of dealing with the pest; traps must be frequently examined, the weevils being collected and destroyed. The Pine Bark Beetles (*Myelophilus piniperda*, Linnæus, and *M. minor*, Linnæus), the Pine Longicorn Beetle (*Rhagium bifasciatum*, Fabr.), and the Banded Pine Weevils (*Pissodes notatus*, Fabr., and *P. pini*, Linnæus), cause injury by the larvæ feeding on the cambium. Sickly or dying trees are usually the first to be attacked. Their removal and the immediate burning of the bark may check the spread of the pest. The bark should be removed from cut timber in places where this insect is known to be. The Pine Sawfly (*Lophyrus pini*, Linnæus) is sometimes destructive amongst young trees from the larvæ feeding on the leaves. Hand-picking and destroying the larvæ are the most effective means of coping with this insect, other than the protection of insect-eating birds. The Resin-gall Tortrix Moth (*Retinia resinella*, Linnæus) and the Pine-shoot Tortrix Moth (*R. buoliana*, Schiff), cause considerable injury to young and old trees by the larvæ destroying the leading shoots of trunks and branches. In some cases injured leading shoots recover, but an ugly curve is given to the trunk, which is very noticeable for many years. Hand-picking of injured shoots and the preservation of insect-eating birds appear to be the only means of

dealing with these moths. The Pine Looper Moth (*Bupalus piniarius*, Linnæus), the Pine Moth (*Gastropacha pini*, Ochsch), the Black Arches Moth (*Limantria monacha*, Linnæus, and the Pine Sphinx Moth (*Sphinx pinastri*, Linnæus), sometimes cause considerable injury in this or other countries by feeding upon the leaves. Pine Aphides (*Chermes* spp.) are often present upon Weymouth, Scots, and other pines. They are distinguished by the white, woolly protective covering, and stems, leaves, and cones are sometimes white with insects. They are capable of causing considerable injury, and they should be kept in check by spraying infested trees with a paraffin wash and by seeing that all trees are perfectly clean before leaving the nursery. Cut timber may be attacked by Giant and Blue Wood Wasps (*Sirex gigas*, Linnæus, and S. *juvencus*, Linnæus). The wasps should be destroyed whenever possible, for their larvæ sometimes ruin timber during the seasoning process.

Fungi such as *Rhizina inflata*, Quelet, *Trametes radiciperda*, Hartig, and *Armillaria mellea*, Vahl, sometimes kill many trees by attacking the roots and the portion of stem immediately above the roots. Trees planted too deeply are very susceptible to attack. Attention to drainage and shallow planting are safeguards against attack, but where stumps and roots of old trees are present in newly planted ground there is always danger. Should an area of woodland be attacked, the infected trees should be dug up and burnt, and a deep trench be dug around the area to prevent the spread of the fungus to the roots of other trees. Fruiting bodies of the fungi should be collected and burnt. Weymouth Pine Rust (*Cronartium ribicolum*, Dietrich), is often disastrous to Weymouth and other "five-leaved" pines. It is conspicuous on the bark in the form of greyish bodies enclosing orange-coloured spores. These spores pass on to the leaves of *Black Currant Bushes*, where another stage in the life-history is passed, the spores of this stage passing again to the pine. Affected pines should be burnt and black currant bushes should be removed from the neighbourhood of plantations. Pine wood is very susceptible to attacks by the Dry Rot Fungus (*Merulius lacrymans*, Fries), and any wood in contact with the earth, or used in places where there is not a free circulation of air, should be protected with creosote or some other suitable preservative. *Bluing* is a condition often noticeable in pine timber. The wood, particularly the sapwood, is more or less deeply stained by blue marks. This indicates the first stage of decay, the discoloration being due to fungus agency. Careful attention to seasoning usually prevents loss from the cause. In the earlier stages bluing does not appear seriously to affect the strength of the wood.

Pinus.

KEY TO THE SPECIES IN CULTIVATION BASED ON THE CHARACTERS OF THE LEAVES AND VIGOROUS YOUNG SHOOTS.

I. *Leaves in Fives.*

Leaf-sheath persistent.
- Young shoots stout, glaucous. Buds cylindric-conic, ½ in. long.—*P. Torreyana.*
- Young shoots stout, not glaucous. Buds ovoid, pointed 1 in. long.—*P. Montezumæ.*
- Young shoots slender, glaucous. Buds, leaves and scales as in P. Montezumæ.—*P. pseudo-strobus.*

Leaf-sheath partly deciduous, basal portion persisting as a rosette.
- Leaf speckled with white resinous exudations.—*P. aristata.*
- Leaves without resinous exudations.—*P. Lambertiana.*

Leaf-sheath ultimately deciduous.
- Leaves with margins minutely toothed.
  - Young shoots glabrous.
    - Shoots glaucous green. Leaves dark or glaucous green, spreading, sometimes slightly bent at base. Cones 6–12 in. long, 1½–2 in. wide; scales thin.—*P. excelsa.*
    - Shoots olive green, sometimes minutely glandular. Leaves yellowish green, 4–6 in. long, sharply bent at base. Cones 4–7 in. long, 2–3½ in. wide; scales thick, often reflexed at apex.—*P. Armandi.*
    - Shoots shining green. Leaves 3–4 in. long, not bent at base.—*P. Peuke.*
  - Young shoots hairy.
    - Winter buds with closely pressed scales.
      - Shoots with dense, shaggy, orange brown hairs. Leaves entire at apex.—*P. Cembra.*
      - Shoots with short, dense, often glandular hairs.
        - Leaves twisted in upper half, blunt at apex.—*P. monticola.*
        - Leaves twisted a complete turn, sharp at apex.—*P. Lambertiana.*
      - Shoots with minute tufts of hairs below the insertion of the leaves. Leaves very slender.—*P. Strobus.*
      - Shoots with scattered, minute hairs. Leaves 1–2 in. long, curved, usually blunt at apex.—*P. parviflora.*
    - Winter buds with scales free at tips.
      - Leaves as in *P. Cembra*, but teeth continued to the blunt tip.—*P. koraiensis.*
      - Leaves as in *P. excelsa.*—*P. Ayacahuite.*

Leaves with entire or obscurely toothed margins.
Leaves 2–3 in. long, stout, rigid, curved.—*P. flexilis.*
Leaves as in *P. Cembra*, but shorter 1½–2 in. long.—*P. pumila.*
Leaves as in *P. flexilis*, but the species is scarcely distinguishable in the absence of cones.—*P. albicaulis.*

II. *Leaves in Threes.*

Leaf-sheaths persistent.
Leaves 6 in. or more long.
Buds more or less resinous, 1–1½ in. long, with points of scales appressed.
Buds ovoid, stout, 1–1½ in. long, sharply pointed. Leaves very stout, yellowish green spreading.—*P. Coulteri.*
Buds cylindric-conic, 1 in. long. Leaves dark green, densely crowded on the branchlets.—*P. ponderosa,*
Buds narrowly cylindrical, 1 in. long. Leaves greyish green, sparsely arranged.—*P. Sabiniana.*
Buds non-resinous, ½–2 in. long, with points of scales free.
Young shoots stout, glaucous. Buds stout, cylindric-conic or ovoid, 1 in. long, with brown scales.—*P. ponderosa*, var. *Jeffreyi.*
Young shoots stout, orange brown. Buds with silvery white fringed scales, 1½–2 in. long.—*P. palustris.*
Young shoots slender, glaucous. Leaves very slender, drooping. Cones 3–4 in. long.—*P. patula.*
Young shoots yellow. Leaves slender. Cones 6–9 in. long, cylindric-conic.—*P. canariensis.*
Leaves and shoots as in *P. canariensis.* Cones ovoid-conic, 4–8 in. long.—*P. longifolia.*
Buds non-resinous, about ½ in. long, with the points of the scales free and reflexed.
Young shoots yellowish brown. Leaves rigid in tufts at end of branches. Scale leaves persistent.—*P. Tæda.*
Buds resinous, ¾ in. long, points of scales free, young shoots glaucous. Leaves 4–8 in., rigid, spreading.—*P. Teocote.*
Leaves less than 6 in. long.
Young shoots greenish. Buds cylindrical, ½–¾ in. long. Leaves bright or grass green, soft in texture.—*P. radiata.*
Young shoots reddish brown. Buds cylindrical, ¾–1 in. long. Leaves rigid, dark green.—*P. tuberculata.*
Young shoots greenish. Buds cylindric-conic, ¼–¾ in. long. Leaves rigid, often produced on the main stem.—*P. rigida.*[1]

[1] *P. serotina* is distinguished from *P. rigida* by the longer leaves and different cones.

Leaf-sheath deciduous.

Bark smooth like a plane. Shoots smooth. Leaves rigid, dark-green, 2–3 in. long. Basal sheath deciduous in first year.—*P. Bungeana.*

Foliage as in *P. Bungeana,* but leaf-sheaths deciduous in the second year.—*P. Gerardiana.*

Leaves occasionally in fours or fives, 3–4 in. long, often appearing on the trunk as in *P. rigida.*—*P. leiophylla.*

III. *Leaves Solitary or in Twos, Threes, or Fours on the same Branch.*

Leaf-sheath partly deciduous, basal portion persisting as a rosette.

Leaves solitary, rigid, circular in section, 1–2 in. long, sharp-pointed, sparingly arranged on the branches.—*P. cembroides,* var. *monophylla.*

Leaves in twos, rarely in threes, sparsely arranged.—*P. cembroides,* var. *edulis.*

Leaves in threes, rarely in twos, densely crowded.—*P. cembroides,* var. *typica.*

Leaves in fours, rarely in fives, remotely arranged.—*P. cembroides,* var. *Parryana.*

Leaf-sheath persistent.

Shoots glaucous or with a reddish tinge. Leaves in twos and threes, 3–5 in. long.—*P. mitis.*

IV. *Leaves in Pairs.*

Winter buds non-resinous; scales with free and recurved points.

Shoots yellowish brown. Buds stout, spindle-shaped, pointed, up to 1 in. long. Leaves 5–6 in. long, stout, rigid.—*P. Pinaster.*

Shoots glaucous green. Buds $\frac{1}{3}$–$\frac{1}{2}$ in. long, leaves 2–4 in. long, slender.—*P. halepensis.*

Shoots yellowish. Buds about $\frac{1}{4}$ in. long. Leaves about 5 in. long, conspicuously flattened.—*P. Pinea.*

Winter buds slightly resinous, bud-scales free at the tips, but not reflexed.

Bark of upper part of trunk reddish. Shoots greenish. Leaves 1–4 in. long, glaucous, flattened, twisted.—*P. sylvestris.*

Bark of upper part of trunk reddish. Shoots glaucous. Leaves 2–4 in. long, dull green, twisted.—*P. densiflora.*

Winter buds more or less resinous, with the points of the scales appressed.

Leaves 4 in. or more long. Buds cylindric or spindle-shaped. Young shoots reddish brown. Leaves stout, rigid. Basal sheath $\frac{1}{3}$–$\frac{1}{2}$ in. long.—*P. muricata.*

Leaves 2–3 in. long. Buds cylindric or spindle-shaped.
Young shoots shining brown. Buds ¾ in. long. Leaves rigid, very sharp-pointed, basal sheath ¼ in. long.—*P. pungens.*
Young shoots slender, glaucous. Buds ⅜ in. long. Basal sheath ⅛–¼ in. long.—*P. virginiana.*
Leaves about 1 in. long. Buds cylindrical.
Young shoots slender, greenish. Buds ovoid, ½ in. long. Basal sheath ⅛–⅙ in. long.—*P. Banksiana.*
Leaves 3–6 in. long. Buds cylindrical, ovoid, often sharply pointed.
Young shoots orange brown. Buds pale brown, ½–¾ in. long. Resin canals in leaves marginal, basal sheath less than 1 in. long.—*P. resinosa.*
Young shoots brown. Buds ½–1 in. long, brown tinged with white. Basal sheath ½ in. long.—*P. Laricio.*
Young shoots glaucous. *Buds* ½–1 in. long, dark brown. Leaves rigid. Basal sheath ½ in. long.—*P. leucodermis.*
Young shoots brown. Buds ½–¾ in. long, white. Leaves rigid. Basal sheath ½ in. long, ending above in two long filaments.—*P. Thunbergi.*
Young shoots light brown. Buds ½–¾ in. long, brown. Basal sheath ½ in. long. Leaves occasionally in twos and threes on the same branch.—*P. sinensis.*
Winter buds white with resin, points of the bud scales appressed.
Young shoots brown. Buds ½ in. long. Leaves twisted, up to 3½ in. long, basal sheath ¼ in. long.—*P. contorta.*
Young shoots brown. Buds ¼–½ in. long. Leaves 1½–2 in. long, basal sheath ½–⅔ in. long.—*P. montana.*

Pinus albicaulis, Engelmann.

WHITE-BARK PINE.

Pinus cembroides, Newberry (not Zuccarini); P. flexilis, Balfour (not James); P. flexilis, var. albicaulis, Engelmann; P. Shasta, Carrière. Alpine Pine; Alpine White-bark Pine; Creeping Pine; Pitch Pine; White-stem Pine.

A sub-alpine species, usually shrubby or prostrate in habit, but occasionally of tree-like dimensions 50 ft. high, and 4–6 ft. in girth of bole, with a contorted trunk and twisted branch system. *Bark* of young trees whitish and smooth, on old trees thin and scaling in small patches. *Young shoots* reddish brown, with scattered minute hairs or sometimes without down. *Winter buds* broadly ovate, sharp-pointed, with loosely overlapping, long, acuminate scales. *Leaves* in fives, similar to those of *P. flexilis.* *Cones* sub-terminal, sessile, spreading, ovoid, 1½–3 in. long, dark

purple when growing, light brown when mature; *scales* much thickened, ¾ in. long, ⅝ in. wide, rounded at the apex, with a sharp point. *Seeds* ⅓–½ in. long, ⅓ in. wide, not shed when ripe; wings rudimentary and remaining on the scales.

P. albicaulis is distinguished from all its allies except *P. flexilis* by its entire leaves, and from *P. flexilis* by its indehiscent cones.

This pine has a more distinctly alpine distribution than *P. flexilis*, occurring on many mountain ranges at altitudes of 5,000–12,000 ft., from British Columbia to S. California and Mexico, and on the Rocky Mountains through Idaho to N. Wyoming. In the more exposed places it is found as flat, table-like masses close to the ground or with long prostrate branches growing over rocks.

Wood moderately soft, annual rings very close, sapwood narrow, quality poor. It is used locally for huts and cabins, mine timber and firewood, but has no general commercial value. The seeds are edible and used for food, but they are difficult to obtain by reason of the depredations of squirrels and crows.

The species is scarcely known in cultivation, and it does not appear to be well adapted for the British Isles, although it may succeed better at high altitudes in Scotland and the north of England than further south. A small tree, which is difficult to identify with certainty in the absence of cones, is growing near the Pagoda at Kew, and is now (January, 1923) 4 ft. 7 in. high, may be this species.

Jepson, *Silva of Calif.* 73 (1910); Sudworth, *Pine Trees of the Rocky Mount. Reg.*, Bull. 460, p. 9, U.S. Dept. of Agric. (1917).

Pinus aristata, Engelmann. (Fig. 82.)

BRISTLE-CONE PINE.

Pinus Balfouriana, Watson (not Balfour); P. Balfouriana, var. aristata, Engelmann. Foxtail Pine; Hickory Pine.

A small but usually a vigorous tree 15–40 ft. or more high, with a short trunk 3–6 ft. in girth. *Bark* of young trees thin, smooth and greenish, becoming ridged and scaly on old specimens. *Young shoots* stout, yellowish brown, clothed with minute reddish brown hairs which are denser than in *P. Balfouriana*. *Buds* and *leaves* as in *P. Balfouriana* except that the leaves are speckled with a white, resinous exudation. *Cones* shorter than in the latter species, 3–3½ in. long, the scales armed with a slender prickle. *Seed-wing* easily separating from the seed.

Native of the Rocky Mountains from Colorado, westward through the mountains of S. Utah and Cent. and S. Nevada and N. Arizona into S.E. California. Introduced into cultivation in 1863.

Wood, uses and cultivation as in *P. Balfouriana.*

Jepson, *Silva of California*, p. 76 (1910); Sudworth, *Pine Trees of the Rocky Mountains*, p. 23, Bull. 460, U.S.A. Dept. of Agric. (1917).

Pinus Armandi, Franchet.

ARMAND'S PINE.

Pinus koraiensis, Masters (not Zuccarini); P. Mastersiana, Hayata; P. quinquefolia, David; P. scipioniformis, Masters.

A tree 60 ft. high with horizontal branches. *Bark* thin, smooth and greenish. *Young shoots*, green, often covered at first with small glands. *Winter buds* cylindrical, blunt, slightly resinous. *Leaves* in fives, persisting 2–3 years, spreading or drooping, usually sharply bent $\frac{1}{2}$–$\frac{3}{4}$ in. from the base, 4–6 in. long, margins finely toothed, apex pointed, under surface green, two upper surfaces white with stomatic lines, resin canals median; basal sheath and scale leaves deciduous. *Cones* sub-terminal, on stalks 1 in. or more long, 1–3 together, cylindrical, tapering to a rounded apex, 4–7 in. long 2–3$\frac{1}{2}$ in. wide, erect at first, pendulous during the second year; *scales* thick and rigid, woody, resinous, about 1$\frac{1}{4}$ in. long and 1 in. wide, broadly triangular, the concealed portion reddish brown, the exposed part yellowish brown and rounded at the apex, which is sometimes slightly reflexed. *Seeds* wingless, $\frac{1}{2}$–$\frac{5}{8}$ in. long, liberated soon after ripening. *Male flowers* smaller, more loosely arranged and extending much further along the shoot than in *P. excelsa.*

P. Armandi closely resembles *P. excelsa* in foliage, but the distinct bend near the base is characteristic of the former. The young shoots of *P. Armandi* are usually more or less covered with fine glands, whilst those of *P. excelsa* are glabrous. The cones of the two species are quite distinct, those of *P. Armandi* being much stouter and the scales wider than in *P. excelsa.*

The species is wild in the mountains of W. China, where it is widely distributed, and usually found in rocky places, rarely forming pure forests. It was originally discovered by Père David in 1873, south of the Yellow River in Shensi, and subsequently by other travellers in Yunnan, Hupeh, and Szechuen, and more recently in Formosa.

It grows rapidly at Kew in light, well-drained loam under similar conditions to *P. excelsa.* Trees 20 years old cone freely, and some of the seeds are fertile.

The largest trees at Kew (February 1923) are 37 ft. and 35 ft. high respectively, and the former is 2 ft. 3 in. in girth at 5 ft. above the ground.

Elwes and Henry, *Trees of Great Britain and Ireland*, v, 1043 (1910); Clinton-Baker, *Illust. Conif.* i, 6 (1909).

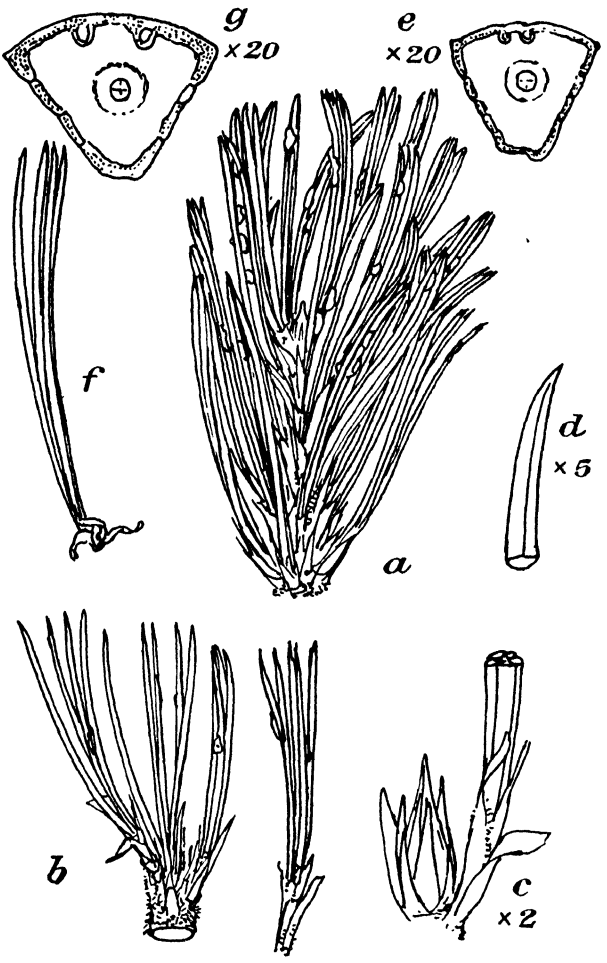

FIG. 82.—*PINUS ARISTATA* and *P. BALFOURIANA*.

Pinus aristata.—*a*, branchlet; *b*, part of shoot with three leaf clusters showing resin exudation; *c*, winter bud; *d*, smooth apex of leaf; *e*, section of leaf showing two resin canals. *P. Balfouriana.*—*f*., cluster of five needle leaves; *g*, section of leaf.

Pinus Ayacahuite, Ehrenberg.

MEXICAN WHITE PINE.

Hickory Pine; the Ayacahuite Pine.

A tree up to 100 or more ft. high and 12 ft. in girth, with the graceful habit of *P. excelsa*. *Bark* thin and smooth, except on old trees, where it is thicker and fissured or scaly about the lower parts. *Young shoots* covered with short, soft, orange-coloured hairs, or occasionally glabrous, bright brown or greyish in colour.

Winter buds conical, resinous, about ½ in. long, scales long-pointed and free at the tips. *Leaves* in fives, spreading, usually persistent for 3 years, slender, 4–8 in. long, margins finely toothed, apex pointed, inner surfaces flat with 3–4 lines of stomata, no stomata on outer surface; resin canals marginal; basal sheath deciduous. *Cones* sub-terminal, large, solitary or clustered, cylindrical, tapering at the apex, 8–18 in. long, 2½–6 in. wide at the base when expanded, on stalks 1–2 in long; *scales* ovoid, 2–3 in. long, 1–1½ in. wide, the enlarged tip resinous and often reflexed, basal scales reflexed. *Seed* ovoid, about ⅜ in. long, usually with a well-developed wing.

Var. **brachyptera**, Shaw.

P. strobiformis, Engelmann.

Differs from the type in its very short and ineffective seed-wing and its abnormally large seed.

Var. **Veitchii**, Shaw.

P. Buonapartea, Roezl; P. Loudoniana, Gordon; P. Veitchii, Roezl.

Differs from the type by its large cones, comparatively short seed-wing (about ½ in. long), and by its larger seeds (½ in. long). On vigorous young trees the leaves may be more than 5 in a cluster.

This species, although very variable in foliage and cones, is generally recognized by its large cones with reflexed basal scales. It resembles *P. excelsa* in foliage, but can usually be distinguished by the downy young shoot. The cones of the two species are often very similar in size and outline, but *P. Ayacahuite* can be distinguished by the distinctly reflexed basal scales. Trees growing in the southern part of its range are said to bear seeds with the longest wings, the wings being gradually reduced in size as its most northerly latitude is approached.

P. Ayacahuite is found on mountain slopes, and at the heads of ravines in Cent. America, extending from Guatemala through Mexico to the United States border. Discovered by Ehrenberg in Mexico in 1836 and introduced by Hartweg in 1840.

Little is known of the wood in this country, but from an examination of small specimens it would appear to compare with that of *P. excelsa* and to be suitable for similar purposes. It is used with that of other Mexican pines for general carpentry and for joiners' work, and probably has a bearing upon the rather small turpentine and rosin industry of that country, an industry that is stated to be capable of considerable expansion.

Its wide distribution, both in latitude and altitude, has an effect upon its hardiness, and trees grown in this country may be hardy or tender according to the place from which seeds were

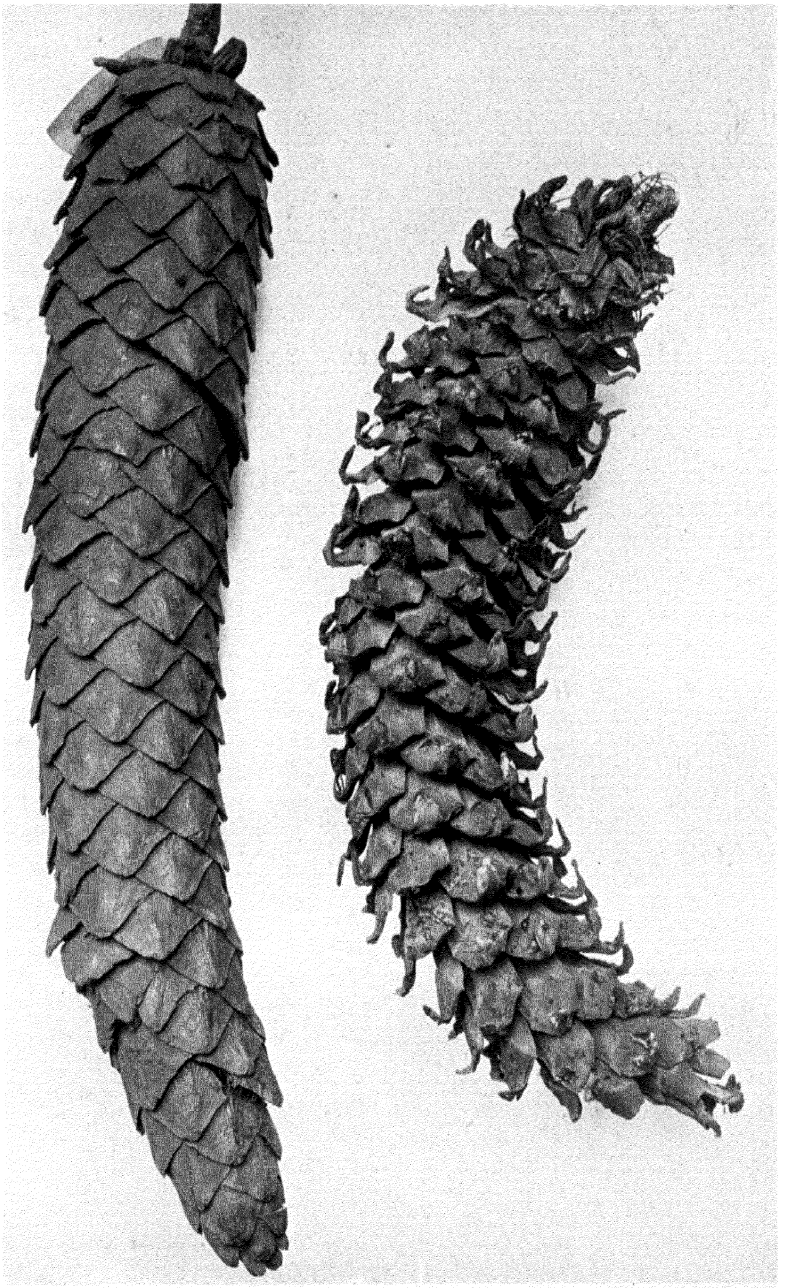

Photo. by G. Atkinson.

PLATE XIX. CONES OF *PINUS LAMBERTIANA* (LEFT) AND OF *PINUS AYACAHUITE* (RIGHT).

received. It may be expected to thrive throughout the south of England, but is more suitable for warm and sheltered gardens than for cold and exposed places. Moist but well-drained loamy soil is required for its proper development. In this country it can only be regarded as a decorative tree. In a few places it has seeded freely, the seeds having fair vegetative powers.

At Westonbirt, the seat of Lieut.-Col. Sir G. Holford, there is a specimen 70 ft. high and 7 ft. 2 in. in girth at 5 ft. above the ground. Many seedlings have been raised from it.

Shaw, *The Genus Pinus*, 30 (1914); Elwes and Henry, *loc. cit.* v, p. 1017 (1910).

Pinus Balfouriana, Jeffrey.

Fox-tail Pine.

Balfour Pine.

An alpine tree attaining a maximum height of 90 ft. with a trunk up to 15 ft. in girth, but frequently less than 50 ft. high, with a cone-shaped crown. *Bark* of young trees thin, smooth, greenish, becoming ridged and scaly on older specimens. *Young shoots* stout, yellowish brown, clothed with minute, reddish brown hairs. *Winter buds* ovoid, about $\frac{1}{4}$ in. long with closely pressed scales. *Leaves* in fives, persisting many years, densely crowded on the branchlets, incurved, rigid, spreading equally all round, about $1\frac{1}{2}$ in. long, margin entire, apex sharp-pointed, white with lines of stomata on the inner surfaces, shining green on the outer side, resin ducts marginal; basal sheath membranous, splitting into 5 segments, which become reflexed and form a rosette around the base of the leaf-cluster, as in *P. cembroides*. *Cones* sub-terminal, spreading, cylindric-conic, $3\frac{1}{2}$–5 in. long, $1\frac{1}{4}$–2 in. broad, without stalks; *scales* narrow, elongated, the exposed part convex and transversely keeled, with a minute incurved prickle. *Seed* about $\frac{1}{3}$ in. long, with a wing 1 in. in length.

P. Balfouriana is distinguished from all other five-leaved pines, except *P. aristata*, by its short incurved leaves with partly deciduous sheaths, and from *P. aristata* by its leaves being without resinous exudations and by the different cones.

This species is confined to the mountains of California, where it is found in two distinct stations, one on the Northern Coast Range and the other on the Southern Sierras. It often grows at the timber line, and occasionally reaches an altitude of 11,000 ft. Discovered by Jeffrey in N. California in 1852, and introduced by him soon afterwards through the Scottish Oregon Association.

Wood light, soft and brittle, with orange-brown heartwood and pale yellow sapwood. It has little economic value and is only of local use.

P. Balfouriana is rarely seen in cultivation in the British Isles.

In well-drained, loamy soil it is of slow and dense growth, forming a bush rather than a tree, and so far has not produced cones. In its native habitats it is usually found on thin rocky soil.

Jepson, *Silva of California*, p. 75 (1910); Shaw, *The Genus Pinus*, p. 42 (1914).

Pinus Banksiana, Lambert.

JACK PINE.

Pinus divaricata, Dumont de Courset; P. hudsonica, Poiret; P. rupestris, Michaux. Banksian Pine; Black Pine; Black Jack Pine; Canada Horn Pine; Check Pine; Grey Pine; Hudson Bay Pine; Labrador Pine; Scrub Pine; Sir Joseph Banks' Pine.

A tree 25–60 ft. high, with a trunk 2–5 ft. in girth, or in favourable positions up to 90 ft. high and 6 ft. in girth; but sometimes shrubby in habit. *Branches* on young trees slender with an upward tendency, forming a compact, oval head; on old trees strong and wide-spreading, with tough and flexible branchlets. *Bark* reddish brown, with deep fissures forming narrow ridges. *Young shoots* smooth, without down, pale yellowish green, reddish or brown the second year. *Winter buds* $\frac{1}{8}$–$\frac{1}{4}$ in. long, dark brown, cylindrical, resinous, with closely pressed scales. *Leaves* in pairs, lasting 2–3 years, olive green, stiff, curved or slightly twisted; $\frac{3}{4}$–$1\frac{1}{2}$ in. long, margin with minute or rudimentary teeth, apex short-pointed, stomata on each surface; resin canals marginal; basal sheath about $\frac{1}{8}$ in. long at first, often absent on the older leaves. *Cones* lateral, irregular in outline, ovate-conic, oblique, curved, $1\frac{1}{4}$–$2\frac{1}{2}$ in. long, $\frac{1}{2}$–1 in. wide at the base, often remaining on the trees unopened for many years; *scales* on the outer side much larger than those next the stem, up to $\frac{5}{8}$ in. long and $\frac{1}{4}$ in. wide, exposed part tawny yellow, the apex often of two distinct shades, rhomboidal, spineless; opening irregularly and gradually liberating the seeds. *Seeds* triangular, $\frac{1}{10}$–$\frac{1}{16}$ in. long, blackish brown, mottled. Wing $\frac{1}{2}$ in. long.

P. Banksiana is easily identified by its crooked branches, short leaves, and curved or warped cones.

It is the most northerly of the American species, growing near the Arctic Circle in the Valley of the Mackenzie River, and is common throughout the Canadian forest belt.

Wood variable in texture and weight, sometimes soft and of little use, at others approaching the wood of *P. resinosa* in hardness. It is usually brittle and weak, and decays rapidly when in contact with the soil. Heartwood yellowish brown, sapwood creamy white. The timber is used for rough construction, log huts, etc., also for railway sleepers when creosoted, and for paper pulp and fuel. The best qualities are sometimes sawn into lumber, and it has been marketed mixed with wood of *P.*

resinosa. In 1916, 80,068 cords of wood of the Jack pine were used for paper pulp.[1]

P. Banksiana is extremely hardy, and is said to grow on land that is permanently frozen two feet beneath the surface. It occurs on well-drained, sandy or rocky land from 100–1,200 ft. above sea-level. Throughout life it is very intolerant of shade. It is an abundant seed-bearer, even when very young, and good seed years occur at intervals of 2–3 years. Naturally a short-lived tree, its commercial age does not exceed 110 years, and trees rarely exceed 150 years of age. Some attention has been given to the species for forest planting in cold and exposed parts of the British Isles, but it should not be planted where a more profitable species is likely to succeed, for it can have little or no value as a commercial tree.

Pinus Bungeana, Zuccarini. (Fig. 83.)

LACE-BARK PINE.

Pinus excorticata, Lindley and Gordon. Bunge's Pine.

A tree 80–100 ft. high and 12 ft. in girth in China, or, in cultivation in this country a small pyramidal tree or bush densely branched to the ground. *Bark* on young trees smooth, dull grey, scaling off in small patches like a plane tree, changing to chalky-white on old trunks by which the species can be recognized from a long distance. *Young shoots* smooth, without down, greyish green. *Winter buds* spindle-shaped, nearly ½ in. long, not resinous, composed of reddish brown scales. *Leaves* in threes, rather sparsely arranged on the branchlets, persisting 3–4 years, giving off a turpentiny odour when bruised, dull green, rather rigid, flattened, 2–3 in. long, margins finely toothed, apex sharply pointed, faint stomatic lines on each surface; resin canals marginal and prominent; sheath soon falling away. *Cones* solitary or in pairs, subterminal but often appearing lateral by the growth of a summer shoot, globose or ovoid, 2–2½ in. long, on short, stout stalks; *scales* terminated by a reflexed, triangular spine. *Seed* with a short, loosely attached wing.

P. Bungeana is most closely allied to *P. Gerardiana*, from which it is distinguished by its smaller cones and stiffer leaves. From other three-leaved pines it is separated by its smooth, scaling bark, sparsely arranged foliage, peculiar habit, and the strong odour of its bruised leaves.

Native of China, where it was first seen by Dr. Bunge near Pekin in 1831. It has lately been found in the mountains of Cent. China by Wilson, and is widely cultivated by the Chinese in the vicinity of temples and cemeteries.

[1] Brown, Nelson Courtlandt: *Forest Products, their Manufacture and Use*, 29 (1919).

Little is known of the timber of *P. Bungeana*, but from small available specimens it appears to be of fair quality. Even in its native country, however, it is not plentiful enough to be of much economic importance. From the quantity of the oily matter liberated by the punctured branches and leaves it would

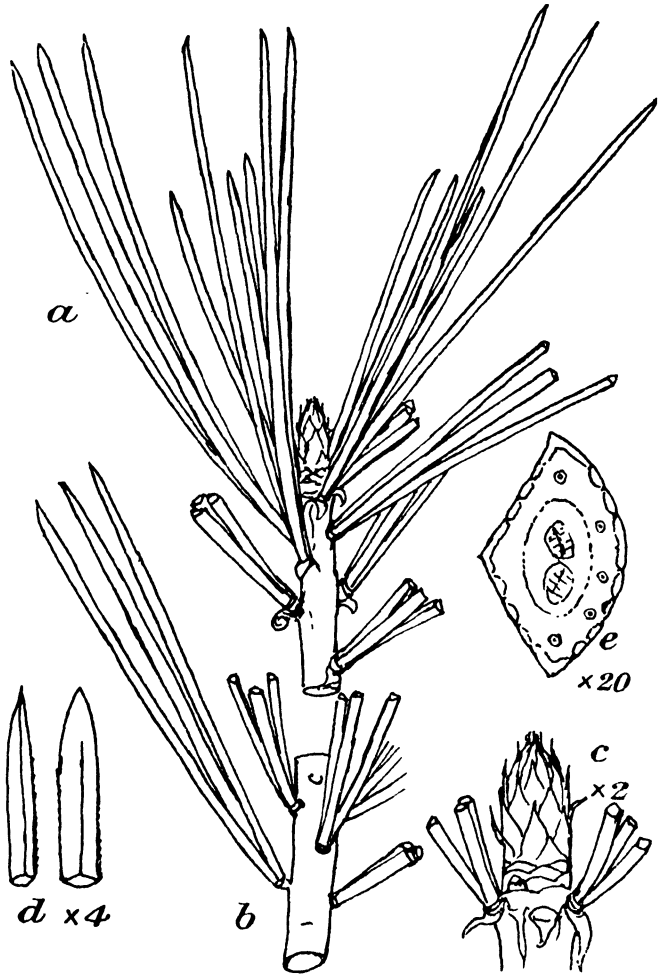

FIG. 83.—*PINUS BUNGEANA*.

a, end of branchlet; *b*, lower part of shoot with needle leaves in clusters of three; *c*, winter bud; *d*, apex of leaf with serrulate margins; *e*, section of leaf, showing five resin canals.

probably be of use to distillers for the production of pine oil.

The cultivation of this species in Britain should be limited to the milder parts, where it should be given deep, loamy soil and be planted in permanent positions when not more than 1½ ft.

high. There are several trees upwards of 25 ft. high at Kew, and good specimens are occasionally seen in other collections.

Shaw, *loc. cit.* p. 40 (1910); Elwes and Henry, *loc. cit.* 1050 (1910).

Pinus canariensis, C. Smith.

CANARY ISLAND PINE.

Tea Wood.

A tree 80–100 ft. high and 10 ft. or more in girth in the Canary Islands, with spreading branches and drooping branchlets, forming a tree of somewhat weeping habit. *Bark* thick, reddish, slightly fissured, dividing into irregular scales. *Young shoots* without down, yellow, prominently ridged. *Winter buds* large, ovoid, acute, with lance-shaped, deeply fringed scales, which are free at the tips. *Leaves* in threes, highly glaucous on seedlings and very young trees, grass green on older specimens, persisting 2 years, densely crowded on the branchlets, flexible, 7–12 in. long, margins finely toothed, apex-pointed, 2–4 stomatic lines on each surface; resin canals median; basal sheath persistent, $\frac{3}{4}$ in. long. *Cones* sub-terminal, solitary, or clustered, 6–9 in. long, 3 in. broad, nut-brown in colour, deflexed or pendent on short, stout, scaly stalks; *scales* thick, about $1\frac{3}{4}$ in. long by $\frac{3}{4}$ in. broad, the terminal portion sharply ridged with a dark brown, prominent apex. *Seed* $\frac{1}{2}$ in. long, with a wing nearly three times its length.

P. canariensis is distinguished from other three-leaved pines by its yellow shoots, fringed bud-scales, long, slender leaves, and large cones. It appears to be most closely related to *P. longifolia* amongst Old World species.

Native of the Canary Islands, where it grows on dry, exposed slopes and was formerly widely spread. Large woods of it still exist in Tenerife, La Palma, and Grand Canary, at altitudes of 3,700–6,600 ft. Most of the largest recorded trees have disappeared.

Wood strong and serviceable, rather similar in appearance to that of the Indian *P. Merkusii* and *P. caribæa* of Florida and the Bahamas. Heartwood and sapwood very distinct, the former reddish brown, the latter yellow. It has excellent lasting qualities and may be classed amongst the best grades of pine wood. In the dry climate of the Canaries objects built of heartwood have remained sound after full exposure to weather for 200 years. A block of heartwood in the Museums at Kew weigh 68 lb. 3 oz. per cubic ft. Unfortunately the available supply of timber is scarcely sufficient to supply local demands, and there is none for export. The fine and soft fallen leaves of the Canary Island pine were formerly utilized with those of *Musa Cavendishii* for packing Canary Island bananas, the fine packing material being known as "grass" amongst importers.

The Canary Island pine is quite unsuitable for the climate of the British Isles, although it may succeed in a few places such as the Scilly Islands and Falmouth. It is a sub-tropical tree, and adapted for countries where considerable dry periods are experienced. In certain parts of S. Africa it is giving very good results as a forest tree, whilst it might also succeed in N. Nigeria, Egypt, Algeria, Morocco, S. Europe, Australia, etc. A small business might be encouraged in the British Isles by cultivating small plants in pots for table and house decoration.

Hutchinson, *Kew Bulletin*, No. 1, 1918, p. 1.

Pinus caribæa, Morelet.

THE CUBAN PINE.

Pinus bahamensis, Grisebach ; P. cubensis, Sargent (not Grisebach) ; P. Elliottii, Engelmann ; P. heterophylla, Sudworth ; P. recurvata, Rowley ; P. Tæda, var. heterophylla, Elliott. Bastard Pine ; Meadow Pine ; Pitch Pine ; She Pine ; She Pitch Pine ; Slash Pine ; Spruce Pine ; Swamp Pine.

A tree 90–100 ft. or rarely 120–150 ft. high, with a shapely trunk 7–9 ft. in girth, often free from branches for 50–70 ft. *Branches* usually large and spreading. *Bark* thick, reddish, deeply fissured and shed in thin, wide scales. *Young shoots* glaucous. *Winter buds* smooth, cylindrical, narrowed to the apex. *Leaves* in twos or threes or more, densely crowded on the branches, falling during the second year, dark green, glossy, 8–12 in. long, margins finely toothed, apex a short, horny point, stomatic lines on each surface ; resin canals internal ; basal sheath $\frac{1}{2}$–$\frac{3}{4}$ in. long. *Cones* sub-terminal, reflexed, ovate or conical, 4–5 in. long and 2–2$\frac{1}{2}$ in. wide, on short stalks, rather like the cones of *P. Pinaster*, often leaving a few basal scales on the tree when they fall ; *scales* about 2 in. long and $\frac{5}{8}$ in. wide, the exposed part shining, reddish brown, swollen, ending in a minute prickle. *Seeds* triangular, black, scarcely $\frac{1}{4}$ in. long, with well-developed brown wings 1 in. or more long.

Distinguished from *P. Tæda* by the varying number of leaves in the bundle, and by the glaucous young shoots, and from *P. palustris* by the thinner, terminal buds and the shape of the cone-scales.

The Cuban pine is found in the sub-tropical parts of the S.E. United States, S. Carolina, Georgia, and Florida, also in Cuba and Honduras, etc.

Wood strong and of good quality, though rather coarse-grained, very resinous, with prominent resin ducts. It resembles the wood of *P. palustris* and equals it in strength and usefulness. For general purposes there is little to choose between the wood of the two species, and it appears to be mixed when marketed. The Cuban pine furnishes very good resin, which is stated to be

richer in turpentine than that of *P. palustris*. For this purpose alone it is worth attention in sub-tropical countries.

The southerly distribution of this species makes it of no value for the British Isles, but it is likely to become a more important tree than at present in its natural habitat and possibly in other countries also. In a wild state it reproduces itself well and is taking the place of *P. palustris* in some localities. The best specimens are found on good low-lying wet ground, growth on poor and dry land being restricted.

Mohr, *The Timber Pines of the Southern United States*, pp. 79–89 (1897).

Pinus Cembra, Linnæus. (Fig. 84.)

AROLLA PINE.

Pinus Cedrus, Uspensk; P. coronans, Litvinof; P. montana, Lamarck (not Miller); P. sibirica, Mayr. Alpine Pine; Cedar; Cedr; Cembran Pine; Siberian Cedar; Swiss Stone Pine.

A tree 60–130 ft. high in a natural state, with the primary branches spreading and sometimes very stout. In cultivation in Britain its dimensions are smaller, usually not more than 50–70 ft. high, with short, horizontal branches, forming a tree of compact, pyramidal habit. *Bark* on young trees thin, greenish grey, smooth or with numerous resin blisters, at length rugged, and separating into thin, scaly patches on older trees. *Young shoots* clothed with dense, orange-coloured down. *Winter buds* about $\frac{1}{4}$ in. long, ovoid, long-pointed, resinous, with narrow, lance-shaped, closely-pressed scales. *Leaves* in fives, persisting 3–5 years, crowded on the shoot, erect, rather rigid, $2\frac{1}{2}$–$3\frac{1}{2}$ in. long, margins toothed, the teeth being distant and not extending to the pointed tip, stomata confined to the two inner surfaces in rather faint lines; resin canals median; basal sheath deciduous. *Cones* subterminal, egg-shaped, erect, 2–3 in. long, $1\frac{1}{2}$–$2\frac{1}{4}$ in. wide, on short stalks, greenish with a violet tinge at first, then purplish-brown when fully ripe, never opening; *scales* rounded in outline, 1 in. long, $\frac{3}{4}$ in. wide, with a thickened apex, minutely downy on the outer surface. *Seeds*, edible, wingless, or with a rudimentary wing, liberated by the scales rotting, or by birds and animals in search of food.

The following varieties are sometimes seen in cultivation :—

Var. **aurea**, Hort.

Foliage yellowish. The plant is not very robust.

Var. **chlorocarpa.**

Habit dwarf and compact.

P. Cembra may easily be distinguished from all other five-leaved species except *P. koraiensis* by its distinct habit and the shaggy, orange-brown pubescence on the young shoots. In *P.*

koraiensis the shoots are similarly pubescent, but the leaves are stouter, and the teeth on the margins more numerous and carried to the tip. The cones of the two trees are very distinct.

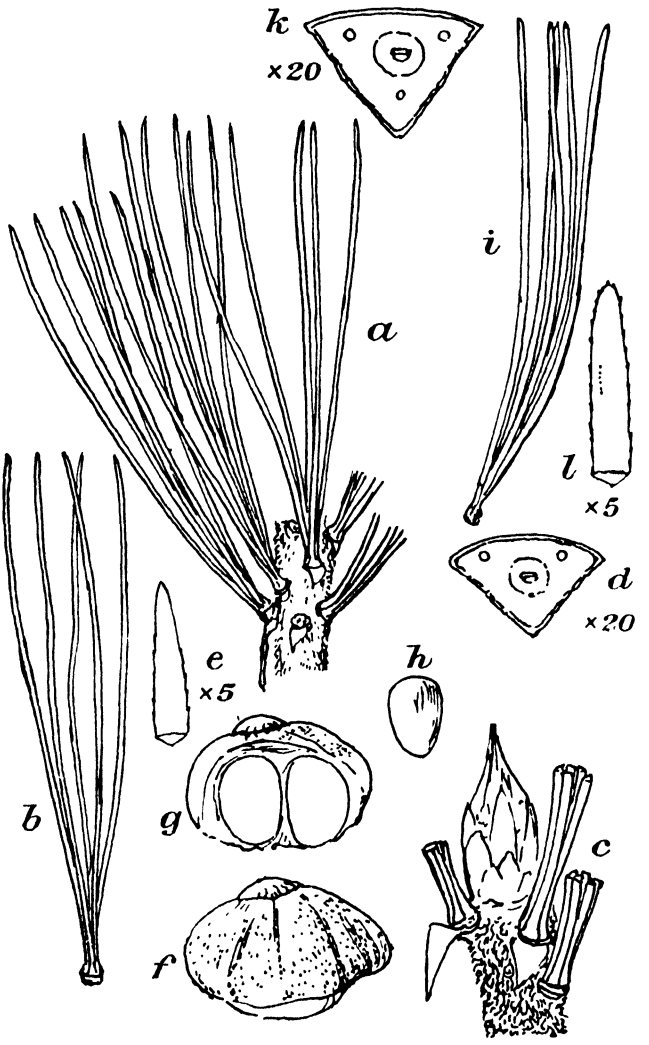

FIG. 84.—*PINUS CEMBRA* and *P. KORAIENSIS*.

Pinus Cembra.—*a*, portion of shaggy shoot with leaves in clusters of five; *b*, leaf cluster; *c*, winter bud; *d*, section of leaf; *e*, smooth apex of serrulate leaf; *f*, outer view of cone-scale; *g*, inner view of cone scale, with two seeds; *h*, seeds. *P. koraiensis*.—*i*, cluster of five leaves; *k*, section of leaf with three resin canals; *l*, serrulate apex of leaf.

As a native tree the species is found in two widely separated regions, the Alps of Cent. Europe and Siberia. In Europe it is distinctly alpine and seldom found at a lower altitude than 5,000 ft., occurring to the limit of tree growth at 8,000 or more ft. in

Switzerland, Italy, and Tartary. In Siberia it is found at much lower levels, covering immense tracts of country. Further east it gives place to its near ally *P. koraiensis.* Introduced by the Duke of Argyll in 1746. One probably of the original seedlings mentioned by Loudon as being at Whitton in 1838, was still alive in 1908, when it was a tree 80 ft. high and 5 ft. in girth.

Wood light in weight, with large and numerous resin ducts. Heartwood yellowish or yellowish-brown, sapwood paler, sometimes almost white. It is straight-grained, clean, easily worked, compact and soft, or it may contain numerous large, dark brown knots that are not easily separated from the surrounding wood, such wood being harder and more difficult to work. Clean wood is used extensively for carving, cabinet-making, turnery, and general joinery work, particularly the indoor finish of houses; it takes paint and polish well. Very knotty wood is sometimes used for panelling, producing a curious and rather ornamental effect. The seeds are used for food in Switzerland, and to some extent in this country, but more extensively in Russia and Siberia. They are known as pine kernels. In Siberia seed collection forms a distinct industry. The process is, however, a destructive one, the branches often being badly broken during the work. The yearly collection is stated to be "several tens of thousands of poods (1 pood equals 32 cwt.)"[1] The trade is chiefly conducted in the Governments of Tobolsk, Tomsk, and Enessy. Collecting begins about the middle of August, the crop being termed "the cedar harvest."[2] The shells of the seed ground up yield an oil sold as "cedar oil."

P. Cembra succeeds throughout the British Isles, but thrives best on the mountains and in the valleys of Wales, the N. of England, and in Scotland. It forms a handsome decorative tree and has been tried in one or two instances under forest conditions, but without much success. Close silvicultural planting is necessary. The tree succeeds in light well-drained soil, and cones fairly regularly after the age of 25–30 years. In Siberia it reproduces itself readily on dry ground, often crowding out larch and other species. The commercial importance of the seed limits, to some extent, the exploitation of the timber of the natural forests of Siberia, whilst the difficulty of extraction is great. There are, however, large reserves of timber in that country. Under cultivation in the British Isles it appears to be susceptible to attacks of the "Tree Root Rot" or "Collar Rot Fungus" (*Armillaria mellea*), which is often present on stumps and dead roots of trees; it is therefore advisable, when planting, to avoid ground that has recently been cleared of timber. Deep

[1] Stebbing, *British Forestry*, p. 158 (1916).
[2] *Loc. cit.* p. 154.

planting must also be avoided. Trees affected by this fungus should be dug up carefully and burned, a trench 2 ft. wide and 2½ ft. deep being dug round the affected area to prevent the spread of the disease.

Large trees of the Arolla pine are to be seen in many places, notably at Walcot, Shropshire, the seat of the Earl of Powis, where it was planted extensively about 1820. Several of these trees remain.

Elwes and Henry *loc. cit.* v, 1035 (1910).

Pinus cembroides, Zuccarini. (Fig, 85.)

MEXICAN NUT PINE.

Pinus fertilis, Roezl; P. futilis, Sargent; P. Llaveana, Schiede; P. osteosperma, Engelmann. Mexican Pine; Mexican Piñon; Nut Pine; Piñon; Piñyon; Stone Pine; Three-leaved Nut Pine.

A bush or low tree 15–25 ft., or, in favourable positions, upwards of 40 ft., high, with a short trunk and round, bushy head. *Bark* on mature trees thin and scaly. *Young* shoots, slender, glaucous, minutely downy, or without down. *Winter buds* about ¼ in. long, with densely imbricated scales. *Leaves* usually in threes, but sometimes solitary, or in pairs, fours or fives, persisting 3–4 years, closely arranged, incurved, 1–2 in. long, margins entire, apex sharp-pointed, stomata on each surface, resin canals marginal, segments of leaf-sheath persisting, but rolling backwards to form a rosette round the base of the leaf-cluster. *Cones* globular or egg-shaped, 1–2½ in. long, and the same in width, yellowish or reddish brown; *scales* few, large, flat, wide-spreading in the mature cone. *Seeds* ½–¾ in. long, ¼–⅜ in. wide, dark brown below, rather lighter above, wingless, edible.

The above description applies to *P. cembroides* in its widest sense, and includes *P. edulis*, *P. monophylla*, and *P. Parryana*, which have until recently been considered as distinct species. We follow Voss in regarding them all as varieties of one species.

Var. **edulis**, Voss. (Fig. 85.)

TWO-LEAVED NUT PINE.

P. cembroides, Gordon (not Zuccarini); P. edulis, Endlicher; P. Fremontiana, Gordon (not Endlicher); P. monophylla, var. edulis. M. E. Jones; Caryopitys edulis, Small. New Mexican Piñyon; Nut Pine; Piñyon; Piñon; Pine; Rocky Mountain Nut Pine.

Not differing materially from *P. cembroides* except in the leaves being usually stouter and in pairs, occasionally in threes or singly, and not so crowded on the branchlets. Distribution more northerly than *P. cembroides*. Discovered by Dr. Wislizenus in New Mexico in 1846. There is a plant at Kew 23 ft. high.

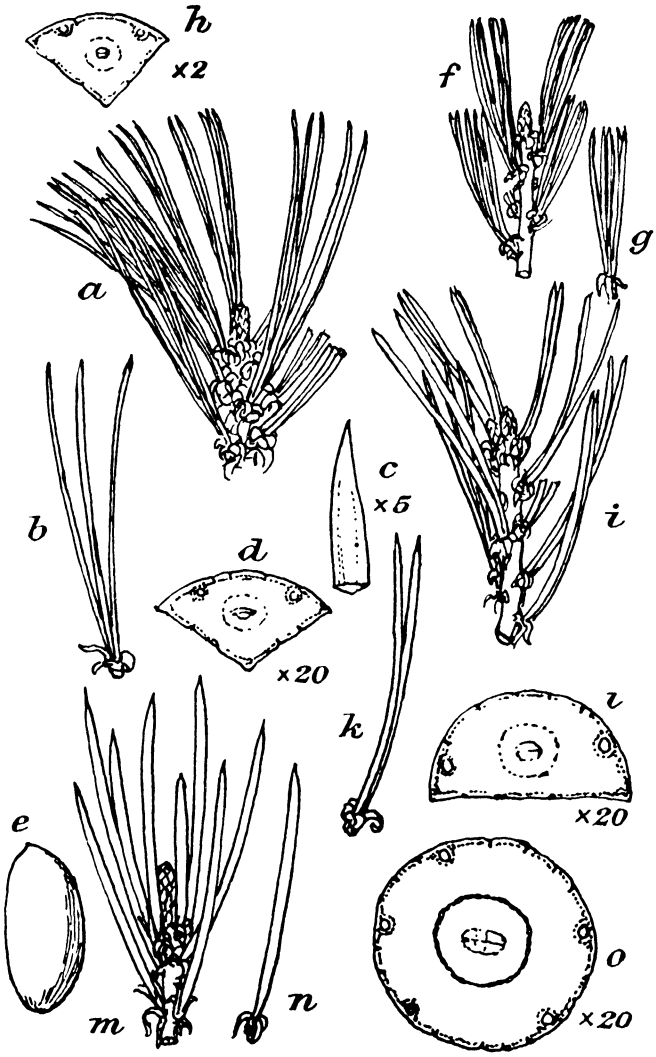

FIG. 85.—*PINUS CEMBROIDES.*

Pinus cembroides — *a*, branch with winter bud; *b*, cluster of three leaves; *c*, apex of smooth leaf; *d*, section of leaf; *e*, seed Var. *Parryana.*—*f*, branchlet with leaves in clusters of four or five; *g*, cluster of five leaves; *h*, section of leaf. Var. *edulis* —*i*, branchlet with leaves in pairs; *k*, a pair of leaves; *l*, section of leaf Var. *monophylla.*— *m*, branchlet with solitary leaves; *n*, leaf; *o*, section of leaf, showing five resin canals.

Var. **monophylla**, Voss. (Fig, 85.)

SINGLE-LEAVED NUT PINE.

Pinus monophylla, Torrey and Fremont; P. Fremontiana, Endlicher. Fremont's Nut Pine; Gray Pine; Nevada Nut Pine; Nut Pine; One-leaved Nut Pine; Piñon; Piñon Nut Pine; Single-leaf Pine.

Differs from *P. cembroides* and var. *edulis* by the leaves being usually solitary or occasionally in pairs. Distribution as above.

Var. **Parryana**, Voss. (Fig. 85.)

FOUR-LEAVED NUT PINE.

Pinus Parryana, Engelmann; P. quadrifolia, Sudworth. Mexican Piñon; Nut Pine; Parry's Nut Pine; Parry's Pine; Parry's Piñon.

Differs from the type and other varieties by the leaves being usually stouter and produced in fours, occasionally in fives or smaller numbers. All the varieties may produce short shoots bearing primordial or juvenile leaves, the phenomenon being very marked in this variety.

P. cembroides is distinct amongst three-leaved pines by the reflexed basal scales to the leaves and its few-scaled cones and large seeds. The basal scales are similar in the five-leaved *P. Balfouriana* and *P. aristata*.

Native chiefly of Mexico, but also found in Arizona and California. Discovered in Mexico about 1830.[1]

Wood moderately heavy for pine, varying in the different forms from 35–40 lb. per cubic ft. It is strong, slow-grown, often knotty, and is used locally for building purposes, fencing, mine timber, and firewood, but is of no commercial value outside its own range. The edible seeds of both type and varieties make the several trees of considerable food value, particularly to the Indians.

The value of type and varieties in the British Isles is purely arboricultural; all, however, form distinctly interesting trees or bushes, and should be included in collections. Plant in light loamy soil.

Shaw, *Genus Pinus*, 38 (1914); Shaw, *Pines of Mexico*, 5 (1909); Jepson, *Silva of California*, 92–93 (1910).

Pinus clausa, Vasey.

SAND PINE.

Florida Spruce Pine; Oldfield Pine; Scrub Pine; Spruce Pine.

A low, spreading tree 15–20 ft. high, with smooth branches and branchlets. *Young shoots* multinodal, smooth, reddish brown. *Leaves* in pairs, slender, 2–3½ in. long, with persistent basal sheaths. *Cones* ovate-conic, reflexed, 2–3½ in. long, produced in clusters, often remaining closed on the branches for many years; *scales* concave, armed with short stout straight or recurved deciduous prickles.

Closely allied to *P. virginiana*, but distinguished by its numerous persistent cones.

A pine of limited range, confined to the sandy coast of Alabama and Florida. It is not in cultivation and does not appear to possess any economic value except as a sand-binder and for fuel in its native country.

Shaw, *Genus Pinus*, p. 80 (1914).

[1] Sargent, *Silva of N. America*, xi, 48 (1897).

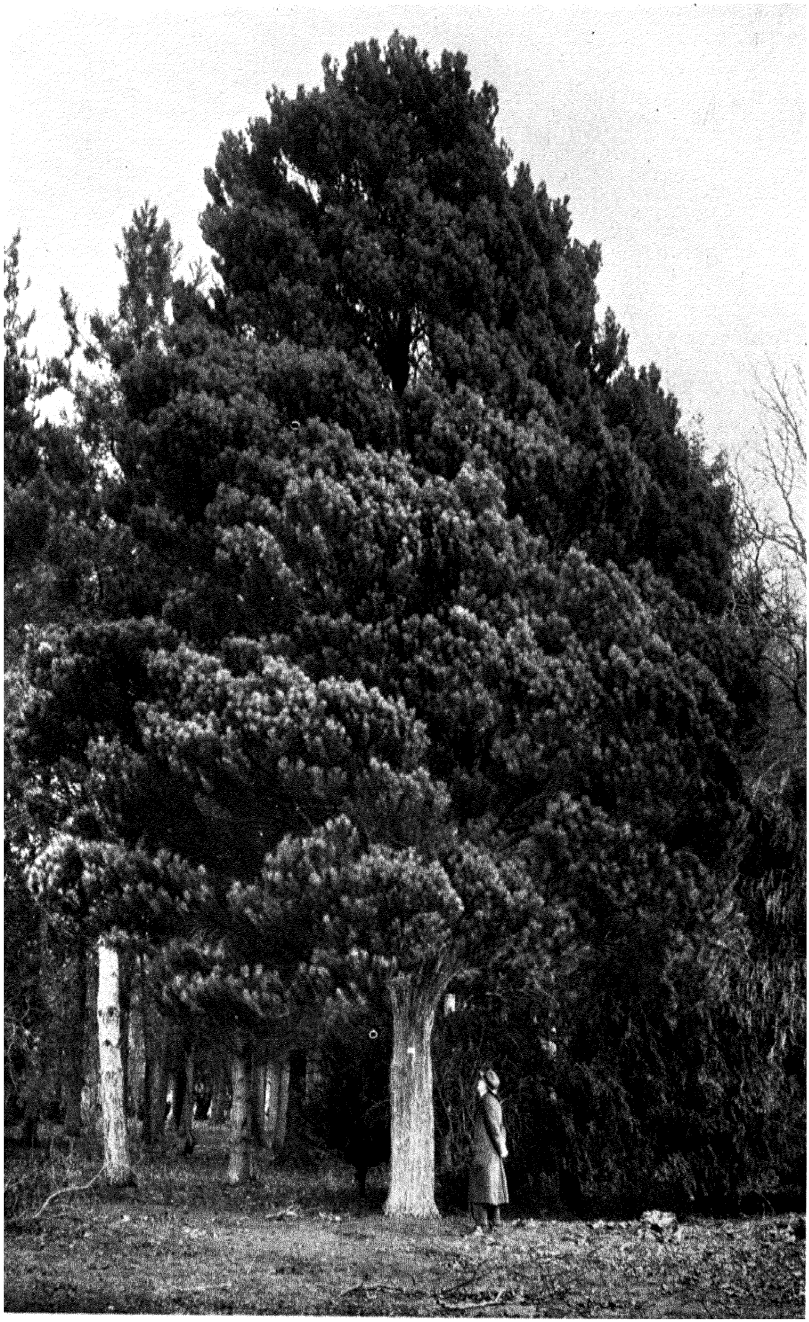

Photo. by R. A. Malby

PLATE XX. *PINUS CONTORTA* VAR *MURRAYANA* AT WESTONBIRT, GLOUCESTER.

Pinus contorta, Douglas. (Fig. 86.)

BEACH PINE.

Pinus Banksiana, Lindley and Gordon (not Lambert); P. Bolanderi, Parlatore; P. Boursieri, Carrière; P. inops, Bongard; P. Macintoshiana, Hort.; P. muricata, Bolander (not D. Don); P. tenuis, Lemmon. Bolander's Pine; Henderson's Pine; Sand Pine; Scrub Pine; Shore Pine; Tamarack Pine; Twisted Pine; Twisted-branch Pine.

A tree varying greatly in stature and habit, according to situation, from a stunted bush or small tree 10–30 ft. high, with short and twisted branches, to a tree 70–200 ft. high. *Bark* on mature trees $\frac{1}{4}$–$\frac{3}{4}$ in. thick, reddish brown, dividing into thin scales. *Young shoots* green, without down, becoming brown in the second year. *Winter buds* cylindrical, short-pointed, $\frac{1}{2}$ in. long, resinous. *Leaves* in pairs, persisting 3–8 years, yellowish green, often of a metallic lustre, twisted, varying in length and breadth on different trees, 1–3 in. long, $\frac{1}{16}$–$\frac{1}{8}$ in. wide, margins with rudimentary teeth sometimes difficult to distinguish, ending in a short, horny point; numerous stomatic lines on each surface; resin canals median; basal sheath $\frac{1}{8}$–$\frac{1}{4}$ in. long at first, becoming shorter on older leaves. *Cones* sub-terminal, opening when ripe or remaining closed for years; shortly stalked, solitary, in pairs or in clusters, ovoid or conical, $\frac{3}{4}$–$2\frac{1}{2}$ in. long; *scales* thin, $\frac{1}{2}$–$\frac{3}{4}$ in. long, $\frac{1}{4}$–$\frac{3}{8}$ in. wide, the exposed part armed with a short, often deciduous, prickle. *Seeds* reddish brown, $\frac{1}{8}$–$\frac{1}{6}$ in. long, with darker spots.

P. contorta in its restricted sense is found on the Pacific Coast from Alaska to the W. Cascade Mountains. It is recorded as having been discovered by David Douglas in 1825, near the mouth of the Columbia River in Washington, and was apparently introduced about 1855, when it appeared in Lawson's catalogue under the name of *P. Macintoshiana*.

Var. Murrayana, Engelmann.

LODGEPOLE PINE.

Pinus contorta, var. latifolia, Engelmann; P. Murrayana, Balfour. P. Tamrac, Murray; Black Pine; Murray Pine; Pitch Pine; Prickly Pine; Red Pine; Spruce Pine; Tamarack Pine; Tamrac Pine; White Pine.

A tree 70–200 ft. high with a tapering trunk and scaly bark, differing from the type in its more vigorous habit, broader leaves, and larger cones. As it is usually found under more favourable conditions of growth, these differences may be entirely due to soil and shelter. Intermediate forms occur. It is a very common tree in the mountains from Alaska to California, where it was discovered in 1805. It was introduced to Great Britain by Jeffrey in 1853 or 1854.

P. contorta and the variety *Murrayana* may be distinguished

amongst other pines by the twisted or stunted appearance of the branches, the short, twisted, yellowish green leaves, and the long buds encrusted with resin. Leaf specimens are only liable to be confused with *P. montana*, from which it may be dis-

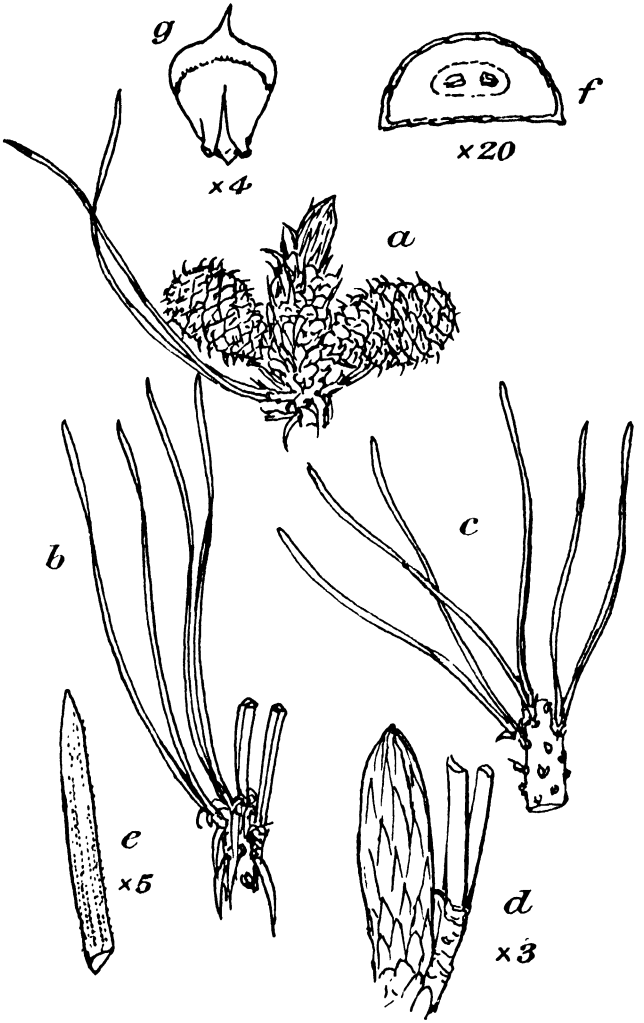

FIG. 86.—*PINUS CONTORTA.*

a, winter bud with two young cones and a leaf cluster; *b*, part of shoot, showing leaves in pairs and leaf scales; *c*, older part of shoot; *d*, winter bud; *e*, apex of leaf with serrulate margins; *f*, section of leaf; *g*, young cone-scale with small awl-shaped bract.

tinguished by the short basal sheaths, twisted leaves, and median resin canals.

The *wood* varies in weight, according to the rate of growth, from 25–36 lb. per cubic ft. It is often of slow growth, with

very close annual rings. That from trees near the coast is of little value, but the timber yielded by the Lodgepole variety is similar in quality to that of *P. Pinaster*. A good deal of the timber is knotty, but the best qualities are moderately strong and straight-grained, with reddish or brown heartwood and pale yellow sapwood. It works well, and is used for log-houses, interior finish of houses and other buildings, boat-building, general construction, cooperage, box-making, and, when creosoted, for railway sleepers, paving blocks, and fencing. Large quantities of timber are available, the marketable timber in British Columbia alone having been estimated as 11,861,000,000 board ft.[1] The common name of lodgepole pine arose through its common use for the centre-pole of the huts of N. American Indians.

The coast form is often found on sand-dunes fully exposed to violent winds, and it has a value for the fixing and protection of such areas. Its timber value is, however, negligible when grown under these conditions, but in less exposed places inland it grows more freely, even on poor and stony soil, and has an increased timber value. The mountain form (var. *Murrayana*) is common on high land, mountain slopes and valleys, at 7,000–11,500 ft. elevation, the best stands being on north and east slopes. It is not adapted to limestone, but gives excellent results on dry, gravelly soils.[2] In exposed, rocky places it becomes stunted and resembles the coast form. Pure forests of extensive area exist, whilst it also occurs in mixture with other trees. It is very intolerant of shade and cleans itself well when grown in dense stands. Seeds are produced freely every year, and as they are small with well-developed wings, they are widely distributed and regeneration of cleared areas is readily accomplished. Trees begin coning very early in life when in open positions, often at an age of 6–8 years.

Several good specimens of var. *Murrayana* are growing at Westonbirt, the largest being 56 ft. by 4 ft. 3 in. at 5 ft. from the ground, and 55½ ft. by 5 ft. 4 in. at the same height.

There is also a tree at Bayfordbury.

Jepson, *Silva of California*, ii, p. 83 (1910); *Forest Tables: Lodgepole Pine*, For. Ser. Circular, 126, U.S. Dept. of Agric. (1907).

Pinus Coulteri, D. Don. (Fig. 87.)

BIG-CONE PINE.

Pinus macrocarpa, Lindley; P. Sabiniana, Parry (not Douglas). Coulter's Pine; Large-cone Pine; Nut Pine; Pitch Pine.

A tree 80 ft. high and 12 ft. in girth. *Bark* thick, dark brown, deeply and irregularly fissured. *Branches* stout and widely

[1] Whitford and Craig, *Forests of British Columbia*, Comm. of Conservation, Canada, p. 241 (1918).

[2] Sudworth, *Pine Trees of the Rocky Mountain Region*, p. 41 (1917).

spreading, forming a tree of broadly pyramidal habit. *Young shoots* stout, glaucous, without down, prominently ridged, becoming orange-brown with age. *Winter buds* large, ovoid, long and sharp-pointed, 1–1½ in. long, ¾ in. thick, with resinous, fringed, closely pressed scales. *Leaves* in threes, lasting 2–3 years, very stout, stiff, curved, 6–12 in. long; margins toothed, apex a short, horny point; stomatic lines on all surfaces; resin canals median or sometimes marginal; basal sheath 1½ in. long, persistent. *Cones* very large and massive, often weighing 3–4 lb., ovate or oblong-ovate, 10–14 in. long by about 6 in. wide; *scales* thick, woody, 2½ in. long, 1½ in. broad, ending in a strong, curved hook or claw. *Seed* large, oval, ½ in. long, wing 1 in. long, thin above, thicker below, forming a rim-like margin to the seed.

P. Coulteri is distinguished from all other pines except *P. Sabiniana* by its remarkably large and heavy cones and peculiar seed-wings. The cones of *P. Sabiniana* are, however, relatively smaller, and the seeds have a shorter wing.

Barren trees resemble *P. ponderosa*, var. *Jeffreyi*, in their foliage, but may generally be recognized by their large, stout, and resinous buds and usually larger and stiffer leaves.

P. Coulteri grows naturally on the dry mountain slopes of California, from Mount Diabolo and the Santa Lucia Mountains south to the Cuyamaca Range, occurring singly or in small groups at elevations of 3,000–6,000 ft. It was discovered in the Santa Lucia Mountains by Coulter in 1832, and introduced to Britain by Douglas in the same year.

Wood soft, weak, and brittle, with very large resin ducts. It has little value in its native country except as fuel, and timber of trees grown in the British Isles is of very poor quality and subject to early decay. The seeds are edible.

P. Coulteri forms an interesting and ornamental garden tree. In well-drained light loam it grows moderately fast, and there are numerous well-developed specimens in the midland and southern counties of England.

Elwes and Henry, *op. cit.* v, 1067 (1910); Jepson, *Silv. Calif.* 84 (1910).

Pinus densiflora, Siebold and Zuccarini.

Red Pine of Japan.

Pinus japonica, Forbes (not Hort.); P. Massoniana, Hort. (not D. Don, nor Siebold and Zuccarini); P. Pinea, Gordon (not Linnæus); P. rubra, Sieber (not Lambert Michaux, Miller, nor Miquel); P. scopifera. Miquel. Aka Matsu.

A tree 70–120 ft. high, with a trunk 6–12 ft. in girth, frequently twisted or crooked. *Bark* reddish, like that of the Scots pine, particularly about the higher parts of the tree, peeling off in thin scales. *Young shoots* without down, green with a glaucous bloom. *Winter buds* slender, cylindrical, sharp-pointed, ½ in. long, scales free at the tips. *Leaves* in pairs, persisting 3

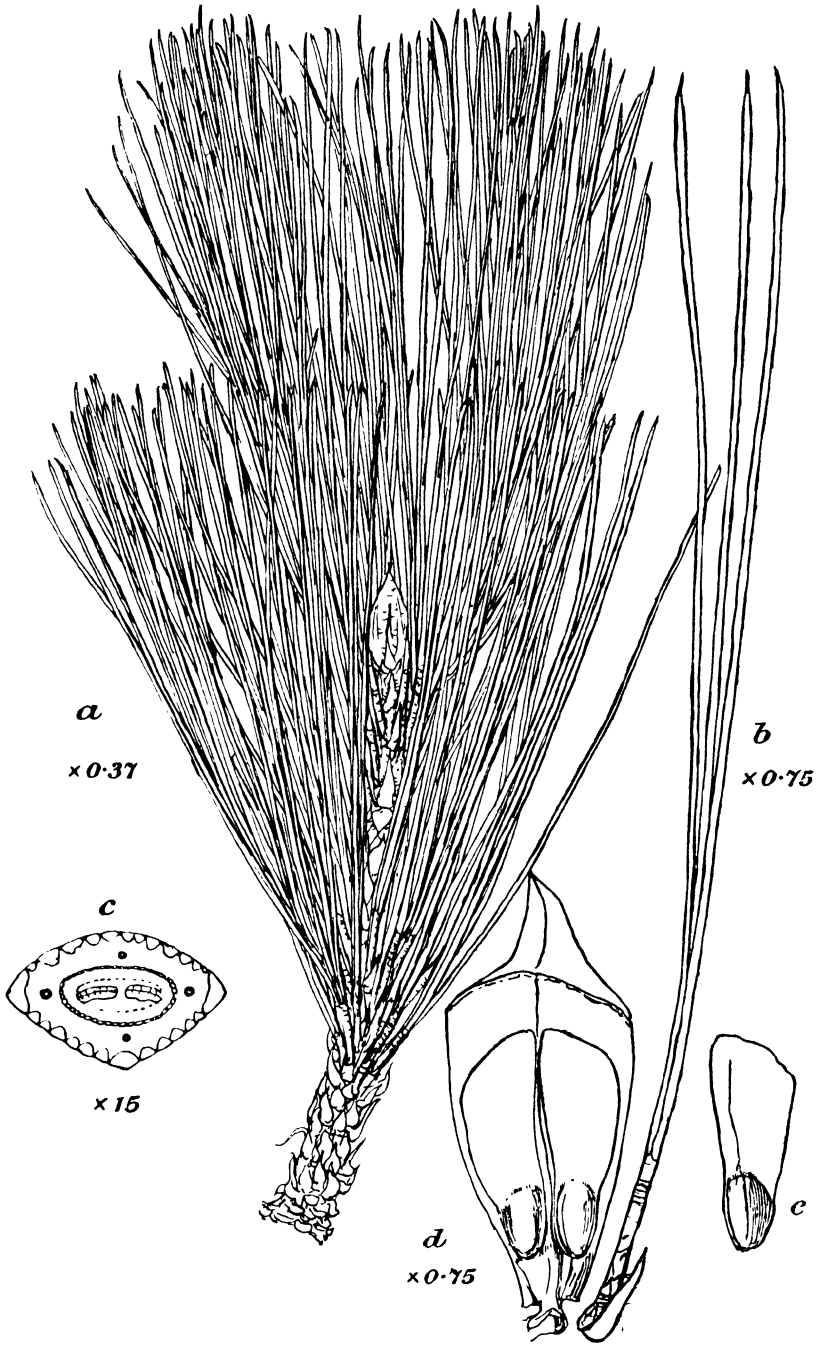

FIG. 87.—*PINUS COULTERI.*

a, branch showing winter bud ; *b*, cluster of three leaves ; *c*, section of leaf ; *d*, cone-scale with two seeds ; *e*, seed.

years, slender, soft, twisted, dull green, 2–4½ in. long, margins finely toothed, apex a sharp point, stomata on each surface but not very clear, resin canals marginal, basal sheath about ⅛ in. long on the younger leaves, shorter later, ending in two long slender points. *Cones* sub-terminal, solitary, or in clusters of 2–3, grey or brownish, rather larger than those of Scots pine; *scales* 1 in. long, ⅖ in. wide, oblong, thin, opening about end of second winter. *Seed* ¼ in. long; wing well developed, ½–¾ in. long.

Var. **argenteo-variegata**, Hort.

Patches of silvery leaves amongst those of normal colour.

Var. **aureo-variegata**, Hort.

Patches of golden leaves amongst those of normal colour.

P. densiflora is distinguished from *P. sylvestris* by its longer and more slender, dull green leaves, glaucous branchlets, and larger cones.

The species is widely distributed in Japan from the southern part of Kyushu to the south of Hokkaido, avoiding marshy ground.

Wood comparable with Scots pine in quality, moderately hard, strong and resinous, with numerous, well-marked resin ducts. The heartwood is reddish, the sapwood pale yellow. It works well with a good finish, and is widely utilized for general constructive work, the indoor finish of houses, and for practically any purpose for which the wood of Scots pine can be used. If placed in contact with the ground it should be creosoted or treated with some other preservative. The resinous roots are often split into sections and used for torches. In forests of this pine it is usual to cultivate "Matsutake," one of the most popular edible fungi of Japan. A considerable revenue is derived from this mushroom-like fungus[1] grown in the forests belonging to Osaka Major Forest Office, Hiroshima Major Forest Office, etc.[2]

P. densiflora thrives in Japan, in clay or heavy loam, and attains its largest dimensions in Honshu at elevations of 6,000–7,000 ft. Seeds are produced freely, and cut or burnt-over land, even when very poor, is quickly covered by seedlings. It is also widely planted in pure and mixed forests. In the latter, however, it can only be grown with shade-enduring species, for it must be the dominating tree if good results are to be obtained. It is regarded as the commonest forest tree in Japan, and occupies there a similar position to *P. sylvestris* in N. Europe. It is rare in cultivation and neither of the varieties has any horticultural value here; in Japan they are used in gardens and, with the type, are included amongst the trees utilized for dwarfing purposes.

[1] *Armillaria edodes*, Berkeley.
[2] *Forestry of Japan*, p. 72 (1910).

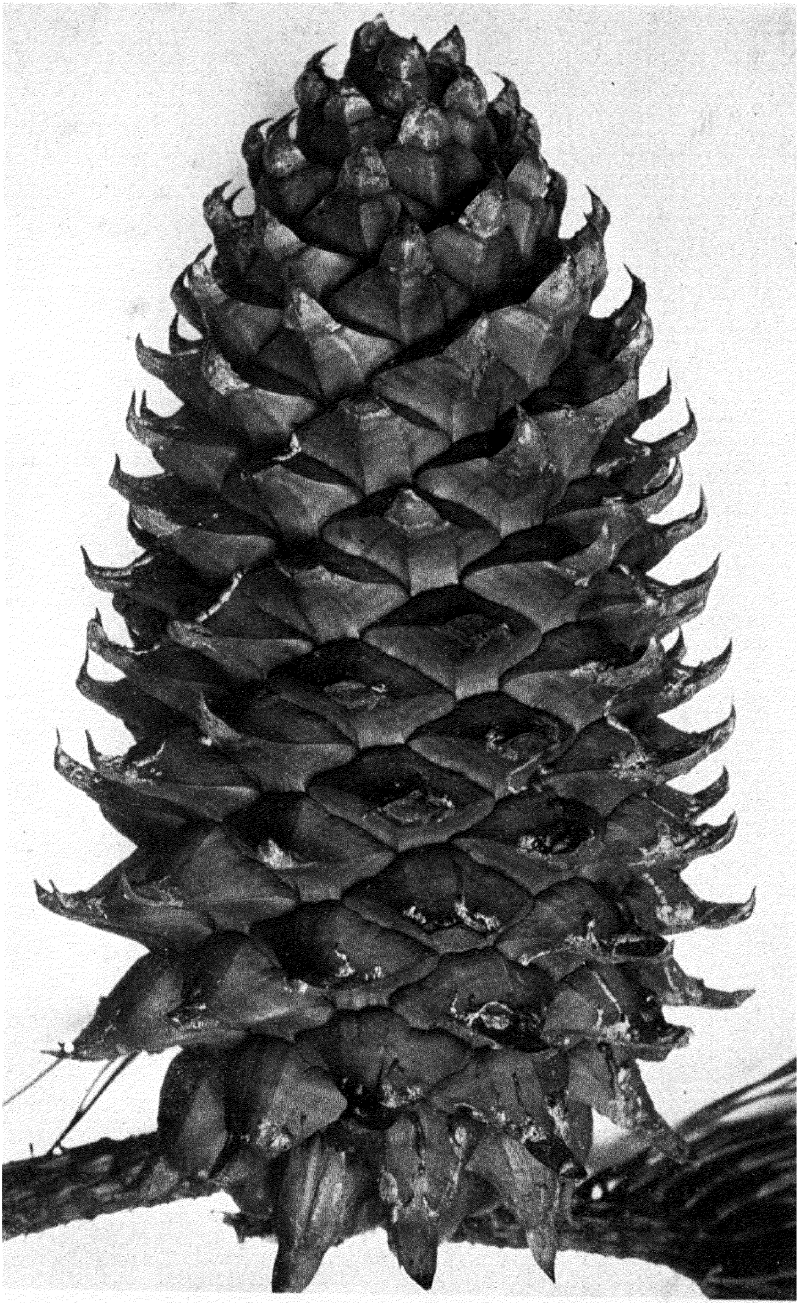

Photo by G. Atkinson

PLATE XXI. CONE OF *PINUS COULTERI.*

Several trees may be seen at Kew. The largest is 35–40 ft. high by 3 ft. in girth at 5 ft. above the ground.

Pinus taiwanensis, Hayata (Journ. Coll. Sci. Tokyo, xxx, Art. 1, 307 (1911), found in the mountains of Formosa, differs from *P. densiflora* in its oblong ovate cones.

P. brevispica, Hayata (Icon. Pl. Form. iii, 191 (1913), also an alpine species from Formosa, is said to differ from *P. taiwanensis* in its shorter male spike, thicker leaves and triangular cones (when open).

Elwes and Henry, *loc. cit.* v, 1125 (1910).

Pinus excelsa, Wallich. (Fig. 88.)

BHOTAN PINE.

Pinus Chylla, Loddiges; P. Dicksonii, Hort.; P. Griffithii, McClelland; P. nepalensis, De Chambray (not Royle); P. Strobus, Buchanan-Hamilton (not Linnæus or Thunberg). Blue Pine; Himalayan Pine.

A tree 50–150 ft. high, of elegant habit, and often, when isolated, feathered with branches to the ground. Branches spreading horizontally, or the upper ones ascending. *Bark* thin, smooth and resinous on young trees, greyish brown and shallowly fissured on old trees. *Young shoots* without down, glaucous, darkening in colour with age. *Winter buds* cylindric-conic, $\frac{1}{4}$–$\frac{1}{2}$ in. long, with lance-like scales, either free or matted with resin. *Leaves* in fives, lasting 3–4 years, those on the young shoot more or less erect, the older ones spreading or drooping, sometimes slightly bent, slender, greyish green, 5–8 in. long, margins minutely toothed, apex sharp-pointed; white stomatic lines on the flat surfaces; convex surface green; resin canals marginal; basal sheath about $\frac{3}{4}$ in. long, soon falling. *Cones* sub-terminal, solitary or 2–3 together, erect when young, pendulous the second year, cylindrical, 6–12 in. long, $1\frac{1}{2}$–2 in. in diameter before expansion, light brown when mature, very resinous; stalks $1\frac{1}{2}$–2 in. long; *scales* about $1\frac{1}{2}$ in. long and 1 in. broad, wedge-shaped, exposed portion longitudinally grooved, with a thickened apex. *Seeds* ovoid with a wing $\frac{3}{4}$–1 in. long, shed soon after ripening, the empty cones remaining on the trees for several months.

Var. monophylla, Carrière.

Differs from the type by its single leaves which apparently consist of five leaves welded together.

Var. zebrina, Croux.

The leaves are barred with green and gold. Neither variety appears to be in cultivation in the British Isles.

The Bhotan pine is distinguished from all other five-leaved species by its large, horizontal lower branches, its glabrous

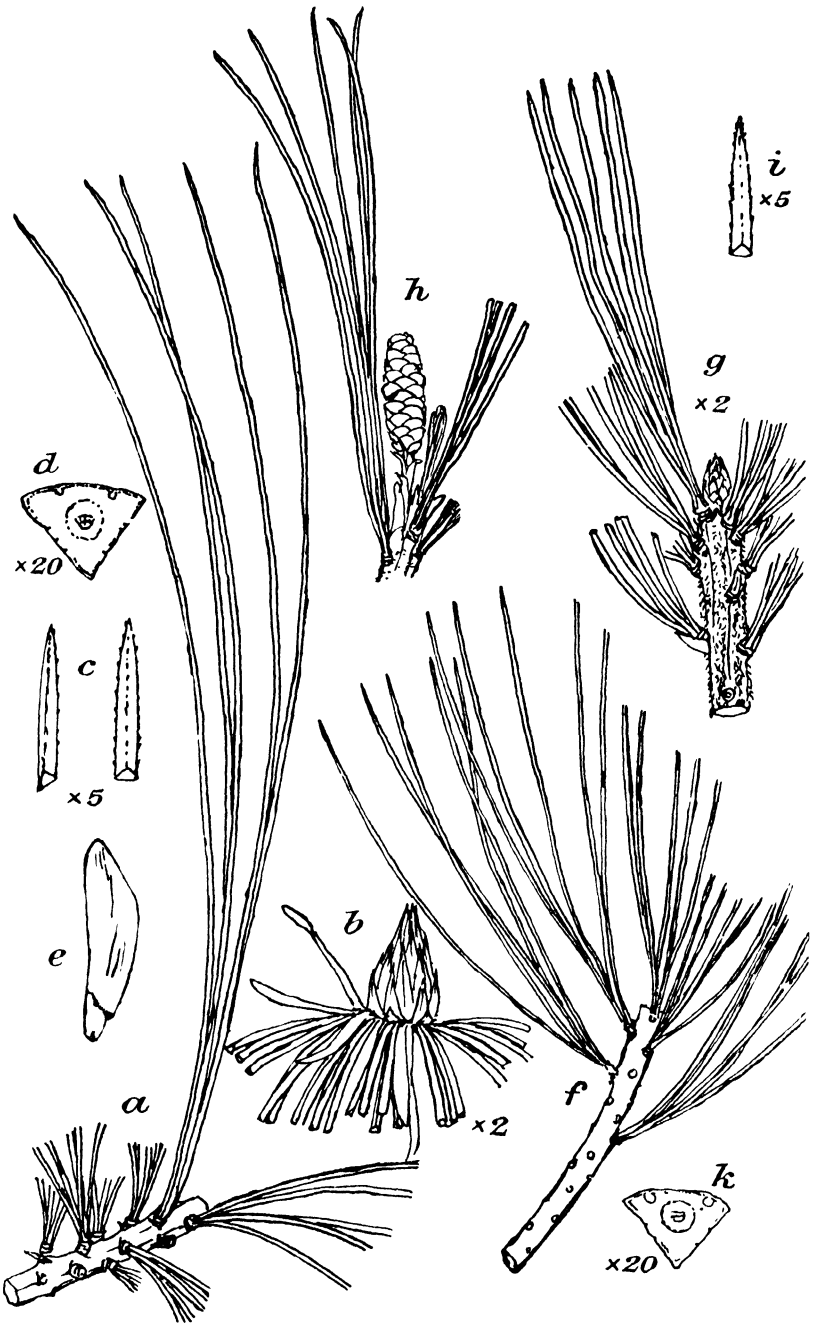

FIG. 88.—*PINUS EXCELSA* and *P. STROBUS*.

Pinus excelsa.—*a*, shoot with needles in clusters of five; *b*, winter bud with bases of leaf-clusters; *c*, apex of serrulate leaf; *d*, section of leaf; *e*, seed. *P. Strobus*.—*f*, shoot with needles in clusters of five; *g*, winter bud and pubescent shoot; *h*, young cone beside an expanding terminal bud; *i*, apex of serrulate leaf; *k*, section of leaf.

and glaucous young shoots, widely spreading leaves, and smooth cones. *P. Ayacahuite* has occasionally glabrous shoots, but the leaves are more slender and the cone-scales have reflexed tips, especially at the base. *P. Armandi* is known by the more decided bend at the base of the leaves, the stouter cones, and by the more loosely arranged male flowers. For the characters which separate *P. excelsa* and *P. Peuke*, see under the latter species.

Native of the temperate Himalaya at 6,000–12,500 ft. elevation, extending westward to Afghanistan and Kafiristan and eastward to Nepal. Introduced by Lambert about 1823, who raised plants at Boyton, Wilts.

Wood 28–30 lb. per cu. ft., resinous, with numerous scattered resin-ducts, and many fine medullary rays of irregular size. Heartwood reddish, sapwood creamy white. The wood, which is fairly hard and durable, works and finishes well. It is used for building purposes, the indoor finish of houses, sleepers, planking, furniture, tea-boxes, torches, and firewood. First-class rosin and turpentine are obtained by distillation of the resin procured by tapping. Tapping operations are conducted on two sides of the trees for three years. The trees are then rested three years, after which the other sides are tapped for a similar period, a ridge of sound bark being left between each two cuts. This tapping at three-year intervals goes on for an indefinite period. The resin is said to run less freely than from *P. longifolia*, but to be of better quality. The heartwood does not deteriorate owing to the trees being tapped, and trees are not easily killed if the work is carefully executed. Next to *Cedrus Deodara* this is the most important coniferous timber tree of the Himalaya. From the roots an oil is obtained which is used to anoint the arms and legs of natives to keep off water insects when working in the rice-fields. During dry winter seasons there is a copious sweet manna-like exudation from the leaves, which is collected and eaten by the natives.

P. excelsa reproduces itself freely in the Himalaya from self-sown seeds, and in open places quickly takes possession of grass and other land. Except in the early stage full light is necessary for its proper development. Under cultivation in this country it forms a handsome decorative tree with large, horizontal branches developing from the lower part of the trunk. In exposed positions the top becomes thin and weak when the tree is 25–40 ft. high, a sheltered position is therefore desirable for isolated specimens. The Bhotan pine does not appear to have been tried here under forest conditions, but would probably meet with a measure of success. The timber from isolated trees is coarse and knotty. Soil and conditions suitable for *P. Strobus* suit this species. As it is rather difficult to transplant, permanent planting should be carried out when the young trees are below 2 ft. high. It is said to be subject in the Himalaya to

attacks of the fungus *Trametes pini*, which causes the disease known as " red rot " in that country.

Gamble, J. S., *A Manual of Indian Timbers*, p. 704 (1921); Elwes and Henry, *loc. cit.* v, p. 1011 (1910); Troup, R. S., *The Silviculture of Indian Trees*, iii, 1015, (1921).

Pinus flexilis, James. (Fig. 89.)

Limber Pine.

Pinus reflexa, Engelmann; P. strobiformis, Sudworth (not Engelmann). Rocky Mountain White Pine; White Pine.

A tree 20–50 or occasionally 80 ft. high, with a short trunk 3–7 or sometimes 12 ft. in girth, usually producing regular whorls of short, flexible branches on young trees, and long, slender, drooping branches, often 16–18 ft. long, on mature trees, the branches drooping at a sharp angle with the trunk.[1] *Bark* of old trees dark brown, 1½ in. thick, fissured into scaly ridges. On young trees the bark is thin and smooth. *Young shoots* without down, or covered with minute brownish hairs. *Winter buds* ovoid, sharply pointed, ⅜ in. long. *Leaves* in fives, persisting about 5–6 years, densely crowded on the ends of the branchlets, pointing forwards, rigid, curved or slightly twisted, 2–3 in. long, margin entire or rarely with distinct teeth on the margins, apex sharp-pointed, 3–4 lines of stomata on each surface, resin-canals marginal. *Cones* sub-terminal, erect when young, spreading when mature, almost stalkless, 3–5 in. long, buff or orange-buff in colour; *scales* thick, opening and spreading horizontally when mature, 1 in. long, ¾ in. wide, obovate, with the upper margin thickened and reflexed. *Seed* shed as soon as ripe, ovoid, reddish brown, mottled, ⅓–½ in. long, wing rudimentary.

The species is distinguished from all other five-leaved pines, except *P. pumila* and *P. albicaulis*, by its entire or almost entire leaves. *P. pumila* differs in its dwarf habit and intensely downy shoots, and *P. albicaulis* has shorter indehiscent cones. In foliage *P. flexilis* and the latter are hardly distinguishable.

P. flexilis is an alpine species widely distributed on the eastern slope of the Rocky Mountains from Alberta to Texas. It also occurs in the mountains of N. Arizona, Utah, Nevada, and S.E. California, growing on arid and rocky slopes at 5,000–11,000 ft. elevation. It was discovered in Colorado in 1820 by Dr. Edward James and was introduced by Jeffrey in 1851. *P. reflexa* of Engelmann is sometimes regarded as a synonym and sometimes as a variety of *P. flexilis*; it has been seen in a wild state only in Mexico and has not, apparently, been introduced elsewhere. The cone-scales are much reflexed, and it is intermediary in character between this species and *P. Ayacahuite*.

[1] Sudworth, *Pine Trees of the Rocky Mountain Region*, Bull. 460, U.S. Dept. of Agric. p. 7 (1917).

Wood light, about 27 lb. per cu. ft., with small resin-ducts. Heartwood orange-yellow or brownish, sapwood narrow and creamy white, annual rings close. The timber is soft, easily worked, and used locally for building construction and other purposes. Although of fair quality and of considerable use in its native country, it has no value elsewhere, and the cost of extraction is likely to limit its further exploitation.

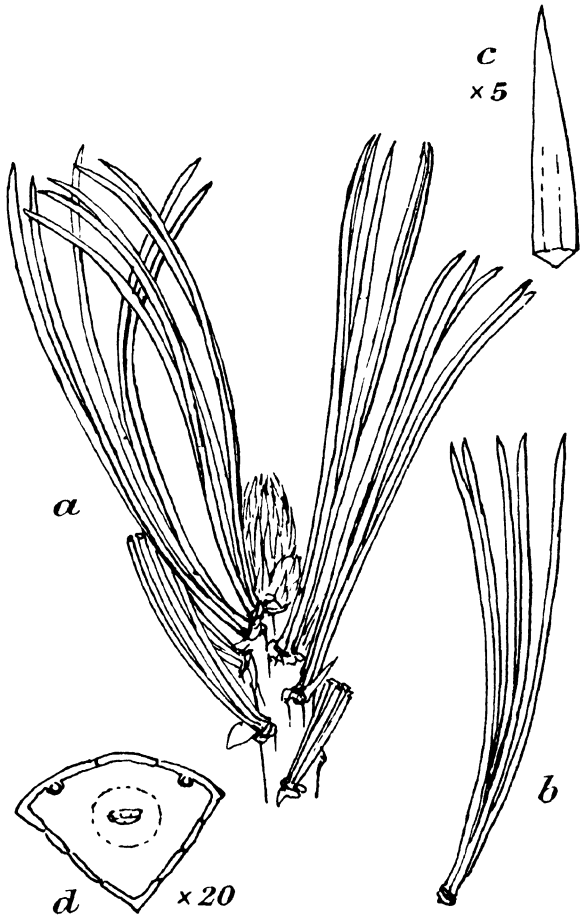

FIG. 89.—*PINUS FLEXILIS.*

a, end of branch with winter bud and leaf clusters; *b*, cluster of five leaves; *c*, apex of entire leaf; *d*, section of leaf.

The tree grows slowly in the British Isles and is not common in collections. Isolated specimens have a narrow pyramidal outline, after the manner of *P. Cembra*, and succeed in light, well-drained, loamy soil. Although it occurs very frequently in dry, rocky positions in a natural state, it attains its greatest luxuriance

in moist and well-drained soils and its highest altitude in clayey soil.[1]

The largest tree at Kew is 40 ft. high and 3 ft. 4 in. in girth at 5 ft. above the ground.

Pinus funebris, Komarov.

A species resembling *P. sylvestris* in stature, but with ashy grey coloured bark. *Young shoots* light brown, shining, without down. *Winter buds* reddish, ovoid, short-pointed, with closely pressed scales. *Leaves* in pairs, slender, 2¼–4 in. long, differing from those of *P. Thunbergii* in having marginal resin canals. *Cones* similar in size to those of *P. Thunbergii* but differing in the greyish terminal portions of the scales, each of which has an elevated centre ending in a short inflexed point. *Seeds* shining dark brown with short broad wings. *P. funebris*, which has been long confused with *P. Thunbergii*, is widely distributed in the mountains of N. Corea and in the Manchurian provinces of S. Ussuri, Kirin, and Mukden. It is also frequently seen as a cultivated tree near temples and tombs. It has not yet been introduced into cultivation and is doubtfully distinct from *P. sinensis*.

Elwes and Henry, *loc. cit.* v, 1144 (1910); Clinton-Baker, *Illust. Conif.* iii, p. 38 (1913).

Pinus Gerardiana, Wallich.

GERARD'S PINE.

Pinus Aucklandii, Loddiges; P. Chilghoza, Elphinstone; P. Neosa, Govan. Chilgoza; Chilgoza Pine; Himalayan Edible Pine; Neosa Pine.

A tree 50–80 ft. high, with a short trunk 6–12 ft. in girth, shedding its bark in small plates as in *P. Bungeana*. *Bark* thin, silver grey. *Branches* short and horizontal, forming a tree of compact habit. *Young shoots* without down, olive green, with prominent ridges. *Leaves* in threes; lasting 3 years, stout, stiff, 2–4 in. long; basal sheath deciduous during the second year. *Cones* oblong-ovoid, 6–8 in. long, 4 in. wide; *scales* 1½ in. long, 1 in. broad, very thick and woody, the exposed portion triangular and reflexed, the swollen apex ending in a recurved spine. *Seeds* cylindrical, oily, ⅝–1 in. long, wing rudimentary. The seeds do not retain their vitality for long.

Gerard's pine is distinguished from *P. Bungeana* by its denser, longer, and more slender leaves, and by its larger cones which have strongly reflexed scales.

Native of the N.W. Himalaya, occurring on the borders of Kashmir and Tibet, in Kafiristan and N. Afghanistan. It grows on dry, rocky ground at elevations of 6,000–12,000 ft., occurring as isolated specimens and in scattered groups. It was discovered by Captain Gerard, an officer of the Bengal Native Infantry,

[1] Sudworth, *The Pine Trees of the Rocky Mountain Region*, 8 (1917).

and was introduced into cultivation by Lord Auckland in 1839.

Wood hard, tough, and very resinous, with scattered and prominent resin-ducts. Heartwood yellowish brown, sapwood lighter. As a timber tree, however, it is of little importance, the few trees felled being put to local use. The seeds are the chief economic product of the species, for they constitute a staple article of food in the W. Himalaya and are imported into India from Afghanistan. They are rich in oil and have a slight turpentiny flavour. The native population use them either raw or cooked, but Europeans prefer them roasted. The value of the seeds prevents any exploitation of the timber.

P. Gerardiana does not adapt itself well to the conditions obtaining in the British Isles, and it is one of ıe rarest pines in cultivation. A good specimen existing in the Botanic Gardens, Cambridge, however, suggests that further trials should be made. In a wild state the tree withstands considerable drought and cold.

Troup, R. S., *The Silviculture of Indian Trees*, 1090 (1921); Gamble, *A Manual of Indian Timbers*, 709 (1921).

Pinus glabra, Walter.

SPRUCE PINE.

Cedar Pine; Lowland Spruce Pine; Poor Pine; Walter's Pine; White Pine.

A tree 80–120 ft. high and 4–6½ ft. in girth. *Bark* close and compact, reddish brown and moderately thick on the lower part of the trunk, thin, smooth, and grey above. *Young shoots* with intermediary buds between the nodes. *Winter buds* ovoid, sharp-pointed, brown. *Leaves* in pairs, lasting 2–3 years, soft, slender, twisted, 1½–3 in. long, margins finely toothed, short-pointed, stomata on each surface; resin canals median; basal sheath short. *Cones* usually solitary, ovate, reflexed, tawny yellow, symmetrical, 1¼–2 in. long, on short stalks. *Scales* rather soft and flexible, the exposed part terminated by a weak prickle which is often deciduous. *Seeds* rough, triangular, $\frac{3}{16}$ in. long and $\frac{1}{8}$ in. wide, wing $\frac{1}{2}$ in. long.

P. glabra is distinguished from *P. mitis* by its leaves being invariably in pairs, by its close and smooth bark, and by its softer cone-scales.

Native of the Atlantic forests in S.E. United States, being found in S. Carolina, Cent. and N.W. Florida and Louisiana, usually as single trees and small groups.

Wood very like that of *P. Tœda*, but weaker. It can be used for similar purposes.

P. glabra can only be grown in sub-tropical countries where the atmosphere is moist. Conditions suitable for magnolias, hickories, and nyssas are said to suit it admirably. Young trees

withstand more shade than most pines, but eventually full light is required. In the S.E. United States it is regarded as being likely to become an important forest tree of the future, whilst its graceful habit and luxuriant foliage give it a very ornamental appearance.

Mohr, *The Timber Pines of the Southern United States*, 135–140 (1897).

Pinus Greggii, Engelmann.

GREGG'S PINE.

Pinus patula, var. macrocarpa, Masters ; P. patula, var. stricta, Bentham.

A tree 40–50 ft. high, with smooth grey bark except at the base of old trees, where it becomes rough and fissured. *Young shoots* without down, glaucous at first, greyish buff the second year. *Branchlets* slender, often with lateral shoots. *Winter buds* slender, cylindrical, sharp-pointed, non-resinous, the scales free at the tips. *Leaves* in threes, bright green, slender, persisting 2–3 years, 4–6 in. long, margins finely and regularly toothed, apex short-pointed ; faint stomatic lines on each surface, resin canals median, basal sheath ½ in. long the first year, ¼ in. the second year. *Cones* clustered, ovate-conic, 3–6 in. long, irregular in outline, reflexed, tawny yellow in colour, remaining closed on the branches for several years.

Gregg's pine is closely allied to *P. patula*, from which it may be separated by the smooth grey bark on the upper part of the trunk.

A native of Mexico, where it is found on the north-eastern sierras at cool temperate elevations.

Little is known of the economic properties of *P. Greggii*, which has no commercial value outside its native country.

Although too tender for general ornamental planting in the British Isles, this pine would probably grow quite well in the south-west counties of England and in Ireland, or in any place where *P. patula* thrives. Soil conditions are likely to suit both species alike. The light, graceful appearance and bright green leaves of *P. Greggii* make it an attractive object for the garden or pinetum. There are small plants in the Temperate House at Kew, and we have seen it in the open air at Leonardslee where there is a plant about 10 ft. high.

Shaw, *Genus Pinus*, 86 (1914).

Pinus halepensis, Miller.

ALEPPO PINE.

Pinus abasica, Carrière ; P. abcharica, Hort. ; P. alepensis, Poiret ; P. arabica, Sieber ; P. australis, Hort. (not Michaux) ; P. colchica, Booth ; P. eldarica, Medwejew ; P. genuensis, Cook ; P. hierosolymitiana, Duham, Cl. ; P. hispanica, Cook ; P. maritima, Lambert (not Poiret) ; P. minor, Hort. ;

P. Parolinii, Visiani; P. persica, Strangways; P. Pityusa, Steven; P. sylvestris, Gouan (not Linnæus, Miller, or Thunberg); P. tatarica, Hort. Jerusalem Pine.

A tree rarely exceeding 50–60 ft. in height, but occasionally 80 ft. high with a trunk 12–15 ft. in girth, the branches irregularly arranged, numerous and slender. *Bark* smooth, silvery grey and shining at first, becoming reddish brown, fissured and scaly on old trunks. *Young shoots* glaucous grey, without down, slightly ridged. *Winter buds* conic, about $\frac{1}{3}$ in. long, the scales fringed and often reflexed at the tips. *Leaves* in pairs, lasting 2 years, slender, curved, twisted above, 2–3$\frac{1}{2}$ in. long, about $\frac{1}{32}$ in. wide, margins minutely toothed, apex a short, horny point, stomatic lines on both surfaces, resin canals marginal; basal sheath $\frac{1}{3}$ in. long, persistent. *Cones* solitary or 2–3 together, lateral, spreading or deflexed, reddish, ovate-conic, 2–4$\frac{1}{2}$ in. long, symmetrical or nearly so, on thick, scaly stalks, sometimes remaining closed for several years, or remaining on the branches after the dispersal of the seeds. *Scales* shining, yellowish brown or reddish, about 1 in. long and $\frac{5}{8}$ in. wide, the exposed part rhomboidal, flat or slightly raised towards the centre with a transverse ridge, the apex unarmed. *Seed* nearly $\frac{1}{4}$ in. long, light brown on the lower and blackish on the upper surface; wing nearly 1 in. long.

Var. **Brutia**, Elwes and Henry.

CALABRIAN PINE.[1]

Pinus Brutia, Tenore; P. Carica, D. Don; P. conglomerata Graefer; P. Loiseleuriana, Carrière; P. Pallasii, Parolin; P. Penicillus, Lapeyrouse; P. Pseudo-halepensis, Denhardt; P. pyrenaica, Carrière; P. resinosa, Loiseleur (not Roezl, Savi, Solander, or Torrey).

Leaves longer than in the type, 4–6 in. long, darker green in colour and more rigid. *Cones* spreading or pointing forwards, *never deflexed as in the type*, sometimes borne in whorls of 3–6. This appears to be a geographical variety, the distinctive characters being due to the influence of soil and climate.

P. halepensis is recognized by its shining reddish cones, the ashy grey colour of its branches and branchlets, and its slender leaves.

The species is common in the countries bordering the Mediterranean, including Spain and Portugal, S.E. France, Italy, Greece, Asia Minor, Cyprus, and Algeria. It is also found in W. Asia. The variety *Brutia* has a more restricted and more easterly distribution than the type. According to Loudon, *P. halepensis* was first cultivated in England by Bishop Compton in 1683. Fine specimens are rarely seen in collections, the largest tree known being at Margam, Glamorganshire.

[1] The name of Calabrian Pine is sometimes applied to *Pinus Laricio*, var. *calabrica*.

Wood of poor quality, coarse-grained and resinous, comparable with that of *P. Pinaster*.[1] Heartwood yellowish brown, sapwood yellow. The timber is used for inferior kinds of carpentry and joiners' work, boxes, crates, mine-props, sleepers, telegraph poles, fuel, and charcoal. Resin of good quality is produced by the tree, and systematic tapping, under the control of the French Forestry Officials, has been conducted in the Algerian forests of Oram for the last 15 years. Thereabouts the forests of Aleppo pine extend to 267,886 acres at an altitude of 3,280 ft. The resin does not appear to run so freely as that of *P. Pinaster*, and the inaccessibility of the forests makes it a less profitable species. Trees must be 36 in. in girth before they can be tapped. The bark has been used for tanning.

The Aleppo pine is a great drought-resisting tree and is valuable for hot and dry regions, where it has been planted in many places to check soil erosion and as a windbreak. It has grown well in S. Spain, Morocco, Tunisia, Algeria, Cyprus, S. Africa, and other places where a light rainfall is followed by prolonged periods of sunny weather and hot drying winds. The best results are obtained by breaking up patches of ground 12–16 in. square and a few feet apart, and sowing a few seeds in each about 1 in. below the surface. Each seed-plot is then covered by light brush as a protection against sun and wind until the seedlings are well established. If plants are put out they are only successful when a ball of soil remains attached to the roots; treated in the ordinary way they become shrivelled before the roots penetrate the soil. Trees 15–20 years old seed freely, the seed ripening about September. This pine should only be planted where more profitable species fail. It succeeds on thin limestone soils.

Elwes and Henry, *loc. cit.* v, 1099 (1910); Woolsey, *French Forests and Forestry* (1917).

Pinus Khasya, Royle.

KHASIA PINE.

Pinus Cavendishiana, Hort.; P. insularis, Endlicher; P. Kasya, Parlatore; P. keseya, Royle; P. khasia, Engelmann; P. khasyana, Griffith; P. sinensis, Endlicher (not Lambert).

A tree of small or moderate size in Khasia, but 100–150 or more ft. high in Burma, with a trunk up to 10 ft. in girth. *Bark* thick, deeply fissured. *Young shoots* without down, light brown, slender. *Winter buds* oblong-conic, pointed; scales brown, free at the tips. *Leaves* in threes, usually falling during the second year, very slender, green or grey green, 5–9 in. long, margins finely toothed, apex a long, fine point, stomatic lines on each surface; resin canals marginal; basal sheath $\frac{1}{3}$–$\frac{3}{4}$ in. long. *Cones* solitary, in pairs, or occasionally in threes, ovoid, symmetrical,

[1] *Pinus Saportæ*, Rouy (Fl. Fr. xiv, 368 (1913), a supposed hybrid between *P. halepensis* and *P. pinaster*, has been recorded from France (Vaucluse).

bright brown, 2–3 in. long, 1¼ in. wide, stalks short and stiff; *scales* about ¾ in. long, ⅓ in. wide, the exposed part prominently developed, with a thick tip transversely keeled. *Seeds* about ⅓ in. long with a round-topped wing.

Distinguished from other three-leaved pines by its fine, grass-like leaves and symmetrical cones.

A native of N. Burma, occurring in the Khasia Hills, Shan Hills, and the Hills of Martaban, usually at elevations of 3,000–7,000 but occasionally at 10,000 ft.; also found in the Philippine Islands. Its largest dimensions are attained in Burma. In the Shan States it is said to cover an area of 100–200 square miles.

Wood very resinous and of good quality. Heartwood reddish brown, sapwood yellow. The timber is used locally for building and other purposes, and is in demand for fuel. Resin from this species is stated to be of better quality than that of any other Indian pine, but, owing to the tree growing in somewhat inaccessible places, its collection is not a profitable undertaking.

P. Khasya is of no value for the British Isles, but would probably succeed in S. Africa, Australia, and New Zealand, if planted in well-drained soil moderately free from lime.

Gamble, *Man. of Ind. Timb.*, p. 708 (1921).

Pinus koraiensis, Siebold and Zuccarini. (Fig. 84.)

COREAN PINE.

Pinus mandschurica, Ruprecht; P. Strobus, Thunberg (not Linnæus). Cedar Pine; Cedr; Corean Nut Pine; Kedr.

A tree 100–150 ft. high, with a large, clean trunk bearing stout, spreading, or erect branches. *Bark* thin, except on old trees, reddish grey, smooth, or dividing into scaly plates. *Young shoots* clothed with dense, rusty brown hairs, similar to those of *P. Cembra*. *Winter buds* ½–¾ in. long, cylindric-ovoid, the points of the scales free. *Leaves* resembling those of *P. Cembra* in arrangement and structure, but differing in the blunter apex and closely and sharply toothed margins. They are also whiter on the surface from the more numerous lines of stomata. Basal sheath soon deciduous. *Cones* sub-terminal, erect, cylindrical, blunt or rounded at the apex, yellowish brown, 5–6 in. long, about 3 in. in diameter, stalks very short, sometimes scarcely noticeable; *scales* 1½–2 in. long, 1 in. wide, leathery with a wavy margin and often reflexed tip. *Seeds* about ½ in. long, wingless, not readily shed.

Var. **variegata,** Hort.

The leaves are marked with yellow. It is scarcely decorative.

P. koraiensis differs from *P. Cembra* in its stouter leaves with a whiter inner surface and by the margins having more

numerous teeth which continue to the apex of the leaf. The cones are longer and the scales less formal in outline.

The species is widely distributed in Eastern Asia, occurring in Amurland, Manchuria, Corea, and Japan. In the forests of Cent. Japan it occurs mixed with deciduous trees. Introduced by John Gould Veitch in 1861.

Wood light, about 25 lb. per cubic ft. when dry, with prominent resin ducts. The heartwood is yellowish-brown, the sapwood white or pale yellow. It is straight-grained, easily worked, compact and soft, finishes with a good surface, and takes paints and polish well. Compared with other pine timber it closely resembles that of *P. Strobus* and is of value for all the purposes for which that wood is used. It is obtainable in large sizes and in pre-War days was becoming a very valuable article of export to Chinese and other Asiatic and Australasian ports. The timber was well received in Europe, but the long journey and heavy freight did not allow it to compete with Russian, Scandinavian, and Canadian timber. It is shipped from Vladivostok and other N.E. Asiatic ports, and must be regarded as one of the most important soft woods for exploitation during the present century. The seeds are sometimes used for food.

The Corean pine does not grow so freely in this country as *P. Cembra*, and it is doubtful whether it has any other value than for decorative purposes. One of the principal timber trees of the more northerly parts of the Far East, it may be more suitable for Scotland than for the S. of England.

Good trees are to be seen at Bicton.

Elwes and Henry, *loc. cit.* v, 1041 (1910); Wilson, *Conifers of Japan*, 15 (1916).

Pinus Lambertiana, Douglas. (Fig. 90.)

SUGAR PINE.

Big Pine; Gigantic Pine; Great Sugar Pine; Shade Pine; White Pine.

The largest species of the genus, attaining in America a height of 250 ft. or more, and a girth of 40 ft., with a straight trunk often clear of branches for 100 ft. *Bark* on old trees 2–3 in. thick with irregular, scaly ridges; that of young trees smooth and thin. *Young shoots* minutely downy all over. *Winter buds* small, oval, $\frac{1}{8}$ in. long, pointed, with closely pressed, chestnut-brown scales. *Leaves* in fives, falling during the second or third year, rigid, twisted, $3\frac{1}{2}$–4 in. long, margin finely toothed, apex sharp-pointed, stomata on each surface, basal sheath $\frac{3}{4}$ in. long, deciduous. *Cones* sub-terminal, erect at first, pendulous when fully grown, 12–18 in. long, 3–4 in. in diameter, borne on stalks 3 in. or more long on the topmost branches; *scales* broad, almost fan-shaped, with a thickened, resinous apex, becoming widely spreading in

the open cone. *Seed* ½ in. long, with a wing 1–1½ in. long and ½ in. broad, shed as soon as ripe.

This species is distinguished from all other five-leaved pines with deciduous sheaths by the young shoots being minutely glandular downy, and by the sharp-pointed, rigid, spirally twisted leaves, the twist making a complete turn.

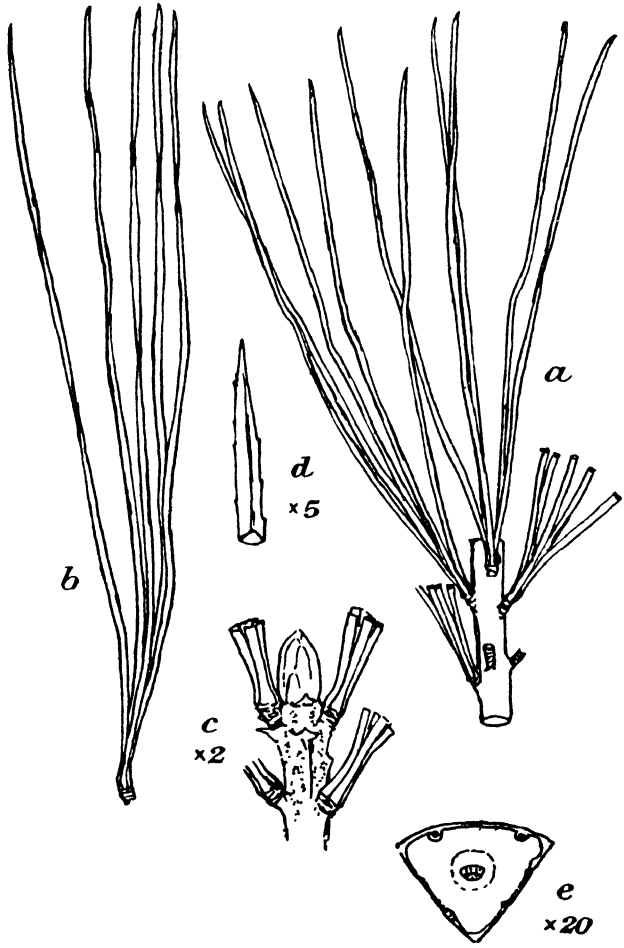

FIG. 90.—*PINUS LAMBERTIANA.*

a, shoot with leaf clusters; *b*, cluster of five leaves; *c*, winter bud; *d*, apex of leaf; *e*, section of leaf.

Native of Oregon and California, occurring on mountains from 2,000–9,000 ft. elevation. It is one of the most prominent species of the timber belt of the Sierra Nevada, especially on its western slope, where, in company with *Pinus ponderosa* and *Abies Lowiana*, it forms an important element in the main coniferous timber belt. It ranges south to the high mountains

of S. California and north to the Cascades and Coast Ranges of Oregon. Discovered by Douglas in 1825 on the Multomah River in Oregon and introduced by him in 1827. Most of the plants reared from his seed appear to have died, but a further supply of seed was collected by Lobb in 1851. A section of wood of the original tree introduced to the garden of the Royal Horticultural Society is preserved in the Forestry Museum at Kew. It is 18 in. in diameter and several of the annual rings are $\frac{1}{2}$–$\frac{3}{4}$ in. apart.

Wood light, 22–24 lb. per cubic ft. when dry, with conspicuous resin ducts. Heartwood yellowish to pale brown, not reddish as in *P. Strobus*, sapwood yellowish white. The timber is of first-class quality and very slightly inferior to that of *P. Strobus*; is straight-grained, easily worked, compact, soft, polishes well, and is obtainable in large dimensions free from blemishes, but requires careful seasoning. The total cut for 1916 is given as 169,250,000 board ft. It is used for building purposes, particularly the indoor finish of houses, and for all other uses of best white pine, including pattern-making. A sugary exudation possessing cathartic properties is obtained from the heartwood, particularly of charred and wounded trees, and is sometimes used as a substitute for sugar. Similar exudations may be noticed from the sawn wood. The seeds are occasionally used for food, but are less valuable than those of several other species.

In its native country the sugar pine does not cone in a young state and mature trees do not cone freely with any degree of regularity. Unless the seed falls upon ground offering ideal conditions for germination and subsequent growth, reproduction is poor, and *P. ponderosa* takes its place. Shade is necessary for seedlings, but later it is very intolerant of shade and often occurs as the dominant tree over an undergrowth of fir. The root system is shallow and the best specimens are found on light but good moist loamy soil. Moist climatic conditions are advantageous, and the best trees are usually found in misty valleys with an annual rainfall of at least 35–40 in. It is not common in collections in the British Isles, and cones are produced sparingly on cultivated trees. Good specimens occur here and there in gardens in the midland and southern counties of England, growing under similar conditions to the Weymouth pine, and it is worth trying in experimental forest groups in the deep valleys of Wales, Ireland, and W. Scotland. The difficulty of obtaining seed in quantity is against its general inclusion in forest schemes in this and other countries. In addition to other places good specimens are growing at Dropmore, Arley Castle, Westonbirt, and Kew.

Cooper, *Sugar Pine and Western Yellow Pine in California.* For. Ser. Bull. 69, U.S. Dept. of Agric. (1906); Jepson, *Silva of California*, 7 (1910); Hough, *American Woods*, vi, No. 146, p. 51 (1895).

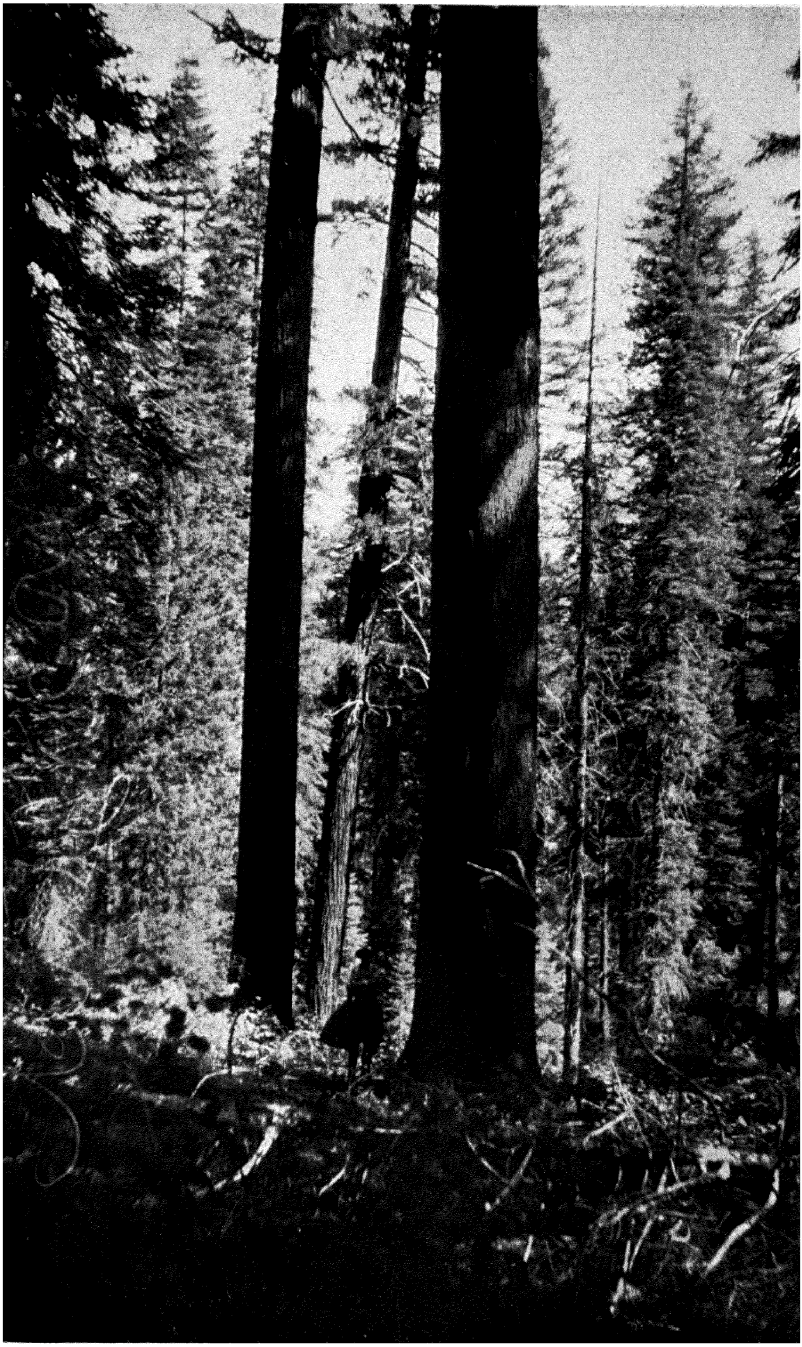

Photo. by F. R. S. Balfour, Esq.

PLATE XXII. *PINUS LAMBERTIANA* NEAR MOUNT SHASTA, CALIFORNIA.

Pinus Laricio, Poiret. (Fig. 91.)

CORSICAN PINE.

Pinus corsicana, Loudon ; P. Heldreichii, Christ ; P. Laricio, var. latisquama, Willkomm ; P. L. var. Poiretiana, Antoine ; P. maritima, Aiton (not Lamarck or Miller) ; P. nigra, Arnold.

A tree 120–150 ft. high, with a girth of 12–20 ft., bearing

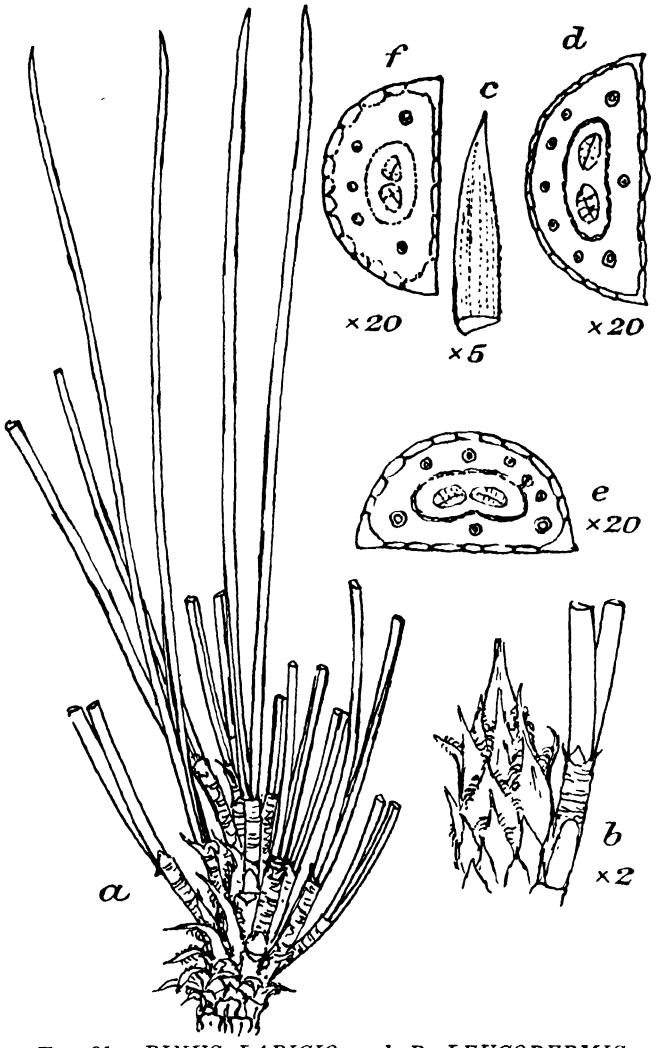

FIG. 91.—*PINUS LARICIO* and *P. LEUCODERMIS*.

Pinus Laricio.—*a*, shoot with leaf clusters ; *b*, winter bud and base of a pair of leaves ; *c*, apex of leaf ; *d*, section of leaf. Var. *nigricans.*—*e*, section of leaf, showing thicker hypodermis. *P. leucodermis.*—*f*, section of leaf, with even thicker hypodermis.

rather short, horizontal branches. *Bark* of old trees dark grey, deeply fissured, about 1 in. thick. *Young shoots* without down,

yellowish brown, prominently ridged, with leaf-bases persisting for several years on the older leafless branchlets. *Buds* cylindrical, ½–1 in. long, abruptly contracted to a sharp point, scales light brown, resinous. *Leaves* in pairs, persisting about 4 years, less dense on the branchlets than in the Austrian pine but more flexible than in that variety, bending when lightly tapped at the apex; stout, straight or curved, often twisted, 4–6 in. long, margins minutely toothed, apex a thickened, horny point; 12–14 lines of stomata on each surface, resin canals median, basal sheath about ½ in. long, becoming shorter on old leaves. *Cones* tawny-yellow, solitary or in clusters, sub-sessile, ovoid-conic, 2–3 in. long, 1 in. wide before opening; *scales* about 1 in. long, transversely keeled near the apex, which often terminates in a more or less persistent prickle. *Seed* greyish or brownish, more or less mottled, about ⅙ in. long, with a wing several times its length.

P. Laricio is a very variable species, including several geographical forms, some of which differ from the type in habit and density of foliage. The above description refers to the typical form common in Corsica, named by Loudon var. *corsicana*. The species may generally be distinguished amongst two-leaved pines by its yellowish-brown shoots, stout leaves, ovoid, abruptly pointed buds, and tawny-yellow cones.

P. Laricio is widely distributed in S. Europe from Spain to the Crimea and Caucasus, and in Asia Minor to the Taurus Mountains.

Henry considers the various geographical forms of this species can be divided into two main geographical groups characterized as follows:

1. Leaves broad, rigid, owing to the presence of several layers of hypoderm under the epidermis. Leaves more persistent than in Section II.

Var. **nigricans**, Parlatore.

AUSTRIAN PINE.

P. Laricio, var. austriaca, Endlicher; P. austriaca, Hoess.

Leaves not or scarcely twisted, resin canals numerous (averaging 11), with 14–16 stomatic lines on each surface. Common in Austria, Servia, and Hungary.

In the British Isles this name is given to a tree with stout branches bearing dense masses of foliage. The timber is coarser and more knotty than that of the Corsican variety. As a shelter tree it is of considerable importance, for it succeeds in very poor soil and on limy soil, in positions fully exposed to the sea.

Var. **Pallasiana**, Endlicher.

Var. caramanica; var. taurica.

Leaves rigid, broad (1·4–1·6 mm.), twisted; resin canals few, stomata in 12–14 lines.

In Britain this name has been given to trees with numerous stout branches, the lower ones ascending parallel to the trunk.

These varieties occur naturally on limy soils.

II. Leaves not rigid. Hypoderm in one or two layers. Leaves less persistent than in Section I.

Var. **corsicana**, Loudon.

Leaves twisted, 1·4–1·6 mm. broad; resin canals numerous. Stomatic lines 12–14. Hypoderm in one layer. Spain, Corsica, S. Italy, and Greece.

Var. **pyrenaica**, Grenier and Godron.

Var. cebennensis; var. tenuifolia.

Leaves narrow, with few (10–12) stomatic lines. Hypoderm in one layer and numerous resin canals. A small, slow-growing tree found on poor soil in exposed places. Cevennes and Pyrenees.

Var. **calabrica**, Loudon.

Leaves narrow (1·2–1·4 mm. broad). Resin canals few; stomatic lines few.

The following horticultural varieties are sometimes grown.

Var. **aureo-variegata.**

Leaves golden-variegated; of no decorative value.

Var. **nana aurea.**

A dwarf form with yellowish leaves. Suitable for the rock-garden.

Var. **pendula**, Beissner.

Branches pendulous. Of little merit.

Var. **pumila.**

A low bush suitable for the rock-garden.

Var. **pygmæa**, Rauch.

A low, dense bush suitable for the rock-garden.

Var. **variegata.**

Leaves variegated; of no decorative value.

The timber of the several forms of *P. Laricio* varies considerably in quality, and that of the type is superior to that of the Austrian variety when grown in the British Isles. The wood of

mature trees of *P. Laricio* is hard, strong, of good quality, resinous, with prominent resin-ducts, and equal in value to Scots pine for many purposes. There is a considerable contrast between heartwood and sapwood, the former being reddish-brown and the latter pale yellow. The timber is used extensively in the Mediterranean region for general constructive purposes and most of the other objects for which pine timber is needed. As the wood matures slowly it is necessary to cultivate the species on a longer rotation than Scots pine, and in Corsica, where it is one of the commonest trees, the shortest rotation appears to be 160–180 years. In the Valdoniello Forest it is stated that[1] "from the year 1907, all the rotations for Corsican pine have been placed at 360 years, the time, it is estimated, a tree reaches 0·00 to 1 metre (0 to 3 ft. 4 in.) in diameter; but counting rotations in force before 1907, they vary from 240 to 360 years. It is claimed that trees of this size must be furnished by federal or communal forests to supply the demand for large timbers." With the 360-year rotation there are 15 periods of 24 years each, and they propose to cut 0·399 of the available volume in each compartment. In the Antoine forest, with the same rotation, there are three periods of 120 years each, and the yield is cut in triennial fellings.[2]

In an examination of native and home-grown specimens, it was found that a section of trunk grown in Hungary (probably var. *nigricans*), showing 246 annual rings, and averaging 2 ft. 3 in. in diameter, had irregular heartwood, which in the widest part measured 16½ in. and in the narrowest part 13½ in. across, the annual rings of heartwood in one direction numbering 104 and in the other 82. A plank 2 ft. 3¾ in. wide, showing 53 annual rings, cut from a tree grown in Norfolk, had only 9 in. of heartwood confined to 13 annual rings. The disadvantages of so large a proportion of sapwood are the limitations of its uses and its rapid decay unless very carefully seasoned, and used under ideal conditions for preservation. Such timber is very susceptible to moulds or "bluing," the first sign of incipient decay, and a condition which seriously reduces its value, even although in the early stages the discoloration may not seriously affect the strength. Timber of this description should only be put to minor uses. It answers quite well for box boards. The wood of mature trees, however, may be regarded as suitable for all the purposes of Scots pine. In some places the Corsican pine has been planted for use in collieries, but here again the slow formation of heartwood places it at a disadvantage with woods of earlier maturity. On some estates in England and Wales, Corsican pine timber has been in use for a number of years, and

[1] Woolsey, Theodore S., Jun., *French Forests and Forestry*, Corsica, 137 (1917).
[2] *Loc. cit.* 138.

during 1920 we saw a quantity of timber sawn into quartering for use in cottages in Norfolk. This timber had, however, been sold to a neighbouring builder, and Scots pine was being used in the erection of cottages on the estate. The advantages possessed by Corsican pine over Scots pine are its ability to grow in places unsuitable for the latter tree, its comparative safety from attack by rabbits when first planted, its rapid growth, and freedom from serious attacks of insect pests. Conditions being equal, however, it is probable that it would be wiser to plant Scots pine rather than Corsican pine.

Resin has been obtained from *P. Laricio* by tapping, but only when that product realized an exceptionally high price, the yield being insufficient to allow of its competition with *P. Pinaster*.

P. Laricio and its several varieties are excellent seaside trees. The Austrian variety, when exposed to strong sea winds, develops a dense branch system which breaks the force of the wind and makes it possible to cultivate more important timber trees further inland. Therefore, in exposed places, it is often planted as the first line of defence, and behind it are used Corsican pine, Scots pine, and other trees. *P. Laricio* and its varieties are not fastidious as to soil, for they thrive in the pure sand of the sea shore and in heavy loam and clay, their vigour being very similar in limy soil and in soil containing little calcareous matter. Moreover, they are quite hardy throughout the British Isles and succeed as well inland as near the sea. The Austrian pine is often used as a windbreak for gardens and orchards, and for this purpose it is usually planted alternately in two or three rows, the trees being spaced 10–12 ft. apart in the rows. For blocking out unsightly objects it is also of value, although, as is the case with other coniferous trees, it cannot be planted with success in smoky towns or in places where the atmosphere is charged with chemical fumes. For landscape effect the Corsican and Austrian pines must be planted sparingly, otherwise their dark green foliage in mass produces a sombre and depressing effect. Therefore, when planted in mass, the general effect should be relieved here and there by the introduction of groups of other trees bearing brighter foliage. A plantation of about 1,000,000 Corsican and Austrian pines was made on Lord Wharncliffe's Wortley Hall Estate in Yorkshire in 1887.

A large number of trees are also growing on the sand dunes at Holkham in Norfolk, the seat of the Earl of Leicester, whilst old and well-developed specimens are to be seen in the gardens of the same estate. At Holkham a good object-lesson is provided of the value of Corsican and Austrian pines for the improvement of agricultural land by fixing sand-dunes, checking the inland spread of sand, and the provision of shelter. At Kew it is possible to judge of the value of the Corsican pine for planting

on poor, dry, sandy soil, for there are numerous fine trees, including an old one near the Main Gate planted by Salisbury in 1813 and now 95 ft. high with a girth of 9 ft. 2 in. at 5 ft. from the ground. In N. Wales the Corsican pine has given good results on Lord Penrhyn's estate and in other places. Both Corsican and Austrian pines should be planted in permanent places when not more than 18 in. high, and if the planting positions are very exposed, young trees 9–12 in. high are usually more suitable than larger ones. The Corsican pine, although not immune from attacks by rabbits, is less seriously injured than Scots pine. It is sometimes injured by pine aphis, and young trees occasionally fall a prey to root fungi, but on the whole the species is singularly free of enemies. Like most other pines, it requires plenty of light. For plantation work good results have been obtained by planting the trees 5 ft. apart each way.

Elwes and Henry, *loc. cit.* ii, p. 407 (1907); Woolsey, *French Forests and Forestry* (1917).

Pinus Lawsoni, Roezl.

LAWSON'S PINE.

Pinus Altamirani, Shaw.

A tree 80–100 ft. high, with a trunk 6 ft. or more in girth, covered with dark grey scaly bark. *Young shoots* glaucous. *Leaves* in threes, fours, or fives, glaucous green, up to about 9 in. long. Resin canals internal, but often with 1 or 2 in a median position. *Cones* variable in size and in the shape of the scales, ovate-conic, up to about 3 in. long on pliant stalks; *scales* with the exposed portion nut-brown, flat or swollen.

A sub-tropical species found in Cent. and W. Mexico. It sometimes grows with *P. Montezumæ* and other Mexican species, but is recognized by its conspicuously glaucous foliage.

This species is not in cultivation. Its timber is apparently used indiscriminately with that of other Mexican pines.

Shaw, *Genus Pinus*, p. 68 (1914).

Pinus leiophylla, Schlechtendal and Chamisso.

SMOOTH-LEAVED PINE.

Pinus Cedrus, Roezl; P. Comonfortii, Roezl; P. Decandolleana, Roezl; P. dependens, Roezl; P. Fenzlii, Antoine and Kotschy; P. gracilis, Roezl; P. halepensis, Bieberstein (not Muller); P. huisquilcaensis, Roezl; P. Lerdoi, Roezl; P. Monte-Allegri, Roezl; P. verrucosa, Roezl.

A tree of moderate size with slender branchlets, bearing clusters of short shoots on the trunk and branches like *P. rigida*. *Young shoots* slender, glaucous. *Leaves* in fives, persisting 2 years, short, slender, grey-green, 3–4 in. long, marginal teeth scarcely

visible with a lens, apex short-pointed, stomatic lines on each surface; resin canals median with an occasional internal one; basal sheath ½ in. long, soon deciduous. *Cones* sub-terminal or lateral, solitary or several together, ovoid, 1½–2½ in. long, on slender stalks ½–¾ in. long, ripening during the *third* year, and often remaining unopened on the branches for several years; *scales* ¾ in. long, ⅜ in. wide, the hidden part dark brown, the exposed part light brown, terminated by a minute prickle which usually falls early. *Seeds* oval, light brown with a rough, mottled surface, $\frac{3}{16}$ in. long, wing ⅝ in. long.

Var. **Chihuahuana,** Shaw.

P. Chihuahuana, Engelmann.

A northern form differing from the type in its stouter, more rigid leaves, which are usually in clusters of 3–4, and only occasionally in fives. It is often regarded as a distinct species. Shaw,[1] however, places it under *P. leiophylla,* on account of its *triennial* cone. Trees with foliage intermediate in character are known to occur.

P. leiophylla is distinguished from allied species by its triennial cones.

The typical form of *P. leiophylla* is confined to sub-tropical and warm temperate altitudes in Mexico, from Oaxaca, through the central and western States to S. Arizona and New Mexico. The var. *Chihuahuana* is found in S. Arizona and New Mexico, extending S. along the N.W. Sierras to the Territory of Tepic and the State of Zacatecas.

Wood apparently of good quality, although not known in Europe.

The tree is not hardy in the British Isles. It appears to cone freely and to produce abundance of seed, whilst it is almost unique in the fact that it is sometimes reproduced by sprouts from cut-over stumps.

Pinus leucodermis, Antoine. (Fig. 91.)

Bosnian Pine.

Pinus Laricio, var. leucodermis, Christ.

An alpine pine closely allied to *P. Laricio* and resembling *P. Cembra* in habit. It attains a height of 90 ft. and a girth of 6 ft. *Bark* grey, dividing into irregular plates. *Young shoots* glaucous. *Winter buds* like those of *P. Laricio* but darker brown in colour. *Leaves* in pairs persisting 5–6 years, densely covering the branchlets except at the base of each year's shoot which is bare for a short distance, forming a cup-like tuft; dark green, rigid, erect, 2–3 in. long, margins minutely toothed, ending in a

[1] *Pines of Mexico,* p. 14 (1909).

sharp point, stomatic lines on each surface; resin-ducts median; basal sheath ½ in. long. *Cones* ovoid-conic, shortly stalked, differing from those of *P. Laricio* in being a uniform dull brown colour, with the lower scales pyramidal above, ending in a reflexed spine. *Seeds* as in *P. Laricio*.

P. leucodermis is closely allied to *P. Laricio* and is probably but a mountain form of this variable species. The chief difference is seen in its compact branch system and dense foliage.

Native of Bosnia, Herzegovina, and Montenegro, and discovered in 1864 by Maly, who introduced it into cultivation the same year. Found also in Calabria.

P. leucodermis is usually found on the driest limestone formations. At Kew it succeeds in light loam under similar conditions to the Corsican pine, but grows more slowly, and is more compact. The largest specimen at Kew, raised from seed in 1890, is 16½ ft. high. The tree is worth a trial under forest conditions.

Elwes and Henry, *loc. cit.* ii, p. 424.

Pinus longifolia, Roxburgh.

LONG-LEAVED INDIAN PINE.

Pinus Roxburghii, Sargent; P. serenagensis, Madden. Chir.

A large tree 150–180 ft. high and 7–11 ft. or occasionally more in diameter, with a spreading crown when mature. The foliage, although normally evergreen, is occasionally deciduous, or partly so, in arid situations or in very dry seasons. *Bark* of young trees dark grey, deeply fissured, and shed in long, narrow strips, on older trees thicker, darker, often reddish, and shed in large plates. *Young shoots* grey or pale brown, covered with scale leaves which persist for several years. *Winter buds* ovoid, small, not resinous, scales closely pressed. *Leaves* in threes, usually persisting 1–3 years, averaging about 1½ years, although sometimes shed before the end of the first year; light green, slender, 8–13 in. long, margins regularly and finely toothed, apex narrowing into a long, fine point; with several faint lines of stomata on each of the 3 surfaces and marginal resin canals; basal sheath ½–1 in. long. *Cones* long ovoid, 4½–8 in. long, 2½–3½ in. wide at the base, on short, stout stalks; *scales* hard and thick, the exposed part elongated, thickened, and reflexed. *Seeds* ⅓–½ in. long, with a wing about 1 in. in length.

P. longifolia is closely allied to *P. canariensis* but is distinguished from it by the elongated cone-scales.

Native of the outer ranges and principal valleys of the Himalaya, usually at elevations of 1,500–7,500 ft. It covers very wide areas of country as pure forest and in mixture with other species.

The best timber is moderately hard and of fairly good quality,

but inferior to that of *P. excelsa*. It is very resinous with conspicuous resin ducts, the well-marked heartwood being light reddish brown and the sapwood yellow. In some districts it is badly twisted and practically valueless, for it cannot even be split for firewood. The best wood is used for building purposes, general carpentry, box boards, etc., whilst, treated with a preservative, it can be utilized as sleepers. A good deal of wood is made into charcoal, 1,200 lb. of wood yielding 480 lb. of charcoal and 96 lb. of tar. The thick, soft bark is of value for tanning. Apart from its value as a timber tree, *P. longifolia* is of considerable commercial importance, for it is the principal resin-bearing pine of the East. The quality of the resin is not quite so high as that of *P. excelsa*, *P. khasya*, or *P. Merkusii*, but the yield is greater, and as the trees are more accessible it is the only species that is systematically tapped. A sample of the charred leaves of this pine is preserved in the museums at Kew, with the information that they are used in that state as a dye.

P. longifolia grows under a variety of conditions and in very different classes of soil. The finest trees are found where the soil is moderately deep, well-drained, and light, but it also succeeds on shallow soils and on bare rocks wherever it is possible for seedlings to obtain roothold. In poor soil and in exposed places growth is often slow and the trees stunted, whilst twisted timber is stated to be prevalent where trees are growing in crevices of rocks. Provided full light is available, it is not a difficult species to regenerate. Good seed-years may be separated by several years of indifferent seeding, but, when a good year occurs, the seeds are widely distributed and germinate well on land that has been allowed to go out of cultivation, or in other suitable places. On ground covered by dead pine leaves germination is poor. *P. longifolia* does well in S. Africa as far as the rapid production of timber is concerned, but there does not appear to be any prospect of a resin industry resulting from its introduction there. A peculiarity of the tree in S. Africa is its ineffective seeding. Mr. Stainer, of the S. African Forest Service, says that " cones are not produced freely and very little seed is fertile." Similar aged trees of *P. Pinaster*, on the other hand, cone freely, and self-sown seeds germinate well. As *P. longifolia* is a sub-tropical species, it is quite unsuitable for planting in the British Isles, except as an ornamental tree in the mildest localities.

Troup, *Silviculture of Indian Trees*, iii, 1036 (1921).

Pinus luchuensis, Mayr.

LUCHU PINE.

A pine found by Mayr in the Luchu Islands, S. of Japan, where it often attains a height of 100 ft. with a slender trunk

and umbrella-shaped crown. *Bark* of young trees and of the upper parts of old trees, thin, clear grey in colour, shed in patches when old. *Winter buds* reddish, resinous, with closely pressed scales. *Leaves* in pairs, 6–8 in. long, resin canals median or with an occasional marginal one. *Cones* ovate-conic, symmetrical, up to about 2 in. long. *Scales* with the terminal portions shining nut-brown, transversely keeled.

Distinguished from other E. Asiatic hard pines by the smooth bark of the young trees.

Wood very hard and heavy, resembling that of *P. Thunbergii*.

The above description is from Mayr's original diagnosis of the species.[1]

Pinus Lumholtzii, Robinson and Fernald.

PINO BARDA CAIDA.

A wide, round-headed tree with slender, sub-pendulous branchlets and completely pendulous foliage. *Young shoots* shining chestnut brown, more or less glaucous. *Leaves* 8–12 in. long, with finely toothed margins; resin canals median and internal, rarely external; basal sheath 1–1¼ in. long, persistent, chestnut-brown in colour like the buds and branchlets. *Cones* usually about 2 in. long, ovoid, symmetrical, pendent, on slender more or less curved stalks, falling early; *scales* swollen at the summit, dull pale brown in colour with a darker centre.

A beautiful pine with remarkably pendent, bright green foliage, which hangs from the under-side of the branchlets like a beard. It resembles *P. patula* but has larger cones and more decidedly weeping foliage.

Native of the W. and N.W. Sierras of Mexico. Unfortunately it is not in cultivation.

Shaw, *Pines of Mexico*, 15 (1909).

Pinus Massoniana, Lambert.

MASSON'S PINE.

Pinus canaliculata, Miquel; P. rubra, Miquel (not Michaux, Miller, nor Sieber).

A tree 30–80 ft. high, with a girth of 6 ft. *Bark* reddish, resembling that of *P. sylvestris*. *Young shoots* glabrous. *Leaves* in pairs, slender, 6–8 in. long, margins finely toothed, resin canals marginal. *Cones* ovoid, 1½–2½ in. long, falling early; *scales* with the terminal portions thickened, nut-brown in colour with a transverse ridge and a slightly raised boss near the apex. *Seeds* dark brown, ⅛ in. long, with a narrow wing ½ in. long.

[1] *Bot. Centralbl.* lviii, 149 (1894).

It is most closely allied to *P. densiflora* and is recognized by its longer leaves and differently coloured cones. It is sometimes confused with *P. Thunbergii*, from which it may be recognized by its longer leaves and marginal resin canals.

P. Massoniana is a native of S.E. China following the valley of the Yangtse River into Szechuen.

The timber does not appear to have any independent commercial value, although it is doubtless mixed with that of allied species. The pollen is said to be used in confectionery, for the exteriors of cakes and pastry in Chekiang (see specimens in Kew Museums).

Pinus Merkusii, Jungh and de Vriese.

TENASSERIM PINE.

Pinus Finlaysoniana, Wallich; P. Latteri, Mason; P. Merkiana, Gordon; P. sumatrana, Hort.

A tree 60 ft. high in Burma, 100 ft. in Sumatra, of pyramidal habit when young, spreading or round-headed when mature. *Bark* of well-grown trees grey to brown, rather thick and deeply fissured. *Leaves* in pairs, persisting 1½–2 years, 7–10 in. long, margins finely toothed, apex abruptly pointed, resin canals median or with internal or intermediary ducts; basal sheath ½–¾ in. long. *Cones* solitary or in pairs, 2–3 in. long, narrowly cylindrical, often curved; *scales* woody, oblong, the exposed part rhomboidal and furrowed. *Seeds* small with a well-developed wing.

This species is very clearly defined by its peculiar cones and leaf section.

P. Merkusii is the most tropical of all pines occurring in Siam, Java, Cochin China, Burma, Borneo, Sumatra, and the Philippine Islands. In Burma it occupies low hills and spurs at elevations of 500–2,500 ft., and in Siam it is a common tree in some regions at an altitude of 1,500 ft., usually on light, gravelly, well-drained soils, sometimes in almost pure stands, and at others mixed with various broad-leaved trees. The wood is very resinous, with reddish-brown heartwood and yellow sapwood. It is used locally for building purposes and general carpentry, but does not appear to be cut to any great extent. The tree produces a good-quality resin, but it receives little attention owing to the inaccessibility of the forests.

P. Merkusii cannot be grown out of doors in the British Isles, but it might be useful for planting in S. Africa and Australia.

Troup, R. S., *Silviculture of Indian Trees*, iii, 1093 (1921).

Pinus mitis, Michaux.

Short-leaf Pine.

Pinus echinata, Miller; P. Tæda, var. echinata, Castiglioni; P. variabilis, var. echinata, Du Roi. Bull Pine; Carolina Pine; North Carolina Pine; North Carolina Yellow Pine; Oldfield Pine; Pitch Pine; Poor Pine; Short-leaf Yellow Pine; Shortschat Pine; Slash Pine; Spruce Pine; Yellow Pine.

A tree 80–100 or occasionally 120 ft. high, with a trunk 4–6 ft. in girth, and slender, often pendent branches. *Bark* ¾–1 in. thick, reddish, divided into irregularly shaped plates. *Young shoots* pale green flushed with violet and usually coated with a glaucous bloom; changing to brown. *Winter buds* ovate, short-pointed, about ¼ in. long, with closely pressed, resinous scales. *Leaves* usually in pairs, occasionally in threes or fours, lasting 2–5 years, slender, flexible, slightly twisted, 3–5 in. long, margins evenly and finely toothed, apex with a short, horny point, stomata on each surface, resin canals median, basal sheath barely ¼ in. long. *Cones*, 1½–2 in. long, usually clustered, ovate, without or with very short stalks, remaining on the tree after shedding the seeds; *scales* thin, flattish below, rounded above, the exposed part slightly thickened, transversely keeled, ending in a fine, short prickle which is often deciduous before the cones ripen. *Seeds* triangular, $\frac{1}{16}$ in. long, ⅛ in. wide, slightly mottled, wing reddish, ½ in. long.

Distinguished from other yellow pines of the E. United States by its short leaves, and from *P. Tæda* by its leaves being usually in pairs.

The short-leaf pine is widely distributed from S.E. New York, to N. Florida, and W. Virginia, and through the Gulf States to E. Louisiana, E. Texas, S. Missouri, and S.W. Illinois, covering thousands of square miles.

Wood coarse-grained, heavy, strong, and moderately resinous, with well-developed resin-ducts. It closely resembles that of *P. palustris*, *P. caribæa*, and *P. Tæda*, and whilst inferior to the two former in strength, it is stronger than the latter. The heart-wood is orange or yellowish brown, the rather wide sapwood being creamy yellow. Kiln-dried wood averages about 32 lb. per cubic ft. The timber is of great importance, and owing to its less resinous and easier working characters is superior to pitch pine for some purposes. It is used for the lighter kinds of building work, indoor finish of houses, panelling, car-building, furniture, railway sleepers, and all the other purposes for which good pine-wood can be utilized. Large quantities of timber are available for exploitation.

P. mitis succeeds in its native country on light gravelly soils, sand, gravelly clay, and loam. The ground must, however, be well

drained and not very limy. The best results are obtained from light clay containing a fair proportion of gravel. Satisfactory crops of seed are borne almost every year and the tree spreads rapidly over land that has been allowed to go out of cultivation, and elsewhere. It was introduced to the British Isles in 1739, but the climatic conditions do not suit it, and it is rarely seen in gardens. In America it appears to reach its most profitable size in 90–100 years. It is likely to prove one of the most important timber trees of the future in the S.E. United States.

Mohr, *Timber Pines of the Southern United States*, 93–111 (1897).

Pinus montana, Miller. (Fig. 92.)

MOUNTAIN PINE.

Pinus echinata, Hort.; P. Fischeri, Booth; P. obliqua, Santer; P. rostrata, Hort.; P. rotundata, Link; P. rubræflora, Loudon; P. sanguinea, Lapeyrouse; P. uliginosa, Neumann.

A shrub of more or less prostrate habit with numerous crooked, irregularly-spreading branches, or a tree attaining its best development in the Pyrenees and French Alps, where it is often 80 ft. high. *Bark* greyish-black and scaly. *Young shoots* short, without down, green at first with prominent ridges, becoming darker with age. *Winter buds* cylindric, ¼–½ in. long, with reddish brown scales encrusted with resin. *Leaves* in pairs, persisting 5 or more years, rigid, curved, dark green, 1½–3 in. long, margins finely toothed, apex a short, blunt, horny point; stomatic lines on both surfaces; resin canals marginal; basal sheath up to about ⅕ in. long. *Cones* sub-terminal, solitary, or 2–3 together, ovate or ovate conic, symmetrical or oblique, 1–2 in. long, shortly stalked; *scales* with the exposed part tawny yellow or dark brown, with a light-coloured apex surrounded by a darker ring, flat, prominent, or prolonged into a beak. *Seeds* small.

P. montana includes a great number of varieties or geographical forms which are difficult to classify, as the variations in habit are not always correlated with the character of the cones and appear to be due in many cases to soil, climate, and other conditions of growth.

The principal varieties are :—

Var. **Mughus**, Willkomm.

P. Mugho, Poiret; P. Mugus, Scopoli (not Jacquin).

This is very similar to var. *pumilio*, but the upper portion of the cone-scale is flattened and not pyramidal with a central boss. Common in the Eastern Alps and the Balkan States.

Var. **pumilio**, Willkomm.

P. pumilio, Haenke.

A shrub 6 ft. or less in height, often prostrate, and usually without a definite leader. *Cones* symmetrical, usually sub-sessile,

ovoid or globose, smaller than in var. *uncinata*, 1–1½ in. in diameter, spreading, tinged with violet before ripening; *scales* uniform in size, the upper portion unequally divided with the boss near the lower edge. Native of Cent. and S.E. Europe.

Var. **rotundata**, Willkomm.

Usually a small tree up to 30 ft. high, intermediate in habit between vars. *uncinata* and *pumilio*. *Cones* unsymmetrical, with

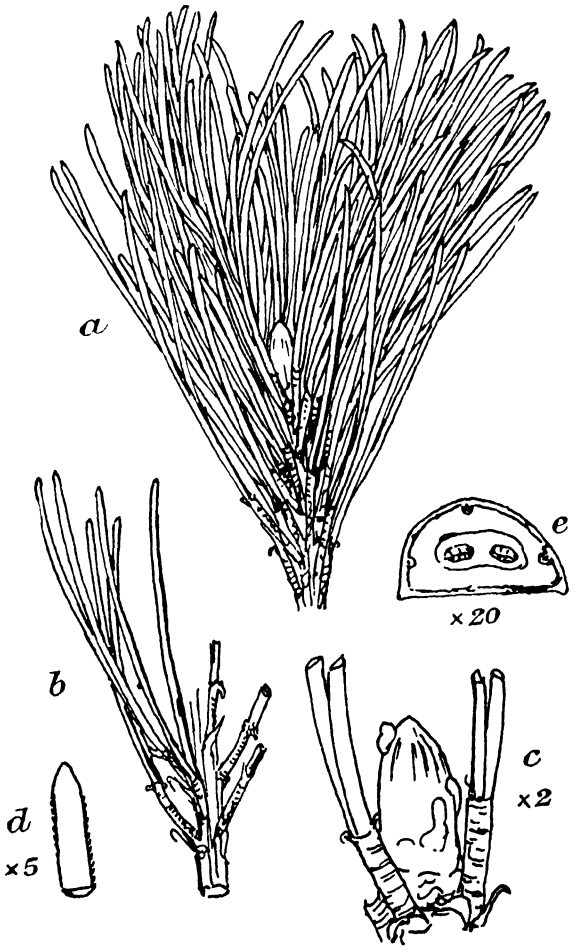

FIG. 92.—*PINUS MONTANA*.

a, branch with winter bud; *b*, portion of shoot with leaves in pairs; *c*, winter bud; *d*, apex of serrulate leaf; *e*, section of leaf.

the lower and occasionally the middle scales on the outer side pyramidal above and directed slightly downwards. Common in the Alps and in cultivation.

Var. **uncinata**, Willkomm.

P. uncinata, Ramond.

A tree 60–80 ft. high, with a girth of 6–9 ft., differing from the type in the apex of the cone-scales being pyramidal and deflexed with hook-like processes. It is the western form of the species and occupies extensive areas in the mountains of France and Spain,[1] usually at sub-alpine altitudes up to the limit of tree growth.

The species may be distinguished from other two-leaved pines with resinous, cylindric buds by the greater length of the leaf-sheath and usually by its bushy habit.

The timber of the variety *uncinata* is of economic importance and is used for general building purposes in the Pyrenees, the best wood being similar to Scots pine. Elsewhere the timber of *P. montana* has little value except as fuel. It is of no importance outside its own region, owing to the limited supply and difficulties of extraction. Pine oil, used for medicinal purposes, is distilled from the leaves.

P. montana and its varieties are grown in the British Isles for cover and for decorative planting, whilst the variety *uncinata* has been given some attention for planting under forest conditions in very cold and exposed places, particularly on mountains in Scotland, to provide shelter for more important trees. It has also been used to some extent for planting on upturned turves on boggy land in Scotland with a fair measure of success. Its ability to withstand wind and considerable cold are its chief recommendations. Light sandy gravelly or loamy soils.

Elwes and Henry, *loc. cit.* v, 1127 (1910).

Pinus Montezumæ, Lambert. (Fig. 93.)

ROUGH-BRANCHED MEXICAN PINE.

Pinus Devoniana, Lindley; P. Russelliana, Lindley; P. macrophylla, Lindley; P. filifolia, Lindley; P. Grenvillæ, Gordon; P. Wincesteriana, Gordon.

A tree 70 ft. high in Mexico. *Bark* reddish brown, rough and irregularly fissured. *Young shoots* without down, reddish-brown, prominently ridged, covered with the persistent scale leaves. *Winter buds* ovoid, pointed, about 1 in. long, composed of narrow-lance-shaped, chestnut-brown, fringed scales. *Leaves* usually in fives, but varying from 3–8 in a cluster according to the vigour of the tree or the climatic conditions under which it has been grown, crowded on the branchlets, lasting about 3 years, bluish-green, erect or spreading, 7–10 in. long, margins minutely toothed, apex a horny point; resin canals median; basal sheaths 1¼–2 in. long. *Cones* solitary or clustered, varying much in size and

[1] *Trans. Roy. Scot. Arb. Soc.* xxi, 10–15, figs. 1–9 (1908).

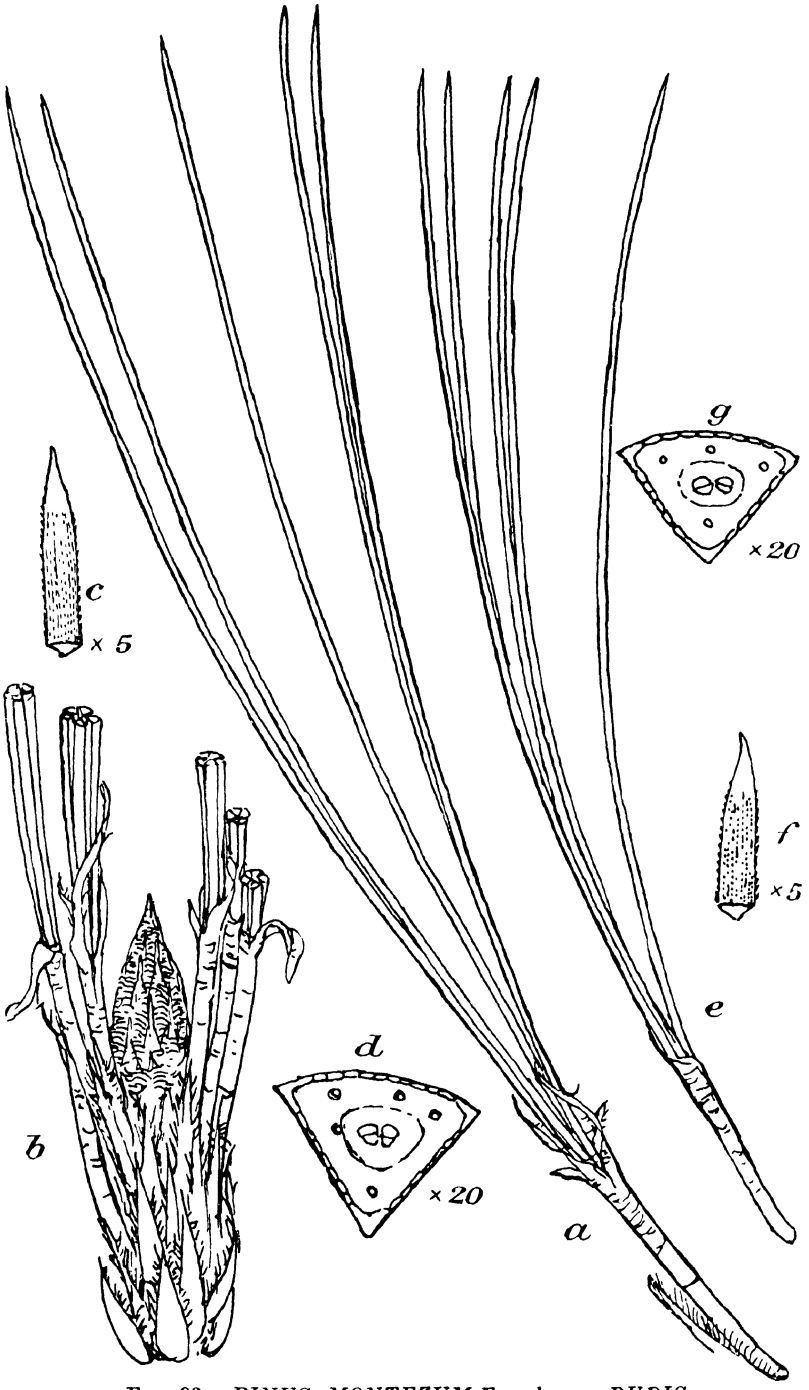

FIG. 93.—*PINUS MONTEZUMÆ* and var. *RUDIS*.

Pinus Montezumæ.—*a*, cluster of five leaves; *b*, winter bud and leaf bases; *c*, apex of serrulate leaf; *d*, section of leaf. Var. *rudis*.—*e*, leaf cluster; *f*, apex of leaf; *g*, section of leaf.

shape, ovoid conic to cylindrical, 2½–10 in. long, stalked ; scales obovate oblong, 1 in. or more long, exposed portion dull yellow, reddish or dark brown to black, flat or swollen, transversely ridged, with a minute, deciduous prickle. *Seed* ovate, brownish, mottled with black, ¼ in. long, wing narrow, 1 in. or more long.

Var. **Hartwegii**, Engelmann.

P. Hartwegii, Lindley.

Leaves often in bundles of 3–4, greyish green or glaucous in colour. Cones similar to those of var. *rudis*, but dark brown or almost black when mature. Native of Central Mexico in colder regions and at higher altitudes than other forms.

Var. **Lindleyi**, Loudon.

P. Lindleyana, Roezl.

Leaves very slender and drooping, 6–10 in. long. *Cones* 4–6 in. long, with the scales flat or slightly pyramidal above, pale brown in colour. Occurring in temperate regions.

Var. **rudis**, Shaw. (Fig. 93.)

Leaves occasionally 6–7 in a cluster, 4–6 in. long. *Cones* blue or bluish black at first, becoming dull or shining brown when mature, 2–2½ in. long. Native of warm, temperate regions. It is connected by intermediate forms with var. *Lindleyi*.

Among the five-leaved pines *P. Montezumæ* may generally be recognized by its long, spreading or drooping leaves, persistent leaf-sheaths and large buds.

The species is common as a wild tree in the mountains of Mexico, where it occurs in tropical and temperate regions at altitudes between 4,000–12,000 ft. It is a very variable species and many of its forms have been described as species,[1] but these have no real distinctions and are connected by numerous intermediates.

The timber of *P. Montezumæ* is unknown in the British Isles save for small specimens. It appears to be in general use in Mexico and to be one of the chief timbers of the country. There is also a small resin industry in Mexico, but it is doubtful from which pine the resin is obtained or whether it is procured from more than one species. In 1920 Mexico exported 28,693 gallons of turpentine to the United States.[2]

P. Montezumæ is represented in the British Isles by var. *Hartwegii* and perhaps by others. It can only be depended upon in the S. and S.W. counties, for even its hardiest forms are

[1] Roezl, *Cat. des Graines de Conif. Mexicains* (1857) describes 82 Mexican pines, only about six of which according to Shaw are distinct species. All of these had been previously described.

[2] *Commerce Reports*, June 24, 1921, 1739.

injured by cold winters and late spring frosts. The best results are obtained by planting it in a sheltered position in good, well-drained, loamy soil.

Good specimens of var. *Hartwegii* are to be found at Strete Raleigh near Exeter, at Windsor, and in other places.

Elwes and Henry, *loc. cit.* v, 1061 (1910); Shaw, *Pines of Mexico*, 21 (1909).

Pinus monticola, Don. (Fig. 94.)

Western White Pine.

Pinus Grozelierii, Carrière; P. nivea, Hort.; P. Strobus, var. monticola, Nuttall. Finger-cone Pine; Idaho White Pine; Little Sugar Pine; Mountain Pine; Mountain White Pine; Short-leaved Weymouth Pine; Silver Pine; Soft Pine; Sugar Pine; White Pine; Yellow Pine.

A tree attaining in America an age of 200–500 years and a height of 80–175 ft., with a trunk 15–25 ft. in girth, and a narrow pyramidal head. Bark of old trees greyish brown, separating into squarish plates, that of young trees thin, smooth, and light grey. *Young shoots* stout, clothed with minute, reddish down. *Winter buds* about ½ in. long, cylindrical or globe-shaped, blunt, scales close and compact. *Leaves* in fives, persisting 3–4 years, glaucous green, rigid, dense on the branchlets, about 4 in. long in cultivation, often shorter on wild trees, margins with fine but distant teeth, apex blunt, stomata in several (often about 5) lines on the inner surfaces; resin canals marginal; basal sheath ¾ in. long, soon deciduous. *Cones* solitary or in clusters from the ends of the branches, pendulous after the first year, green or purple in colour before ripening, 5–8 in. long, 2½–3 in. wide when open, slender and often curved at the apex when closed, stalks short and stout; *scales* thin, widening from the base upwards, reddish brown except the triangular exposed portion which is buff, tip thickened and resinous, lower scales reflexed. *Seeds* reddish brown with black spots, ⅓ in. long, wings about 1 in. long, shed as soon as ripe.

Three varieties have been described.—Var. *porphyrocarpa*, *Master* (*P. porphyrocarpa*, Murray); var. *digitata*, Lemmon; and var. *minima*, Lemmon. In the first case the distinction was based on the purple cones, and in the other two on the shape and size of the cones. It is doubtful whether either one can be regarded as sufficiently distinct to warrant a varietal name.

P. monticola may generally be recognized by its narrow, pyramidal habit, its bark broken into squarish plates on old trees, its downy young shoots, and slender, many-scaled cones, the basal scales being reflexed. From *P. Strobus*, its nearest ally, it differs in its stouter leaves, usually more downy shoots, and by the greater number of its cone-scales. *P. Peuke*, with similar foliage, has glabrous, bright green shoots and shorter, sturdier cones with concave scales.

This pine represents *P. Strobus* in the Pacific Coast region of N. America, extending from S. British Columbia to the western slopes of the Rocky Mountains in N. Montana, the coast region of Washington and Oregon, the Cascades and Sierra Nevada

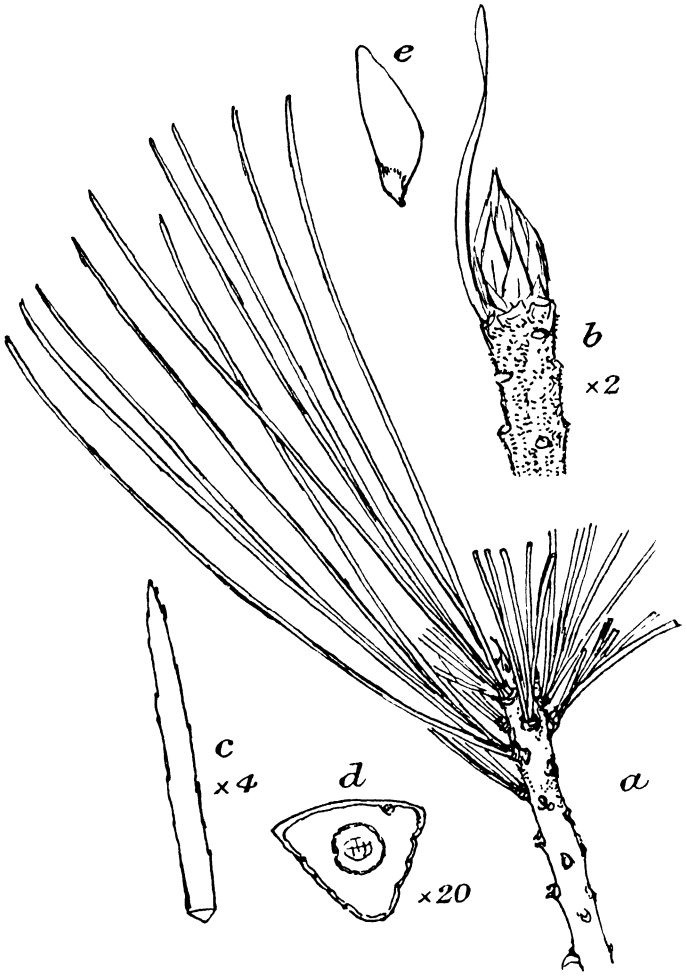

FIG. 94.—*PINUS MONTICOLA*.
a, part of minutely pubescent shoot with leaves in clusters of five; *b*, winter bud and scale; *c*, apex of leaf; *d*, section of leaf; *e*, seed.

ranges in California. On the Californian Sierras it reaches an altitude of 10,000 ft. and is often associated with *P. Lambertiana*. Discovered by Douglas about 1831, it was apparently introduced into cultivation at that time, although not grown much until further supplies of seed were sent to England by Lobb and others some 20 years later.

Wood light, 23–24 lb. per cubic ft. when dry, not very resinous, although the resin-ducts are easily seen; heartwood light brown, buff or reddish, sapwood pale yellow or nearly white. The timber is straight and rather close-grained, easily worked, takes a good finish, and paints and polishes well. It compares in quality with wood of *P. Strobus*, but is rather harder and stronger. The wood of the two species is practically indistinguishable and is suitable for similar purposes, particularly the indoor finish of houses, doors, window-frames, floors, cupboards, pattern-making, boxes, etc. It is obtainable in large and small dimensions, the best qualities being clean and free from knots.

P. monticola can be grown upon a considerable variety of soils, giving the best results upon deep and well-drained loam, where the climatic conditions are on the moist side. In a young state it withstands shade, but eventually requires full light. Native trees are said not to cone freely until they are approximately 50 years old; good seed is then produced at irregular intervals of about two years. The best germination of naturally sown seed occurs on exposed moist mineral soil. It is grown as an ornamental tree in Britain, but less commonly than *P. Strobus*. Trial plantations under forest conditions have been made by Mr. F. R. S. Balfour at Dawyck. Diseases to which *P. Strobus* are subject attack this species also.

Sudworth, *Pine Trees of the Rocky Mountain Region*; For. Ser. Bull., 460, U.S. Dept. of Agric. 4 (1917).

Pinus muricata, D. Don.

BISHOP'S PINE.

Pinus contorta, Bolander (not Douglas); P. Edgariana, Hartweg. Anthony's Pine; California Swamp Pine; Dwarf Marine Pine; Obispo Pine; Prickle Cone Pine; Swamp Pine.

A tree 40–50 or rarely 80–90 or more ft. high, with a trunk 6–10 ft. in girth, bearing stout, often crooked, irregularly spreading branches, which form a heavy, compact, flat-topped head with dense foliage. *Bark* reddish brown, thick on old trees, dividing by deep fissures into scaly ridges. *Young shoots* with irregular branchlets, green at first, then reddish brown, without down. *Winter buds* conic or cylindrical, $\frac{3}{4}$–1 in. long, very resinous. *Leaves* in pairs, lasting 3–4 years, yellowish green or dark green, crowded, stiff, curved or with a slight twist, 3–6 in. long, margins finely toothed, apex a short, horny point, stomatic lines on both surfaces; resin canals median; basal sheath persistent, $\frac{1}{3}$–$\frac{1}{2}$ in. long. *Cones* sub-terminal and lateral, persisting unopened for many years, solitary or in small clusters, more than one cluster sometimes appearing in a year, 2–3 in. long, ovoid, oblique, deflexed; *scales* on the outer side more highly developed than those on the inner side, very hard, swollen at the apex, and

terminating in a sharp prickle. Seed triangular, ¼ in. long, surface rough, *wing* ¾–1 in. long.

P. muricata is distinguished from other two-leaved pines by its resinous buds, long, usually yellowish green leaves, and oblique prickly persistent cones which remain closed on the branches for many years.

Native of the coast of California, where it grows on rocky headlands in scattered stations between Mendocino, San Luis, Obispo Counties; on the N.W. coast of Lower California; and on Cedros Island.

Wood light, moderately strong and coarse-grained, with conspicuous resin-ducts. Heartwood light brown or pinkish, sapwood creamy yellow. The timber is of moderate quality, and is used locally for building and other purposes. It may be classed with that of *P. radiata*, but is not plentiful enough for export.

P. muricata is hardier than *P. radiata*, but is less useful. It succeeds under conditions suitable for *P. radiata* and withstands a good deal of exposure. In this country it is very susceptible to attacks of the pine-shoot moth (*Retinia resinella*), which inflicts such serious injury that the tree becomes stunted into a spreading bush. Its use in the British Isles must be limited to arboriculture. The cones often remain intact upon the branches for 30–40 years, the seeds being liberated by forest fires, after which there appears a good ground covering of seedlings.

There is a very fine tree growing at Claremont, Esher, which is about 75 ft. high. Other fine specimens occur at Essendon, Herts; Garston Manor, Watford; The Heath, Leighton Buzzard; Highnam, Gloucestershire; and Patshull, Staffs.

Jepson, *Silva of California*, 95 (1910).

Pinus Nelsoni, Shaw.

NELSON'S PINE.

A small, bushy tree, rarely exceeding 25 ft. in height and 2½ ft. in girth, with long, slender, densely crowded branches. *Bark* smooth and grey. *Young shoots* slender, glaucous. *Leaves* in threes, but united along a portion of their inner surface, giving the appearance of one leaf in each sheath, 2–2½ in. long, minutely toothed on the two margins of the outer surface, margin of the inner surface entire. *Cones* remarkably distinct, 3–5 in. long, cylindrical on long, stout, curved stalks, remaining on the tree till the third year and leaving a few basal scales on the branch when they fall; *scales* orange-red at the summit, which is transversely ridged with an obscurely defined boss. *Seeds* large, wingless, pale yellow when fresh.

A unique species recognized at once by its adherent leaves and peculiar cones.

P. Nelsoni occurs in great abundance over a limited area on the lower slopes of the Sierras of N.E. Mexico. It is not known in cultivation.

Shaw, *Pines of Mexico*, 8 (1909).

Pinus occidentalis, Swartz.

Pinus cubensis, Grisebach (not Sargent); P. Wrightii, Engelmann.

A species allied to *P. caribœa*, from which it differs in its uninodal shoots, slender leaves which are usually about 6 in. long, and erect young cones. The mature cones are about 2–3 in. long, ovate, symmetrical, reflexed, falling early; *scales* nut-brown and shining above with a shallow, recurved prickle.

This pine grows naturally in E. Cuba, San Domingo, and Hayti. It is unknown in cultivation.

Shaw, *Genus Pinus*, 70 (1914).

Pinus oocarpa, Schiede.

Pinus oocarpoides, Lindley; P. Skinneri, Hort. (not Forbes).

A tree up to 50 ft. high, with stout branches and a round, compact head of bright green foliage. *Young shoots* with buds only at the nodes, glaucous. *Leaves* in threes, fours, or fives, stout, 10–12 in. long, resin ducts mostly septal. *Cones* broadly ovate to ovate conic, 2–3½ in. long, persistent, symmetrical, or oblique, on long, often curved stalks; *scales* with the exposed portion greyish or greenish yellow, flat or convex.

Easily known by its broadly ovate, long-stalked cones. The septal resin-ducts in the leaves are also a distinguishing feature.

A native of Central America extending through S. and W. Mexico to the boundary between the State of Sinaloa and Sonorar. It is not known in cultivation.

Shaw, *Pines of Mexico*, 26 (1909); Shaw, *Genus Pinus*, 77 (1914).

Pinus palustris, Miller.

Long-leaf Pine (America); Pitch Pine (Europe).

Pinus australis, Michaux; P. georgica, Hort.; P. longifolia, Salisbury (not Roxburgh); P. lutea, Walters (not Loddiges); P. Palmeri, Manetti; P. serotina, Hort. (not Michaux). Broom Pine; Fat Pine; Florida Pine; Florida Long-leaf Pine; Florida Yellow Pine; Georgia Pine; Georgia Heart Pine; Georgia Long-leaf Pine; Georgia Pitch Pine; Heart Pine; Long-leaf Pitch Pine; Long-straw Pine; Rosemary Pine; Southern Hard Pine; Southern Heart Pine; Southern Pitch Pine; Southern Yellow Pine; Texas Long-leaf Pine; Texas Yellow Pine; Turpentine Pine.

A tree 80–110 ft. high and 7–9 ft. in girth in America. *Branches* stout, gnarled, and twisted, up to 20 ft. long, forming a tree of irregular outline. *Bark* reddish brown, ¼–¾ in. thick, fissured and deciduous in thin scales. *Young shoots* stout, orange-brown, rough with prominent ridges, without down. *Winter buds*

large, non-resinous, cylindrical, pointed, 1½–2 in. long, with lance-shaped silvery white scales which are ciliate and reflexed at the apex, and persist as a sheath of bud scales at the apex of the second year's branchlet. *Leaves* in threes, lasting two years, densely crowded on the branchlet, slender, flexible, up to 18 in. long on young, vigorous trees, and about 9 in. long on old trees, margins minutely toothed, apex pointed, stomatic lines on each surface; resin canals median; basal sheath ¾–1 in. long. *Cones* sub-terminal, spreading, cylindrical or oblong-conic, 6–10 in. long, 2–3 in. broad, dull nut-brown, leaving a few scales attached to the branchlet when falling; *scales* thin, flat, 2 in. long, ¾ in. wide, the terminal portion rhomboidal and transversely keeled with a reflexed prickle. *Seed* about ½ in. long, with a wing three times its length.

P. palustris is very distinct in its large white, fringed bud and elongated cone.

Native of E.N. America, where it forms forests many miles in width along the Atlantic and Gulf States from Virginia to Florida. Introduced to the British Isles in 1730, but a failure in this country owing to its tender constitution.

Wood very hard, strong, tough, and resinous, with numerous and conspicuous resin-ducts. Heartwood light red or orange, sapwood lighter, annual rings very prominent. The timber is more highly esteemed than that of any other pine for heavy constructive work, both for strength and durability, and it is usually regarded as the standard of comparison for other soft woods. In discussing the wood Roth says:[1] "In its stiffness and strength the wood is remarkable. The average of a great number of tests indicates for the dry wood of long-leaf pine an elasticity of 1,540,000 lb. per square inch; strength in cross-breaking, 10,900 lb. per square in.; strength in compression, 6,850 lb. per square in.; strength in tension, 15,200 lb. per square in.; strength in shearing, 706 lb. per square in."

It grows with three other species, *P. caribœa*, *P. Tœda*, and *P. mitis*, and the timber of the four trees is often mixed in commerce. *P. caribœa* is as strong, and in tests has sometimes been found to exceed in strength the wood of *P. palustris*. The timber of both *P. Tœda* and *P. mitis* are however much inferior both in strength and durability. The wood of these four species is so similar even in microscopic characters that it is practically impossible to separate them, and the mixing of the timber goes on unchecked. Even in strength tests a good grade of *P. Tœda* or *P. mitis* may prove superior to an inferior log of *P. palustris*. The wood has a world-wide reputation, and in the British Isles it is known almost exclusively as pitch pine, although in America it is commonly known as yellow or long-leaf pine. It is used for

[1] Mohr and Roth, *The Timber Pines of the Southern United States*, 53 (1897).

all kinds of purposes where strength and durability are concerned, and particularly in bridge-building, heavy-construction work, naval architecture, church and school furniture and fittings, masts, telegraph poles, railway sleepers, flooring blocks, parquet flooring, etc. The three yellow pines, *P. palustris*, *P. mitis*, and *P. Tœda*, produced between them 26,264,000 railway sleepers in 1910 and 14,115,681 in 1915. Some of the wood is very prettily marked and the best specimens are utilized in the furniture trade and for panelling. *P. palustris* is the most important resin-producing tree in the United States, and large numbers of people find employment in tapping and distillation. There is also an industry connected with the extraction of a fibre from the leaves which is utilized for stuffing mattresses, pillows, cushions, etc., and also for surgical dressings, and for weaving into matting which somewhat resembles coconut matting in general appearance. The by-products obtained in the preparation of the fibre have some medicinal value. By destructive distillation of the wood, pitch, tar, tar oils and charcoal are obtained. The wood has also a high fuel value.

P. palustris requires a warm temperate or sub-tropical climate with plenty of moisture in the soil and atmosphere. It thrives on a variety of soils of a sandy or gravelly nature, attaining its best development in moist but well-drained, deep, light, warm, sandy loam. It, however, also succeeds on marshy land, where the surface is moderately dry. Good seed-years are of irregular occurrence, but following a good year there is a fair average crop of seedlings if the seeds fall upon a suitable seed-bed. Where conditions are not very favourable and *P. Tœda* is a companion tree the latter usually replaces *P. palustris*.

Mohr and Roth, *The Timber Pines of the Southern United States* (1897); Brown, N. C., *Forest Products: their Manufacture and Use* (1919).

Pinus parviflora,[1] Siebold and Zuccarini.

JAPANESE WHITE PINE.

Pinus Cembra, Thunberg (not Linnæus); P. formosana, Hayata; P. morrisonicola, Hayata; P. parvifolia, Hort.; P. pentaphylla, Mayr. Himeko-matsu.

A tree usually 20–50 ft. high, occasionally taller, with a girth of 3–5 ft. Young trees pyramidal, mature trees with flat heads of stout, spreading branches. *Bark* thin, smooth and greyish, ultimately becoming darker in colour and scaly on old trees. *Young shoots* greyish, with a scattered minute down. *Winter buds* ovoid, less than ¼ in. long, slightly resinous. *Leaves* mostly in fives, lasting 3–4 years, slender, curved, 1–2 in. long, margins finely toothed, apex usually blunt, the inner flat surfaces marked

[1] *Pinus Uyematsui*, Hayata (Icon. Pl. Form. iii. 192, t. xxxv, 1913) is a Formosan species resembling *P. parviflora* but with much longer cylindrical cones which have very thin scales. Not in cultivation.

by 3–4 prominent, white, stomatic lines, which give the foliage a variegated appearance; resin canals 2, marginal; basal sheath early deciduous. *Cones* solitary or in clusters, erect, ovoid, 2–2½ in. long by 1–1¼ in. broad.[1] *Scales* few, leathery, broadly wedge-shaped, spreading widely when mature, the outer edge rounded, entire and somewhat reflexed. *Seed* with a narrow rudimentary wing, shed as soon as ripe.

Var. **glauca**, Beissner.

Shoots pale shining, with the leaves stiffer and more glaucous than in the type.

P. parviflora is easily separated from other five-leaved pines by its short, blunt leaves, conspicuously white on the inner surfaces and by its peculiar cones.

A native of Japan where it is a common tree in the mountain forests above 5,000 ft. elevation. It was introduced into English gardens by John Gould Veitch in 1861.

Wood light with well-marked resin-ducts; heartwood brownish-yellow, sapwood pale yellow or whitish. The best qualities are soft, straight-grained, and easily worked, taking paint well. Some of the wood, however, is very knotty. It is used for general carpentry in Japan, but apparently is not exported.

This species succeeds in the British Isles in light, well-drained soil in an open position, but never grows very tall, the tendency being to form a short trunk with a wide head of branches. Cones are produced with great freedom even by young trees. In Japan it is found in both pure and mixed forests, often in rather inaccessible places. The Japanese distinguish several garden forms, including one or two with variegated leaves. They commonly plant it in gardens and also dwarf it for pot culture. It does not possess any commercial possibilities here, although interesting from an arboricultural standpoint.

Elwes and Henry, *loc. cit.* v, 1033 (1910); Wilson, *Conifers of Japan*, 22 (1916).

Pinus patula, Schlechtendal and Chamisso.

SPREADING-LEAVED PINE.

Pinus subpatula, Royle.

A tree of graceful habit 40–60 ft. high, the trunk often forking at a short distance from the ground into two or more stems, with long spreading branches. *Bark* on the lower part of the trunk broken into irregularly shaped plates, higher up thin, papery, reddish-brown, like that of *P. sylvestris*. *Young shoots* many-noded, without down, glaucous-green when young, becoming

[1] A form with larger cones up to 3½ in. in length, and seeds with a longer wing, has been described by C. Mayr as a distinct species, under the name of *P. pentaphylla*, but these characters do not appear to be constant. (Wilson, *Conifers of Japan.*)

reddish brown in the second year. *Winter buds* cylindrical, long-pointed, ½–1 in. long, covered with lance-shaped, long-pointed, fringed scales, which are free and spreading at the tips. *Leaves* in threes or occasionally in fours or fives, persistent 3–4 years, slender, spreading or pendulous, 6–9 in. long, $\frac{1}{25}$ in. or less in width, margins minutely toothed, apex a horny point; stomatic lines on each surface; resin canals median; basal sheath about 1 in. long. *Cones* lateral, persistent, in clusters of 2–5, on short, scaly stalks, ovoid conic, curved, oblique at the base, 3–4 in. long, pale brown, shining; *scales* oblong, nearly 1 in. long, the terminal exposed portion rhomboidal with a sunken centre and a minute prickle. *Seeds* triangular, grey mottled with black, ⅕ in. long, wing ½–¾ in. long.

P. patula is easily recognized by its slender, drooping foliage, its reddish upper trunk and persistent cones.

Native of the warm temperate altitudes of the central and eastern states of Mexico. Introduced between 1820–1837, but only hardy in the warmest parts of the British Isles. There are good specimens in Devonshire, Cornwall, and Ireland.

Nothing is known of the timber of this species or whether it has any special economic value.

Whilst it is too tender for general cultivation in the British Isles, its graceful habit and general ornamental character warrants its inclusion in pineta in the milder parts of the country. It has been tried in Algeria under forest conditions with little success, but in S. Africa it is said to be thriving more satisfactorily than any other Mexican pine that has been introduced.

Shaw, *Pines of Mexico*, 29 (1909).

Pinus Peuke, Grisebach. (Fig. 95.)

MACEDONIAN PINE.

Pinus excelsa, Hooker (not Wallich); P. excelsa, var. Peuce, Beissner.

A tree narrowly pyramidal in outline, somewhat resembling *P. Cembra* in habit, attaining in Bulgaria a height of 100 ft. and a girth of 7 ft. *Bark* thin, except at the base of old trees, similar to that of *P. excelsa*. *Young shoots* smooth, without down, shining green, becoming brownish grey in the second year. *Winter buds* ovoid, short-pointed, about ⅜ in. long, resinous. *Leaves* in fives, lasting three years, slender, sub-erect on the branchlets, 3–4 in. long, margins finely toothed, apex sharp-pointed, stomata on all surfaces; resin canals marginal, basal sheaths ¾ in. long, falling early. *Cones* sub-terminal, solitary, or in clusters of 3–4, spreading or pendulous, sub-cylindrical, 4–5 in. long, 1½–2 in. wide, resinous, brown when ripe; *scales* broadly wedge-shaped, 1¼–1½ in. long, ¾ in. wide, abruptly convex, striated or resinous on the outer surface with a thickened apex.

Seed ovoid as in that of *P. excelsa*, but with a shorter wing, shed as soon as ripe.

This species is allied to *P. excelsa*, but differs in its narrow habit, smaller branches, and shorter, stiffer leaves which are less spreading than those of the Himalayan tree. The green, glabrous

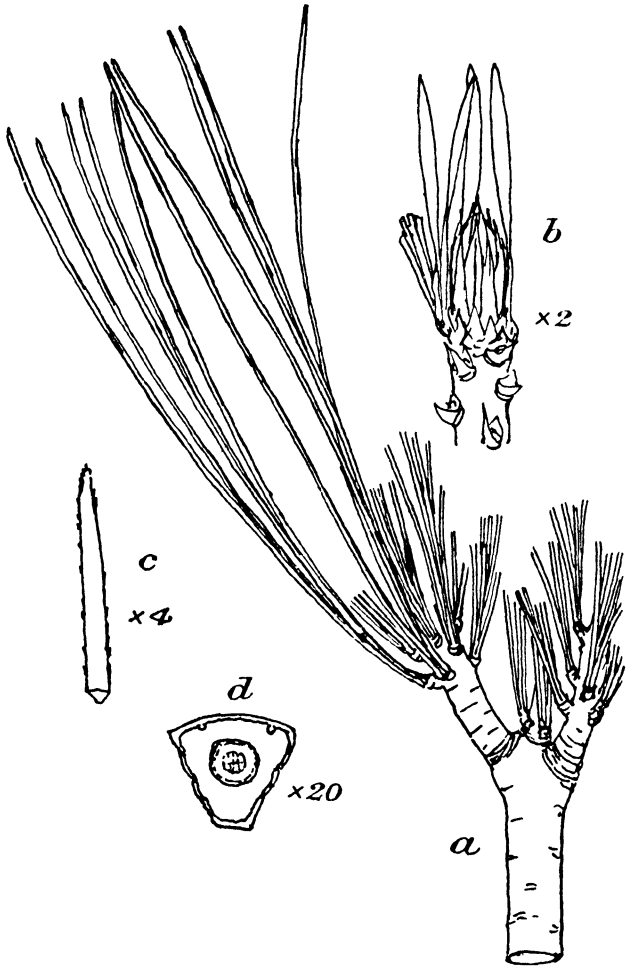

FIG. 95.—*PINUS PEUKE.*

a, part of glabrous shoot with leaves in clusters of five; *b*, winter bud; *c*, apex of leaf; *d*, section of leaf, showing two small resin canals.

shoots distinguish it from *P. Cembra*, which it somewhat resembles in habit. From *P. monticola* it differs in its glabrous shoots and shorter and wider cones.

As a native tree *P. Peuke* has a limited distribution, being confined to three small areas in Bulgaria, Macedonia, and Monte-

negro, at elevations of 2,500–6,000 ft. It was discovered by the German botanist Grisebach on Mount Peristeri near Bitoli, Macedonia, in 1839, and introduced into cultivation in 1864.

The wood is not well known, but appears to be rather like that of *P. Cembra*. The best quality is straight-grained and easy to work, but some of the timber is very knotty. Newly worked wood has a strong resinous odour, and injury to the bark of a growing tree causes a considerable exudation of resin. Resin ducts are well marked, particularly in the autumn wood. The timber has little value from a commercial standpoint outside its native country, and even there the difficulty of extraction limits its usefulness.

P. Peuke grows well in the British Isles, forming a compact, erect tree of medium height, coning freely when 20–30 years old. Light loam, or even sandy soil, provided there is an open subsoil, suits its requirements. It has been recommended as a suitable tree for sylvicultural purposes by German foresters, and experimental plantings at high altitudes should be made in this country.

Specimen trees are to be found amongst other places at Westonbirt, where it has attained a height of 53 ft. with a girth of 4 ft. 8 in.

Elwes and Henry, *loc. cit.* v, 1014 (1910).

Pinus Pinaster, Aiton. (Fig. 96.)

Maritime Pine.

Pinus detritis, Hort.; P. Escarena, Risso; P. glomerata, Salisbury; P. Hamiltoni, Tenore; P. hispanica, Cook; P. maritima, Lamarck; P. monspeliensis; Saltzmann; P. neglecta, Low; P. nepalensis, Royle; P. Nova-hollandica, Loddiges; P. Nova-zelandica, Loddiges; P. sanctæ-helenicá, Loudon. Bournemouth Pine; Cluster Pine; Pinaster; Seaside Pine; Tree of Gold.

A tree 90–120 ft. high with a girth of 6–14 ft., the trunks of old specimens usually bare of branches for the greater part of their length. *Bark* thick, dark reddish brown, deeply fissured. *Young shoots* pale brown, free from down, older branchlets prominently ridged and roughened by the bases of scale-leaves. *Winter buds* stout, ¾–1 in. or more long, spindle-shaped, with whitish brown, fringed, reflexed scales. *Leaves* in pairs, persisting about 3 years, stout, rigid, curved, 5–6 in. long, margins finely toothed, apex a hard, horny point; stomatic lines numerous on each surface; resin canals median; basal sheath 1 in. or more long, persistent. *Cones* sub-terminal, without stalks, produced singly, in twos or threes, or in large clusters, ovate conic, bright brown, shining, 3–7 in. long, 1½–2½ in. wide near the oblique base, spreading or deflexed, sometimes remaining closed for several years; *scales* oblong, about 1½ in. long and ¾ in. broad,

FIG. 96.—*PINUS PINASTER* and *P. PINEA*.

Pinus Pinaster.—*a*, branch with winter bud and leaf clusters; *b*, apex of leaf; *c*, section of leaf; *d*, seed. *P. Pinea.*—*e*, branch with winter bud; *f*, apex of leaf; *g*, section of leaf; *h*, cone-scale, showing cavities from which seeds have fallen; *i*, seed.

the exposed portion rhomboidal and transversely keeled with a thickened apex. *Seed* ⅓ in. or more long, with a wing 1–1½ in. in length.

The following varieties have been described, but it is doubtful whether they are obtainable.

Var. **Aberdoniæ**, Loudon.

Var Hamiltoni, Gordon.

Leaves pale green, cones shorter and more ovoid than in the type.

Var. **Lemoniana**, Loudon.

P. Lemoniana, Bentham.

Cones solitary and erect at the end of the branchlet, the terminal bud undeveloped.

Var. **minor**, Loiseleur.

P. minor, Loudon.

Cones smaller than in the typical form.

The maritime pine is distinguished from other species by its thick, deeply fissured, reddish bark ; by its long, stout leaves, persistent cones, and long, stout winter buds with reflexed scales.

Native of the Mediterranean region, extending as far eastward as Greece, and reaching the shores of the Atlantic in France and Portugal, but its area has been much extended by cultivation. Its most southerly habitat is Algeria.

Wood moderately heavy, 33–48 lb. per cubic ft., fairly hard, coarse-grained and resinous, with numerous large resin-ducts. The heartwood varies in colour from light red to reddish brown, the sapwood from pale yellow to almost white. It is not very durable in contact with the soil, except when treated with creosote or some other preservative. Amongst other pine timbers it may be classed as grade three. It has many uses, and is employed in coarse carpentry, inferior classes of building work, box-boards, laths, pit-props, and, when preserved, for telegraph and telephone poles, railway sleepers and paving blocks. The most important product of the maritime pine, however, is resin, and large quantities are extracted annually. The chief centre of the European resin industry is Western France, whence large quantities of turpentine and rosin are distributed. In the Landes there are immense forests of this pine and resin extraction and distillation gives employment to large numbers of people. The resinous products are obtained in two ways, by tapping and by destructive distillation. In tapping operations a section of bark and a thin sliver of wood are removed from the lower part of the tree, and a narrow strip of zinc is placed at the base of the wound. Resin exudes from the face of the cut surface, and is guided by

the zinc into a vessel specially placed for the purpose. When the face of the wound dries, the resin passages are reopened by the removal of a thin section of bark and wood, the operation being repeated as often as required. At the end of the season the wound may extend to a height of 2 ft. above the ground, the width being restricted to $3\frac{1}{2}$ in. The same cut is extended upwards for four or five years, by which time it has reached a height of 10–$10\frac{1}{2}$ ft. Work is then commenced upon another section of the trunk, taking care to leave a strip of bark intact between each two cuts. Young trees that have to be removed for thinning purposes are tapped freely and practically exhausted in four or five years. Trees intended to grow to maturity are not tapped until they have attained a diameter of 13 in. at 5 ft. from the ground. Such trees may be grown on a 60, 70, 80, or 100 years' rotation, with a rest of a year after every 4 or 5 years' tapping. The crude resin is distilled and the turpentine and rosin separated. Although tapping is said to decrease the rate of growth of the trees, the timber is improved thereby, the wood being harder and more durable than that of untapped trees. A great quantity of the smaller-sized wood is imported into the S. Wales collieries for use as pit-props. Timber from larger trees is cut into lumber and utilized as above. Although the principal seat of the resin industry is W. France, extraction and distillation is also carried on in Corsica, particularly in the Zonga forest. The average yield per tree is stated to be rather less than in the Landes. Destructive distillation is only employed for roots and waste wood. The forest workers in Corsica are encouraged to extract the roots for this purpose.

P. Pinaster thrives on light and well-drained soils, particularly those of considerable depth, but it does not succeed on clay. It is essentially a low level and maritime species, and few trees give better results in sea sand, or are more suitable for planting on sand-dunes. Unfortunately it is not very hardy and it does not succeed in the colder parts of the British Isles. In the southern counties of England, however, it is quite at home, and often forms a very handsome specimen. Excellent examples are to be seen at Bournemouth and at Mount Edgecumbe. When well established in warm climates, trees 25–50 years old produce cones freely and natural reproduction is good. In the British Isles natural seedlings are common in the pine woods about Bournemouth. When grown for the extraction of resin the trees are allowed to develop with good-sized heads, and to encourage this, drastic thinning is practised, for, like most other pines, it demands full light. In France and Portugal some 2,500,000 acres, chiefly sand-dunes, have been reclaimed from a barren, fever-stricken waste by planting the maritime pine. In the Scilly Islands it has been used with *Cupressus macrocarpa* to provide the necessary

shelter for the famous Tresco gardens. A few trees have been used with Austrian and Corsican pines to cover the sand-dunes at Holkham, the Earl of Leicester's estate in Norfolk. They have grown fairly well, but the position is evidently more suitable for the hardier trees. The botanical varieties referred to above are rarely seen in cultivation, although amongst a large number of trees it is probable that individuals could be selected answering to the descriptions. *P. Pinaster* has given satisfactory results in S. Africa.

Woolsey, Theodor S., Jun., *Studies in French Forestry*, pp. 140–209 (1919); *Diplomatic and Consular Report*, Ann. Ser. No. 5080 (France), pp. 17–20 (May, 1913); Elwes and Henry, *loc. cit.* v, 1113 (1910).

Pinus Pinceana, Gordon. (Fig. 96.)

PINCE'S PINE.

Pinus cembroides, Gordon (not Zuccarini); P. latisquama, Engelmann, in part.

A small, bushy tree, with long, slender branchlets. *Bark* smooth and grey except on the lower part of the trunk. *Young shoots* slender, glaucous, without down. *Leaves* in threes, glaucous green, 3 in. long, resembling those of *P. cembroides* but larger, the resin canals marginal. *Cones* cylindrical, 2½–3 in. long, pendent on long stalks; *scales* shining, ochre-yellow.

Native of Mexico from S. Coahuili to C. Hildago, where it grows along watercourses and is often associated with *P. cembroides*.

It is not known to be in cultivation, and possesses no important economic properties.

Shaw, *Genus Pinus*, 38 (1914).

Pinus Pinea, Linnæus. (Fig. 96.)

STONE PINE.

Pinus aracanensis, Knight; P. arctica, Hort.; P. domestica, Matthews; P. fastuosa, Salisbury; P. maderensis, Tenore; P. sativa, Lamarck.

A tree of distinct and picturesque habit, up to 80 ft. high, with a trunk rarely 20 ft. in girth. *Branches* horizontal, forming a flat-topped or umbrella-shaped crown with very dense foliage. *Bark* on old trees reddish-grey, with deep longitudinal fissures. *Young* shoots without down, greyish green, ultimately becoming pale brown. *Winter buds* ¼–½ in. long, with reflexed scales. *Leaves* in pairs lasting 2–3 years, slightly twisted, 4½–6 in. long, margins minutely toothed, apex sharp-pointed, about 12 stomatic lines on the outer and 6 on the inner surface; resin canals marginal; basal sheath about ⅖ in. long. *Cones* ripening in the third year, sub-terminal, solitary or 2–3 together on stout scaly stalks, erect, ovoid or nearly globular, symmetrical, 4–6 in. long, up to 4 in. wide, shining nut brown; *scales* 1½ in. or more long, ¾ in. wide,

the terminal portion stout and cushion-like, with a sharply defined central portion divided into two parts showing the second and third years' growth. *Seeds* large, numerous, often 100 in a cone, $\frac{5}{8}$–$\frac{3}{4}$ in. long, dark purplish-brown, convex on the inner and flattened on the outer surface, with a thick shell and an edible kernel, wing $\frac{1}{8}$–$\frac{1}{4}$ in. long.

The stone pine may always be known by its peculiar umbrella-shaped crown, its reflexed bud-scales, and its large, rounded, symmetrical cones. Leafy shoots without cones are rather like those of *P. Pinaster*.

Native of the Mediterranean region from Portugal to Asia Minor. It has also been extensively planted for centuries, and it is not easy to ascertain whether existing woods are natural or artificial in many localities. It is a familiar ornament of the landscape in S. Europe, and is valued on account of its picturesque habit and edible nuts.

Wood comparable with that of *P. Pinaster* in quality and strength, but the tree is less valuable, as it lacks the resin-producing qualities of that species. It can be used for similar purposes to the wood of the maritime pine, but it is chiefly employed locally, and has little general commercial value. The seeds are of considerable value as food and constitute an important article of commerce under the names of pine kernels, pignons, and pinocchi. They are much used by vegetarians, both raw and roasted.

In the British Isles the stone pine is highly valued on account of its distinct and ornamental habit, and is often grown as a lawn tree. It thrives throughout the midland counties and S. of England, Wales, and Ireland, succeeding in light, sandy soil, and in good loam, inland and near the coast. In S. Europe it is frequently planted for decorative purposes as well as in woodlands. When grown for seed-production wide spacing is necessary.

Elwes and Henry, *loc. cit.* v. 1119 (1910).

Pinus ponderosa, Douglas.

WESTERN YELLOW PINE.

Pinus apacheca, Lemmon; P. Beardsleyi, Murray; P. Benthamiana, Hartweg; P. brachyptera, Engelmann; P. Craigana, Murray; P. Engelmanni, Torrey; P. latifolia, Sargent; P. nootkatensis, Manetti; P. Parryana, Gordon (not Engelmann); P. peninsularis, Lemmon; P. resinosa, Torrey (not Roezl, Loiseleur, Savi, or Solander); P. Sinclairiana, Carrière; P. Sinclairii, Hooker and Arnott.

Big Pine; Bull Pine; Heavy Pine; Heavy-wooded Pine; Long-leaf Pine; Pitch Pine; Red Pine; Yellow Pine.

A tall tree 60–230 ft. high in its native localities, with a straight, clean trunk up to 25 ft. in girth. *Branches* stout, spreading, often drooping, but ascending at the tips, forming a tree with a long spire-like crown; or occasionally the trunk is shorter with a broader

head. *Bark* yellowish or dark reddish brown, breaking up into irregularly shaped scaly plates which become very large and thick in old trees. *Young shoots* stout, glabrous, orange-brown or greenish at first, but eventually becoming nearly black. In some of the varieties the young shoots are glaucous. *Winter buds* cylindric, conic, acute, $\frac{3}{4}$ in. long, scales reddish brown, closely pressed, resinous. *Leaves* in threes, lasting three years, spreading, densely crowded on the branchlets, rigid, curved, 3–10 in. long, $2\frac{1}{0}$–$1\frac{1}{2}$ in. wide, margins minutely toothed, apex a sharp, horny point; stomatic lines on each surface; resin canals median, basal sheath about $\frac{7}{8}$ in. long. *Cones* sub-terminal, solitary or in clusters, without stalks or nearly so, spreading or slightly deflexed, ovoid, 3–8 in. long, and $2\frac{1}{2}$–$4\frac{1}{2}$ in. wide before expansion, light reddish brown, often when falling leaving a few of the basal scales attached to the branchlets; *scales* oblong, about $1\frac{1}{4}$ in. long and $\frac{1}{2}$ in. wide, the terminal portion swollen, rhomboidal, transversely ridged, the apex armed with a minute prickle. *Seed* oval, about $\frac{1}{4}$ in. long, mottled, with a wing $\frac{3}{4}$ in. long.

Several varieties, which by some botanists are kept up as distinct species, have been described. The most distinct, which appear to be connected by intermediates, are the following :—

Var. **arizonica**, Shaw.

ARIZONA PINE.

Pinus arizonica, Engelmann.

Bark black and deeply fissured. *Young shoots* glaucous. *Leaves* 3–5 in a bundle (often 5), very long. *Cones* ovoid, 2–$2\frac{1}{2}$ in. long. Confined to S. Arizona and N. Mexico. Apparently not in cultivation.

Var. **deflexa**, Shaw.

P. deflexa, Torrey.

Bark dark brown or black. *Young shoots* glaucous. *Leaves* 3 together, 3–4 in. long. *Cones* small, 3–4 in. long. There is a tree at Kew.

Var **Jeffreyi**, Vasey. (Fig. 97.)

JEFFREY'S PINE.

P. Jeffreyi, Balfour. Black Pine; Sapwood Pine; Truckee Pine.

Young shoots glaucous, exhaling an aromatic odour when cut or bruised. *Buds* stout, reddish brown, non-resinous, with the points of the scales free. *Cones* large, 5–8 in. long, short-stalked with recurved bosses and prickles. *Seed* about $\frac{1}{2}$ in. long. Confined to California. Var. *Jeffreyi* is fairly common in the British Isles.

Bot. Mag. t. 8257 (1909).

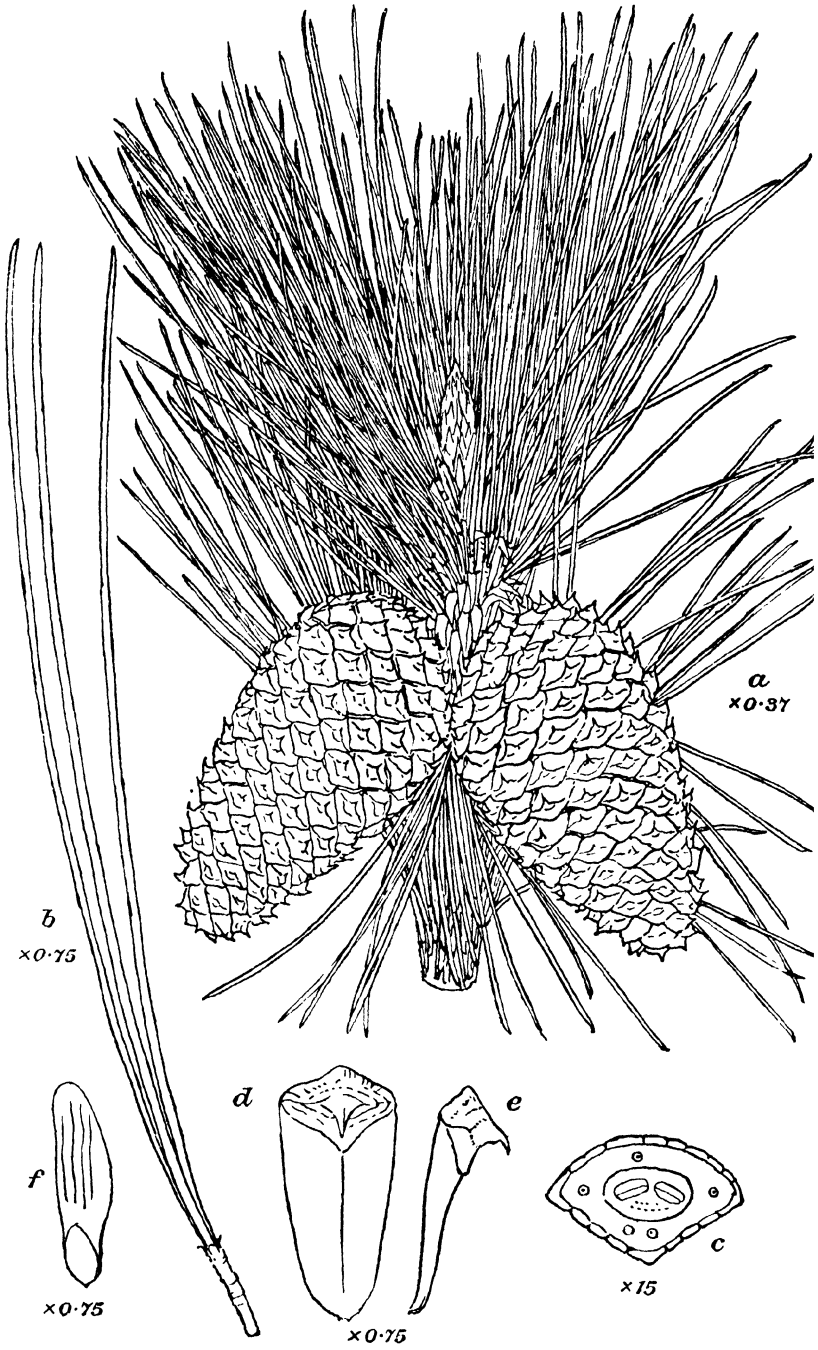

FIG. 97.—*PINUS PONDEROSA*, var. *JEFFREYI*.

a, branch showing winter bud and two cones; *b*, cluster of three leaves; *c*, section of leaf; *d*, cone-scale, outer side, *e*, side-view; *f*, seed.

Var. **macrophylla**, Shaw.

LARGE-LEAVED WESTERN YELLOW PINE.

Leaves 12–16 in. long, in bundles of 3, 4, or 5. *Cones* about 4½ in. long, the upper portion of the scales prolonged into a reflexed protuberance ending in a prickle. Native of Mexico. In cultivation in South Africa.

Var. **Mayriana**, Sargent.

MAYR'S PINE.

P. Mayriana, Sudworth.

Leaves very long and stout, 14–15 in. by $\frac{1}{16}$ in. *Cones* very oblique ; scales with projecting bosses, armed with sharp prickles. Discovered in Arizona by Mayr in 1887. It is not in cultivation in Britain.

Var. **pendula**, Sargent.

Branches drooping at a very sharp angle.

Var. **scopulorum**, Engelmann.

Branches usually drooping. *Leaves* shorter, 3–6 in. long, and *cones* smaller, 3 in. long, than in the type. Not very distinct. Forms of this variety are said to be common in the Dakotas, Nebraska, E. Wyoming, near parts of Colorado, and in Texas.

P. ponderosa is distinguished amongst three-leaved pines by its long, stout, densely tufted leaves and cylindrical buds. *P. Coulteri*, which resembles it in the stout foliage, differs mainly in the more ovoid buds, and much larger and more woody cones with strongly hooked scales. There are two distinct types, one with young shoots, orange-brown or greenish, the other with glaucous young shoots.

The western yellow pine is the most widely distributed species in W.N. America, the largest in size except *P. Lambertiana*, and the most variable. It occupies immense areas in the mountains of W.N. America, ranging from the interior of B. Columbia, southwards to Mexico, and eastwards to N. Nebraska, the foothills of the Rocky Mountains of Colorado and W. Texas.

Wood hard, strong, and resinous, with conspicuous resin ducts, comparable in quality to Scots pine. Heartwood light reddish brown, sapwood yellowish white. It is close-grained, works well, and is obtainable in large dimensions. Amongst other work, it is used for heavy construction, the indoor finish of houses, joists, cupboards, doors, floors, etc., general carpentry, boxes, fencing, railway sleepers, pit-props, and fuel. It is not durable in contact with the soil unless creosoted or treated with some other preservative. The species secretes resin in commercial quantities, although it does not appear to be worked much. Fibre is

extracted from the leaves in Oregon, and used for stuffing medicated pillows, mattresses, etc. A turpentine oil and a snuff-like powder, obtained during the preparation of the fibre, are used in medicine in the treatment of bronchial and catarrhal complaints.[1] The soft sapwood has been used as food by the Indians in times of scarcity. This is one of the commonest species in W.N. America, and as there is a very large quantity of timber of merchantable size, it is probable that exports will largely increase in the near future. It can be shipped from all the important timber ports, from British Columbia southwards to S. California.

P. ponderosa thrives under widely different conditions, and in many kinds of soils. It occurs from low elevations to a considerable altitude, on light and moist soils, and on dry, arid land; on dried-up river-beds and lakes where there is a deep and rich deposit of soil, and on almost bare rocks. The most satisfactory growth takes place on light, deep, and moist, but well-drained soil. Good seed-years occur every third or fourth year, and there is little intermediate seeding. Well-developed trees are said to produce as many as 1,000 cones in one seed-year. Seedlings thrive in full sun and in partial shade. For a number of years, although eventually requiring full light, the tree withstands more shade than most of the other pines. For these reasons it is spreading rapidly and taking the place of more exacting species. In Oregon and California it is often mixed with *P. Lambertiana*. *P. ponderosa* is, however, likely to oust that species if not controlled, owing to its greater adaptability, its more regular seeding, and its smaller reliance upon a perfect seed-bed. Forest fires do not injure *P. ponderosa* so badly as some other species, but it is subject to serious injury by *Dendroctonus brevicomis*, a bark beetle that speedily encompasses the death of large and small trees. There are also other bark beetles that cause serious injury, whilst several parasitic fungi are common on the tree. A mistletoe (*Arceuthobium occidentale*) is often present on the branches, causing them to become stunted and unhealthy, and eventually seriously injuring the trees. *P. ponderosa* and some of its varieties grow well in the British Isles, but it is not likely to become a useful timber tree here.

Jepson, *Silva of California*, 77 (1910); Cooper, Albert W., *Sugar Pine and Western Yellow Pine in California*, For. Ser. Bull. No. 69, U.S. Dept. of Agriculture (1906).

Pinus Pringlei, Shaw.

PRINGLE'S PINE.

A tree up to 60 ft. high, the trunk covered with dark grey, scaly bark. *Branches* slender and curving upwards at the ends. *Young shoots* sometimes glaucous. *Leaves* in threes, 6–10 in.

[1] *Diplomatic and Consular Report*, No. 2666, 1900, p. 23.

long, stout; resin canals internal; basal sheath persistent. *Cones*, conical, 2–4 in. long, persistent, unsymmetrical, or more or less oblique, reflexed, on stout stiff stalks, often produced in abundance. *Scales* with the exposed portion tawny yellow or fulvous brown, the outer scales often much swollen. *Seed*-wing conspicuously thickened at the base.

Confined to the sub-tropical regions of W. Mexico.

It does not appear to possess any special economic properties.

Shaw, *Genus Pinus*, 76 (1914).

Pinus Pseudo-strobus, Lindley.

FALSE WEYMOUTH PINE.

Pinus Antoineana, Roezl; P. Escandoniana, Roezl; P. heteromorpha, Roezl; P. Hoseriana, Roezl; P. Montezumæ, var. Pseudostrobus; P. Orizabæ, Gordon; P. prasina, Roezl; P. protuberans, Roezl; P. Regeliana, Roezl; P. taxifolia, Lambert; P. Tzompoliana, Roezl. False Strobus.

A tree up to 100 ft. high and 18 ft. in girth. *Bark* of young trees smooth, becoming rough at the base in older specimens. *Branchlets* slender, very glaucous. *Buds* and *foliage* similar to those of *P. Montezumæ*. *Cones* ovate or ovate-conic, symmetrical or oblique, 3–5½ in. long; *scales* with the terminal portion variable in shape, flat or protuberant. When the cones fall a few of the lower scales remain on the branches.

Var. apulcensis, Shaw.

P. apulcensis, Lindley.

Cones with the scales much elongated. It grows with the typical form, and is connected with it by intermediates.

Var. tenuifolia, Shaw.

P. tenuifolia, Bentham.

Cones acute or long-ovate, basal scales and stalk persistent on the branch. Hypoderm of the leaves extending from the epiderm to the endoderm, forming partitions across the green tissue.

The species is distinguished from *P. Montezumæ* by its smooth bark and glaucous branchlets.

P. Pseudo-strobus is closely allied to *P. Montezumæ*, and is a native of the sub-tropical and warm-temperate altitudes of Mexico and Central America. It was introduced in 1839.

Uses similar to those of *P. Montezumæ*. It is only suitable for the warmest and most sheltered parts of the British Isles. Specimens are recorded to exist at Pencarrow and Tregothnan in Cornwall.

Shaw, *Genus Pinus*, 62 (1914).

Pinus pumila, Regel.

DWARF SIBERIAN PINE.

Pinus Cembra, var. pumila, Pallas ; P. Cembra, var. pygmæa, Loudon ; P. mandshurica, Murray (not Ruprecht) ; P. pygmæa, Fischer.

A shrub more or less prostrate in habit, but sometimes 10 ft. high, with branchlets similar to those of *P. Cembra*. *Winter buds* narrowly conic, about ¼ in. long, with a sharp-pointed apex, and closely pressed scales. *Leaves* in fives, resembling those of *P. Cembra*, but shorter and more slender, 1½–2 in. long, entire or with faintly toothed margins. *Cones* ovoid, very shortly stalked, never opening to liberate the seed ; about 2 in. long, orange-brown when ripe ; *scales* few, about ⅗ in. broad, with a dark-coloured, triangular, reflexed tip. *Seeds* about ¼ in. long, pear-shaped, wingless.

This plant is distinguished from *P. Cembra* chiefly by its shrubby habit, shorter leaves and smaller cones and seeds, but its general characters are so near those of *P. Cembra* that it ought probably to be regarded as a dwarf form of that species.

Native of E. Asia, occurring in Kamtschatka, Siberia, Amurland, Saghalien, Kurile Islands, and Japan. It usually grows in the coldest and most exposed situations, forming dense thickets on the wind-swept plateaux or on mountains near the snow line.

P. pumila has no commercial value, for the wood can only be used locally as firewood, and the seeds, owing to their small size, are of little use for food. It is rarely seen in gardens, but young plants are growing at Kew. Loudon mentions a specimen at Dropmore, which though 20 years old was in 1837 only 6 in. high. By 1866 it had increased its height to 8½ in. The tree was reintroduced by Admiral Sir Lewis Clinton-Baker from Nikko, Japan, in 1909, when two specimens from that locality were planted at Bayfordbury.[1] The rockery forms a good place for this bush.

Elwes and Henry, v, 1045 (1910).

Pinus pungens, Lambert.

PRICKLY PINE.

Pinus Tæda, Lambert in part (not Linnæus) ; P. montana, Noll (not Miller). Hickory Pine ; Southern Mountain Pine ; Table Mountain Pine.

A tree 40–60 ft. high and 7–9 ft. in girth, or sometimes small and stunted with a low flat head. *Bark* of old trees about 1 in. thick, reddish brown, scaly. *Young shoots* green at first, afterwards reddish brown, without down. *Winter buds* cylindrical, short-pointed, about ¾ in. long, resinous. *Leaves* in pairs, persisting 3 years, crowded on the branches, dark green, rigid, twisted, 2–3 in. long, margined by rudimentary teeth, apex sharp-pointed, stomatic lines numerous and prominent on both

[1] *Gard. Chron.*, xlvi, 93, fig. 41 (1909).

surfaces; resin canals median; basal sheath ¼ in. long, persistent. *Cones* lateral, solitary, in pairs, or in whorls of 5–7, ovoid or conical, 1½–3 in. long, bright brown, often remaining on the tree for many years; *scales* about 1 in. long, by ½ in. wide, the exposed part armed with a strong, hooked spine. *Seed* more or less triangular, ⅛ in. long, light brown; wing ¾–1 in. long. *Male flowers* reddish and very conspicuous.

Distinguished amongst other two-leaved pines by its cylindrical buds, stout, sharp-pointed, rigid leaves, shining reddish brown bark, and by its branches bearing lateral buds and cones.

Native of E.N. America, where it is widely distributed, and quickly spreads over waste and worn-out farm land. Introduced in 1804.

The wood is soft, weak and brittle, very coarse-grained and knotty, with conspicuous resin ducts. It is used for fuel and charcoal, but is of little value for other purposes.

P. pungens, in a natural state, has a distinct value in preparing poor ground for more useful trees. In the British Isles it forms a small, scrubby tree, and is only planted in pineta. It may be grown under conditions suitable for Scots pine.

Pinus radiata, D. Don. (Fig. 98.)

MONTEREY PINE.

Pinus adunca, Bose; P. californiana, Loiseleur; P. insignis, Douglas; P. montereyensis, Rauch.; P. Sinclairii, Hooker and Arnott; P. tuberculata, D. Don (not Gordon). Insular Pine; Nearly Smooth Cone Pine; Remarkable Cone Pine; Small-coned Monterey Pine; Spreading Cone Pine.

A large tree 90–115 ft. high or occasionally taller, and usually 9–12 ft., but sometimes 15–20 ft., in girth. *Bark* of old trees 2 in. or more thick, dark brown, divided into deep ridges. *Young shoots* without down. *Winter buds* ½–¾ in. long, ovate, short-pointed, with closely pressed, brown, resinous scales. *Leaves* in threes, densely crowded on the branchlets, lasting 3–4 years, bright green, slender, 4–6 in. long, margins finely and closely toothed, apex sharp-pointed, stomata in several lines on each surface, resin canals median, basal sheath ⅓–½ in. long, persistent. *Cones* on very short and stout stalks, obliquely ovoid, the outer side larger than the inner, solitary or in clusters of 3–5 or more surrounding the branch, more than one cluster being produced sometimes in a season, reflexed when mature, 3–6 in. long, 2½–3¼ in. wide; *scales* broad, thick, woody, rounded, particularly on the outer side, greyish brown, glossy. The cones usually remain closed on the branches for many years, but in exposed and sunny positions the seeds may be liberated a year or two after ripening. *Seeds* oval, about ¼ in. long, blackish, wing well developed, about 1 in. long, light brown.

The following varieties have been described, but are not in cultivation in Britain.

Var. **aurea.**

GOLDEN-LEAVED MONTEREY PINE.

A golden-leaved variety raised in New Zealand.

Var. **binata**, Hort.

TWO-LEAVED MONTEREY PINE.

Differs from the type in its leaves being usually in pairs.

P. radiata is distinguished from all other three-leaved pines by its slender, bright green leaves, and large, oblique, persistent cones.

Native of Monterey County, California, where its distribution is limited to a very small area of hilly ground near the sea. It was introduced to England by Douglas in 1833.

Wood light, 25–28 lb. per cubic ft., soft, brittle, with conspicuous resin ducts, fine medullary rays, and often very wide annual rings, sometimes ¾–1¼ in. apart. Heartwood light brown or brownish purple, sapwood white or pale yellow, comparable with *P. Pinaster* in quality. The species is of little commercial value in its native country, but is an important timber tree in several countries to which it has been introduced, notably, S. Africa, Australia, and New Zealand, where its rapid growth adapts it for a short rotation crop. Although the timber is inferior in quality to that of several other species, there are many purposes for which it can be utilized, notably indoor work in building construction and box-making.

The principal advantages of this species are rapid growth, dense leafage, and ability to withstand considerable exposure to strong sea winds. The cheerful, bright green, luxuriant foliage makes it a favourite tree for shelter and ornamental planting, but it is only adapted for the warmer, maritime counties of the British Isles, although good trees are occasionally found elsewhere. Well-grown examples of full size occur in the S. and W. of England, but at Kew and in other inland gardens growth is slow, and the foliage is frequently browned by cold winds during winter and early spring. In Devonshire and Cornwall, trees 50 years old may be 70–80 ft. high, and of massive proportions. The Monterey pine grows best in light, moist, but well-drained loamy or sandy soil, whilst trees in disintegrated granite are very vigorous, often adding 3 ft. or more to their height in the year. Planting in permanent positions whilst the trees are very small, preferably, less than 1½ ft. high, is very necessary. Although it has not been used as a forest tree in the British Isles, its rapid growth warrants it a trial in the milder maritime counties, for there are many pur-

poses for which fast-grown wood can be utilized. It has been planted extensively in New Zealand, Australia, and S. Africa with excellent results. Mr. Tannock, Superintendent of Public Gardens and Reserves, Dunedin, informs us that in New Zealand it frequently attains a height of 120 ft. with a trunk 4–5 ft. in diameter when isolated, whilst in close stands it grows quite as high with a clear trunk of 80 ft. The timber is being cut extensively for boxes for dairy produce and other local uses, and is exported from Dunedin to Australia. The value of the wood in the spring of 1921 was 32*s.* per 100 board ft. In Australia it has produced stands of 6,000 cubic ft. per acre at 25 years of age. When growing in the open, branches are formed low on the trunk. To secure well-cleaned trunks recommendations have been made that it should be planted 6 ft. by 6 ft. apart.

Elwes and Henry, *loc. cit.* v, 1079 (1910); Jepson, *Silva of California*, 100 (1910); Hough, *American Woods*, viii, No. 199, p. 59.

Pinus resinosa, Solander.

RED PINE.

Pinus rubra, Michaux. Canadian Red Pine; Hard Pine; Norway Pine.

A tree 70–90 ft. high with a girth of 6–8 ft. in America, or rarely 150 ft. high by 15 ft. in girth. When growing in the open the trunk is short and carries a heavily branched head, but in the forest the stem is often clear of branches for 40–60 ft., and the head is short, open and spreading like the Corsican pine. *Bark* about 1 in. thick, reddish brown, scaly. *Young shoots* without down, pale brown or yellowish. *Winter buds* narrowly conical, about ½ in. long, resinous, with some of the scales free at the tips. *Leaves* in pairs, lasting 4 years, densely arranged on the branches, slender, flexible, 5–6 in. long, margins finely and regularly toothed, apex sharp-pointed, stomata in ill-defined lines on each surface, resin canals marginal, basal sheath ½–¾ in. long, persistent. *Cones* sub-terminal, solitary or in pairs, conical, narrowing rapidly to the apex, 2–2½ in. long, bright brown; after falling a few scales are usually left on the branchlets; *scales* ¾ in long, ½ in. wide in the widest part, the exposed portion slightly thickened and unarmed. *Seeds* ⅛ in. long, light brown with a mottled, roughened surface. Wing about ¾ in. long, and ¼ in. wide. The male flowers are conspicuous by their bright reddish colour.

The red pine is a native of Eastern N. America from Nova Scotia to Pennsylvania.

This species closely resembles *P. Laricio* in the branchlets and foliage, but is readily distinguished by the flexible leaves, marginal resin canals, long basal sheaths, and by the cones falling in an imperfect condition.

Wood heavier than white pine, averaging 29–32 lb. per cubic

ft. Resin ducts prominent, heartwood golden yellow with a pink or reddish shade, turning decidedly reddish on exposure, sapwood cream or pale yellow, annual rings well marked. It is straight-grained, easily worked, finishes well with little shrinkage, is harder and stronger than the wood of *P. Strobus*, and comparable with that of *P. ponderosa* of W.N. America, *P. sylvestris* of Europe, and *P. densiflora* and *P. Thunbergii* of Japan. Under ordinary conditions it is very durable, but must be treated with creosote or some other preservative if used in contact with the earth. Amongst other uses, it is popular for building construction, joinery, spars, boat-building, box boards, railway sleepers, posts and paving blocks. It is shipped from Montreal and Quebec as square logs, deals, scantlings and boards. The total cut in Canada in 1915 was 122,387 metric ft. board measure.[1]

P. resinosa is very intolerant of shade and must be grown in pure stands, or with a slower-growing tree that withstands shade. Sugar maple, beech and elm have been recommended as suitable companion trees in America. Good seed years occur at intervals of 2–4 years, and there is usually sufficient seed to restock cut over forest. Reproduction is good provided faster-growing species are not present. When plantations are made it is recommended that the young trees be spaced 4 ft. apart each way.[2] When planted closely it cleans its trunk of lower branches without pruning.

Light and well-drained loamy or peaty soil containing little or no lime, and never becoming very dry, suit its requirements, whilst it also succeeds on light, sandy soil. It was introduced in 1756, and although occasionally grown as an ornamental tree in the British Isles it is less successful than several other species, and cannot be regarded as having any bearing upon sylvicultural problems. One of the finest known specimens in the country, planted in 1851, is at Bayfordbury.

Elwes and Henry, *loc. cit.* v, 1140 (1910); Shaw, *Genus Pinus*, p. 51 (1914).

Pinus rigida, Miller.

NORTHERN PITCH PINE.

Pinus Fraseri, Loddiges; P. Loddigesii, Loudon; P. serotina, Long (not Michaux). Black Pine; Black Norway Pine; Hard Pine; Long-leaved Pine; Longschat Pine; Rigid Pine; Sap Pine; Torch Pine; Yellow Pine.

A tree 50-80 ft. high with a trunk 2–3 ft. in diameter and horizontal, spreading branches, forming a pyramidal crown, the trunk often bearing clusters of young shoots. *Bark* on young trees thin and broken into reddish brown scales; on old trunks 1 in. thick and deeply and irregularly fissured. *Young*

[1] *Canadian Woods and Structural Timbers*, Bull. 59, Forestry Branch, Dept. of the Int., Canada, p. 42.

[2] *For. Ser. Circular*, 60, U.S. Dept. of Agric. (1907).

shoots with many buds, green at first, becoming dull orange-brown in the second year, prominently ridged. *Winter buds* cylindrical or conical, sharp-pointed, ¼–¾ in. long, scales pressed together, but often free at the tips, usually resinous. *Leaves* in threes, lasting 2 years, spreading, rigid, slightly curved and twisted, 3¼–4½ in. long, margins finely toothed, ending in a horny point, stomatic lines numerous on each surface, resin canals median, basal sheath ⅜–½ in. long. *Cones* lateral, usually clustered, subsessile, variable in size, averaging 2½ in. long, ovoid, light brown, symmetrical at the base; *scales* thin, flat, ⅞ in. long, ⅜ in. wide, the terminal portion shining, tawny yellow, elevated with a transverse keel, ending in a recurved prickle. *Seeds* dark brown, ¼ in. long with a wing ¾ in. long. The cones often persist on the branches for many years, opening at irregular intervals.

This species is remarkable for the formation of adventitious buds which develop tufts of leaves on the trunk. By this character *P. rigida* and *P. serotina* may usually be identified without difficulty.

The Northern pitch pine is widely distributed in E.N. America from New Brunswick to Georgia, extending westward to Kentucky and Tennessee. It is abundant on the Atlantic coast, S. of Boston, forming extensive forests in New Jersey, and in the Delaware Peninsula. According to Aiton this species was in cultivation at Woburn, Beds., before 1759, and was probably planted there about 1743.

Wood soft, weak, coarse-grained and resinous with prominent resin ducts. Heartwood bright brown or reddish, sapwood yellowish. It lasts moderately well, but is distinctly inferior to the wood of *P. palustris* which is the pitch pine of European markets. The timber is sawn into planks and boards, and is used for railway sleepers, building construction, charcoal and fuel. In former times the species was one of the chief sources of turpentine and rosin, but is now superseded by *P. palustris*. It is the true pitch pine of N. America.

P. rigida thrives in America on poor soils and is valuable for reforesting waste and worn-out farm land. It does not succeed very well in the British Isles, although quite hardy, but forms a medium-sized tree in light, well-drained loamy soil.

Elwes and Henry, *loc. cit.* v, 1087 (1910); Sargent, *Silva of N. America*, xi, 115 (1902).

Pinus Sabiniana, Douglas. (Fig. 98.)

DIGGER PINE.

Bull Pine; Grey Pine; Grey-leaf Pine; Nut Pine; Sabine's Pine.

A tree 40–80 ft. high, the trunk often slanting and forking into two or more main stems at 20–30 ft. from the ground, the branches

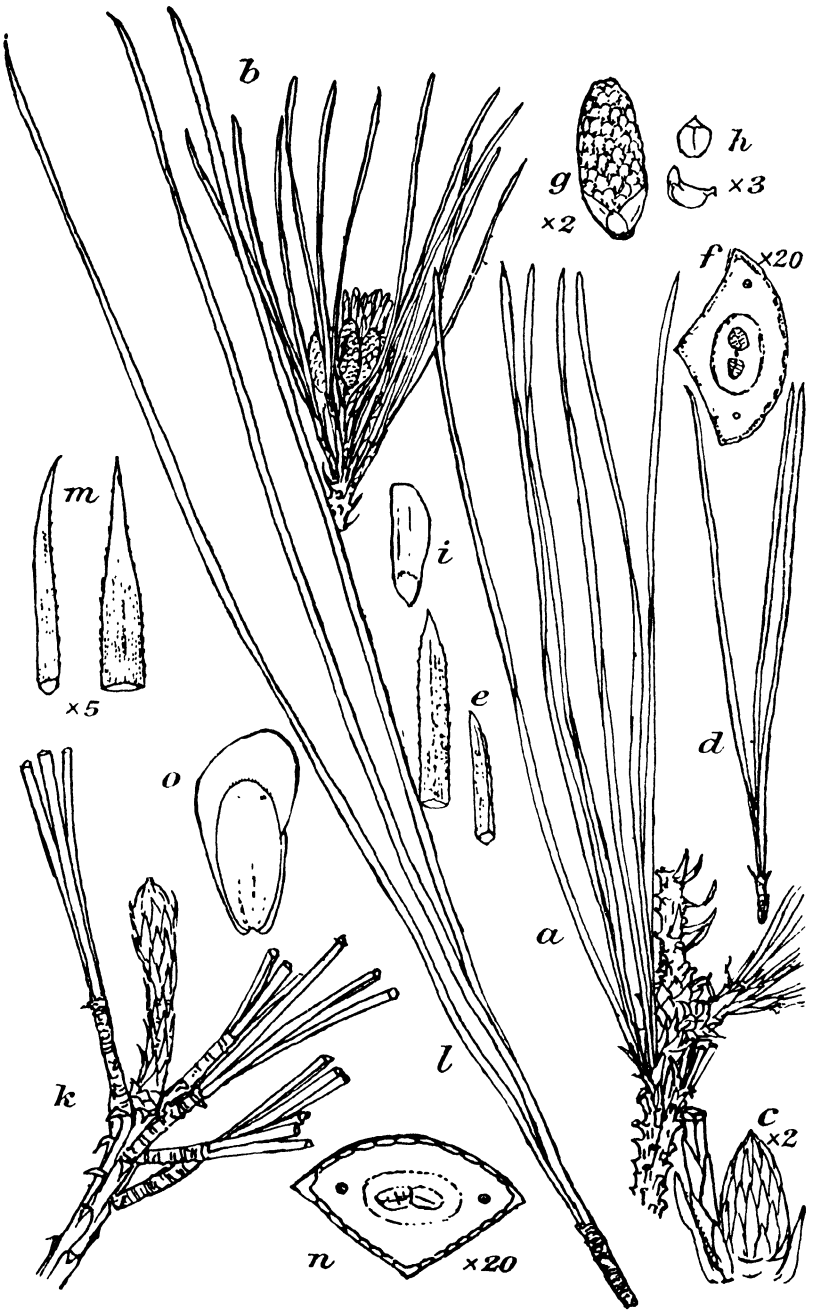

FIG. 98.—*PINUS RADIATA* and *P. SABINIANA*.

Pinus radiata.—*a*, short with needles in clusters of three; *b*, shoot with male cones and expanding terminal bud; *c*, winter bud; *d*, cluster of three leaves; *e*, serrulate apex of leaf; *f*, section of leaf; *g*, male cone; *h*, stamens; *i*, seed. *P. Sabiniana*.—*k*, shoot with expanding winter bud and bases of leaf clusters; *l*, cluster of three leaves; *m*, apex of serrulate leaves; *n*, section of leaf; *o*, seed (after Hickel).

irregularly disposed towards the top and remarkable for their scanty foliage. *Bark* of trunk greyish brown, dividing into irregular plates, exposing the reddish brown cortex beneath. *Young shoots* slender, without down, glaucous, prominently ridged. *Winter buds* narrowly cylindric, acute, ¾–1 in. long; *scales* closely pressed, fringed and more or less coated with resin. *Leaves* in threes, lasting 3 years, sparsely arranged on the branchlets, spreading or drooping, greyish green, 9–12 in. long, minutely toothed on the margins, ending in a horny point, stomatic lines on each surface; resin canals median; basal sheath about 1 in. long. *Cones* lateral, remaining on the tree 1–7 years after releasing the seeds and when falling breaking away near the base, ovoid, reflexed, 6–10 in. long and 4–6 in. wide, on short stout stalks; *scales* dark brown, woody, about 2 in. long with an obliquely raised, pyramidal, terminal portion which is prolonged into a talon-like hook; *basal scales* more or less deflexed. *Seeds* in deep hollows on the scales, dark brown or blackish, ¾ in. long, wing thick with a short membraneous margin.

P. Sabiniana differs from the other three-leaved pines in its grey-green, sparsely arranged foliage. From *P. Coulteri*, its near ally, it also differs in the shorter seed wing, but intermediates between the two species are said to occur. A form with the cone scales more strongly hooked and with slightly longer seed wings has been named var. *explicata* by Jepson.

The Digger pine is a native of California where it is found on the arid foot-hills of the Sierra Nevada and Coast Ranges at altitudes varying from 250–4,900 ft. It was discovered by Douglas in 1826 and introduced into cultivation by him in 1832.

Wood soft, weak, brittle and very resinous. Heartwood light brown or reddish, sapwood yellow. It is not durable and except for local use has no commercial value. The seeds are edible and at one time formed an important article of food for the Indians, who used them in the same way as the seeds of the various nut pines. The name of Digger pine is taken from the Digger tribe of Indians. A medicinal oil has been obtained from the resin.

The tree thrives in the British Isles, but is better adapted for the milder than for the colder parts. It succeeds in well-drained, light loamy soil, and is sometimes met with as a medium-sized, ornamental tree.

Jepson, *Silva of California*, 86 (1910).

Pinus serotina, Michaux.

POND PINE.

Pinus alopecuroides, Hort. Bastard Pine; Black Pine; Bull Pine; Loblolly Pine; Marsh Pine; Meadow Pine; Spruce Pine.

This pine is closely allied to *P. rigida* and is by some botanists considered to be only a southern variety of that species. It is

distinguished from *P. rigida* by its more resinous winter buds, much longer leaves (6–8 or rarely 10 in. long), and less prickly, subglobose cones, which often remain closed for years. The cones, however, are variable in shape. In general characters the two trees agree.

Native of the S.E. United States, from N. Carolina to Florida, growing in wet flats or sandy or peaty swamps. It was introduced, according to Loudon, in 1713, but is very rare in cultivation at the present time.

Wood very similar to that of *P. rigida* and used for similar work. Turpentine has been obtained from the tree.

As a rule it succeeds under moister conditions than *P. rigida*, but like that tree is not well adapted for the British Isles. It requires a warm temperate climate.

Sargent, *The Silva of N. America*, xi, 119 (1902).

Pinus sinensis, Lambert. (Fig. 99.)

CHINESE PINE.

Pinus Cavendishiana, Hort.; P. Henryi, Masters; P. leucosperma, Maximowicz; P. tabulæformis, Carrière; P. Wilsoni, Shaw.

A tree varying in habit according to situation, being sometimes a shapely tree of medium size, or in exposed places a low, flat-headed specimen with gnarled branches. *Bark* usually dark grey, but occasionally on the exposed upper parts of the tree, red and peeling off in thin sheets. *Young shoots* without down, glaucous at first, afterwards light brown. *Winter buds* oblong, pointed with closely pressed scales. *Leaves* in pairs or in threes, often varying in number on the same plant, erect or spreading, densely crowded on the branchlets, 4–6 in. long, margins finely toothed, apex a sharp, horny point, stomatic line on both surfaces, basal sheath persistent, about ¼ in. long. *Cones* ovate, oblique, up to 2 in. long, persistent; *scales* with the terminal portion shining, pale, tawny yellow at first, gradually changing to a dark nut brown.

Var. densata, Shaw.

P. densata, Masters; P. prominens, Masters.

This chiefly differs from the type in its oblique cones, the terminal portions of the outer scales being conspicuously swollen. The common pine of the mountains of W. Szechuen with an altitudinal range higher than that of any other Chinese species.[1]

Var. yunnanensis, Shaw.

P. yunnanensis, Franchet.

Leaves in threes on all the main shoots and much longer than in the type, up to 10 in. long, slender, drooping. *Cones* up to 3½ in. long. It is the low-level pine of the river valleys of S.W.

[1] Wilson, *Plantæ Wils.* II, i, p. 17 (1914).

Szechuen and is also found W. of the limit of the Red Basin, extending S. into W. Yunnan.

P. sinensis is often confused with the Japanese *P. Thunbergii* and *P. densiflora*, but is easily distinguished from the former by

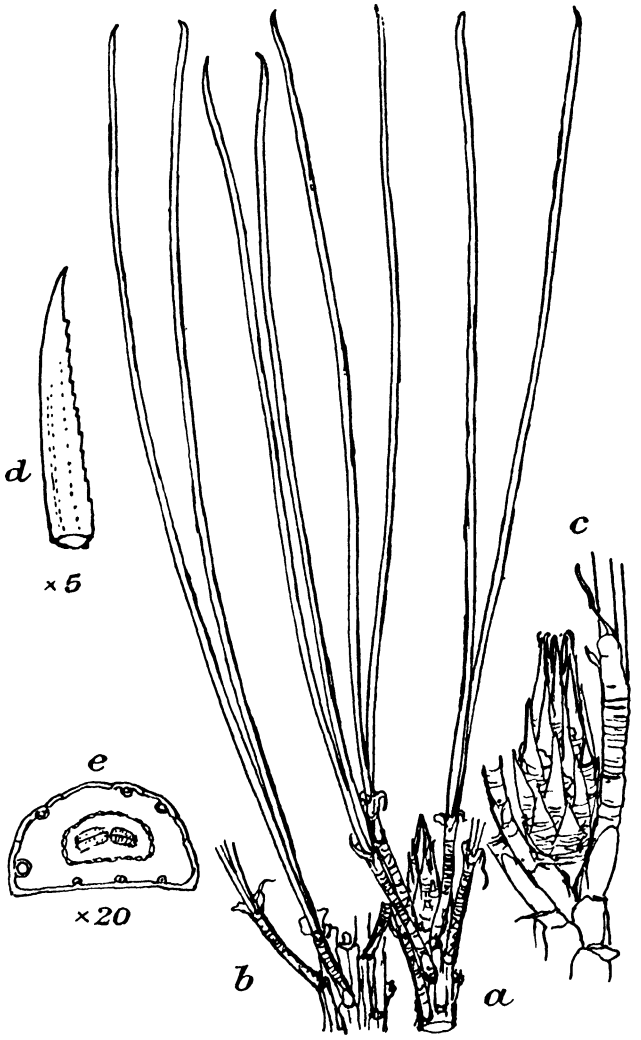

FIG. 99.—*PINUS SINENSIS.*

a, branch with winter bud; *b*, part of shoot with leaves in pairs, sometimes in threes; *c*, winter bud; *d*, apex of serrulate leaf; *e*, section of leaf.

the colour of its buds and from the latter by the colour variation of the cone.

The species is common on the mountains of Cent. and W. China and at lower levels in N. China and in Corea.

Pinus Strobus, Linnæus. (Fig. 88.)

WHITE PINE OR WEYMOUTH PINE.

Pinus alba, var. canadensis, Provancher; P. canadensis, var. quinquefolia, Du Hamel; P. tenuifolia, Salisbury; P. tabulæformis, Hort.; P. umbraculifera, Hort.; Strobus Strobus, Small. Apple Pine; New England Pine; Northern Pine; Pumpkin Pine; Quebec Pine; Sapling Pine; Soft Pine; Tonawanda Pine; Yellow Pine.

A tree attaining in America a height of 80–150 ft. with a tapering trunk 9–12 ft. in girth, the branches of old trees forming a round-topped or pyramidal crown with the leaves in horizontal masses. *Bark* thin and smooth on young trees, becoming rugged and fissured about the lower parts of old specimens, and 1–2 in. thick. *Young shoots* slender with tufts of short hairs below the insertion of the leaf bundles, usually without down elsewhere.[1] *Winter buds* conic, with a sharp point, ¼ in. long, resinous, with some of the scales free at the tips. *Leaves* in fives, persisting 2–3 years, slender, bluish green, 3–5 in. long, margins finely toothed, white stomatic lines on the two inner surfaces; resin canals marginal; basal sheath about ⅝ in. long, soon falling away. *Cones* sub-terminal, pendulous, cylindrical, often curved and pointed at the apex, 4–6 in. long, 1 in. in diameter before opening, resinous, on stalks up to 1 in. long; *scales* thin, smooth, the exposed portion light brown when mature, rounded at the apex. *Seed* ovoid, ¼ in. long, reddish brown, mottled with black, wing narrow, 1 in. long.

The following horticultural varieties are sometimes met with :—

Var. **aurea,** Hort.

Leaves yellowish when young.

Var. **monophylla,** Tubeuf.

Leaves cohering more or less throughout their length and forming a single leaf.

Var. **nana,** Knight.

A dwarf variety of compact, shrubby habit, rarely exceeding 6 ft. in height. *Branches* short, slender; branchlets crowded. *Leaves* short, ¾–1½ in. long. The varieties described as *compacta*, *densa* and *umbraculifera* are of similar habit. It is one of the best of dwarf conifers for planting in rock gardens.

Var. **nivea,** Booth and Knight.

Leaves short and silvery-white beneath.

[1] The pubescence is occasionally spread over the whole surface of the branchlet, thus approaching the character of *P. monticola*, but it is denser below the insertion of the leaves.

Var. **prostrata**, Masters.

Prostrate in habit. A plant may be seen in the rock garden at Kew.

This species is distinguished amongst the five-leaved pines by the horizontal masses of its bluish green foliage, and the tufts of hairs below the insertion of the leaves. The essential characters of its near ally *P. monticola* are described under that species.

As a native tree the Weymouth pine has a very wide distribution in Canada and the N. United States. The northern limit of its range extends from Newfoundland to Manitoba, and it is found throughout the United States from Minnesota to the Atlantic, and south of Pennsylvania along the Appalachians to N. Georgia. In accessible places the original forests have, owing to the commercial value of the timber, been much reduced and few large trees remain. *P. Strobus* is the tallest conifer occurring east of the Rocky Mountains, and records exist of trees up to 260 ft. high and 20 ft. in girth. Such giants have, however, disappeared and specimens of 150 ft. high are not common. *P. Strobus* was originally distinguished by Plunkenet in 1696, and was first cultivated in Britain at Badminton, Gloucestershire, by the Duchess of Beaufort, but none of the original specimens are known to exist there. The tree owes its common name of Weymouth pine to the fact that Lord Weymouth planted it largely at Longleat, Wilts, early in the eighteenth century.

Wood light, about 24 lb. per cubic ft. when dry, resin ducts easily seen with a lens, but they are not very numerous, rays fine, not easily seen. Heartwood usually pinkish, light red on exposure, sapwood pale yellow or almost white, narrow. The timber is straight-grained, soft, easily worked, and finishes with a fine even surface. It rarely shrinks once it has been well seasoned, and takes paint and polish well. In large trees the wood is very free from knots, and it is not subject to serious shakes. It is useful for general joinery work, particularly the indoor finish of houses, doors, window-sashes, cupboards, joists, flooring, aircraft, pattern-making for foundry work, veneered cabinet work, boxes, matches, also in shipbuilding for spars, masts, etc. It is one of the most important timbers of the United States and Canada, and is typical of a group of species, including *P. monticola*, *P. Lambertiana* and *P. koraiensis*, all of which produce very similar timber suitable for the same purposes. They may be used as substitutes for one another. The supply of timber of *P. Strobus* has decreased considerably during recent years; the cut in Canada for 1915 amounted to only 849,196 metric ft. board measure, as against 1,038,542 metric ft. in 1911.

P. Strobus gives the best results when planted under cool

Photo by F. J. Wallis

PLATE XXIII. SCOTS PINE (*PINUS SYLVESTRIS*) AT KEW.

climatic conditions, on sweet, deep light loam, or on sandy soil with a well-drained subsoil. It also succeeds on dry sandy soil on rocky mountain slopes, in ravines, and on low land where the soil approaches clay in consistency, but it is not adapted for very limy soils. If it is planted in any position where water is inclined to lie, even though the ground may not be water-logged for more than a few weeks, open drains must be made at frequent intervals. Although it withstands considerable exposure inland, it is less suitable than several other species for planting near the coast for withstanding the full force of strong winds direct from the sea. It is sometimes planted under forest conditions in the British Isles with good results, but where the climatic conditions are very mild and on the dry side, or in places where the soil is unsuitable and the trees do not grow freely, it is very subject to attacks of the Weymouth pine aphis. An area of 6–7 acres of timber cut in Windsor Forest in 1916, at an age of 70 years, yielded over 4,000 cubic ft. of timber to the acre, quarter girth, under bark measure; the largest tree containing 107 cubic ft. of timber.[1]

Natural regeneration is satisfactory in America, good seed years occurring every 4–7 years, with a small annual seed production. It is stated[2] that 10,000 plants may be expected from every pound of fertile seed sown, and that although the best results follow the use of new seed a fair percentage of seed kept in cold storage for 5 years remains fertile. Seedlings and young trees withstand a good deal of shade, but as the trees advance in age they require more light and must be able to dominate companion species by the time they are 40–50 years old. In America spacing 6 ft. by 6 ft. is recommended for plantations, either pure or as a two-thirds mixture with one-third of chestnut, oak, spruce or maple. One of the best combinations appears to be Weymouth pine and *Picea excelsa*, the two trees cleaning each other well. Spaced similarly in the British Isles it is probable that the lower branches would become too large to clean naturally and pruning would become necessary. In America when spaced 6 ft. by 6 ft. the first thinning is required at the end of 30 years, but when planted 4 ft. by 4 ft. thinning is necessary at the end of 10 years. The bark of young trees being very thin, sudden exposure to hot sun must be avoided. As an ornamental tree it has much to commend it, but it should not be planted in hot or very dry places.

The Weymouth and several other five-leaved pines are subject to serious injury by various diseases. In the British Isles, the *Weymouth Pine Rust* (*Cronartium ribicolum*, Dietrich) sometimes causes serious loss. There are two distinct stages in the life

[1] *Quarterly Journal of Forestry*, Oct. 1916, p. 286.
[2] Pinchot, *For. Ser. Circular*, 67, U.S. Dept. of Agric. (1907).

history of this fungus, the æcidium stage which appears on the bark of *P. Strobus* and other five-leaved pines as conspicuous, greyish bodies, enclosing orange-coloured spores, and the teleutospore stage which occurs as small, yellow, dust-like patches on the leaves of *black currant* bushes. The removal of black currant bushes from the neighbourhood of plantations and the prompt burning of affected pine trees are the best means of checking the spread of the disease.

Weymouth Pine Aphis (Chermes strobi, Hartig) is another destructive pest. It infests the trunk, branches, young shoots and cones, being most persistent in shade. It is easily recognized by the dense, white, fluffy exudation which bears a resemblance to the protective covering of *Beech Coccus*, although there is no connection between the two insects. Isolated specimens and small woods should be sprayed with a paraffin wash, but there is no effective means of dealing with large areas of trees. Preventative measures should be adopted by confining plantations to suitable ground in places where favourable climatic conditions prevail, and by fumigating young stock before it leaves the nursery.

Elwes and Henry, *loc. cit.* v, 1025 (1910); Shaw, *Genus Pinus*, 36 (1914).

Pinus sylvestris, Linnæus.

Scots Pine: Yellow Deal.

Pinus altissima, Ledebour; P. armena, Koch; P. borealis, Salisbury; P. caucasica, Fischer; P. Friesiana, Wichura; P. genevensis, Hort.; P. haguenensis, Loudon; P. humilis, Link; P. Kochiana, Klotzsch; P. pontica, Koch; P. rigensis, Desfontaines; P. scariosa, Loddiges; P. tatarica, Miller. Northern Pine; Scotch Fir [1]; Scotch Pine; Wild Pine; Pin sylvestre; Sapin rouge du Nord; Bois rouge du Nord; Pin de Hagenau; Pin a' Mature; Pin Sauvage; Pin d' Ecorse; Pin de Geneve; Pin d'Auvergne; Pin Blanc d'Autriche; Gemeine Kiefer Fohre; Forle; Forche; Kichne; Weiss-Kiefer; Redwood; Baltic Redwood; Red Deal; Yellow Pine; Riga Fir; Memel Fir; Archangel Fir; Petchora Fir; Danzig Fir; Stettin Fir; Norway Fir; Polish Fir; Whitewood.

A tree commonly 70–100 ft. but sometimes 150 ft. high, with a straight cylindrical trunk, 6–12 ft. in girth. *Branches* regularly whorled in young trees, in old specimens branching only at the top and giving rise to a flat crown. *Bark* on the lower part of the trunk fissured into irregular, longitudinal plates, reddish brown or greyish brown in colour, the upper part of the tree light red or orange, shining and shed in papery scales. *Young shoots* greenish, smooth and shining, becoming greyish brown in the second year, marked with prominent bases of the scale leaves. *Winter buds* oblong-ovate, ¼–½ in. long, pointed, with lance-shaped, fringed scales, the upper ones free at the tips. *Leaves* in pairs, lasting about three years, variable in length, twisted, stiff, grey-green,

[1] The name fir is only correctly applied to the genus *Abies*.

1–4 in. long, short-pointed, margins minutely toothed, glaucous with many well-defined lines of stomata on the flat, inner surface, green with interrupted lines of stomata on the outer side; resin canals marginal; basal sheath at first white and ⅓ in. long, becoming grey and shorter later. *Cones* solitary or 2–3 together, variable in shape but usually ovoid-conic, symmetrical or oblique,

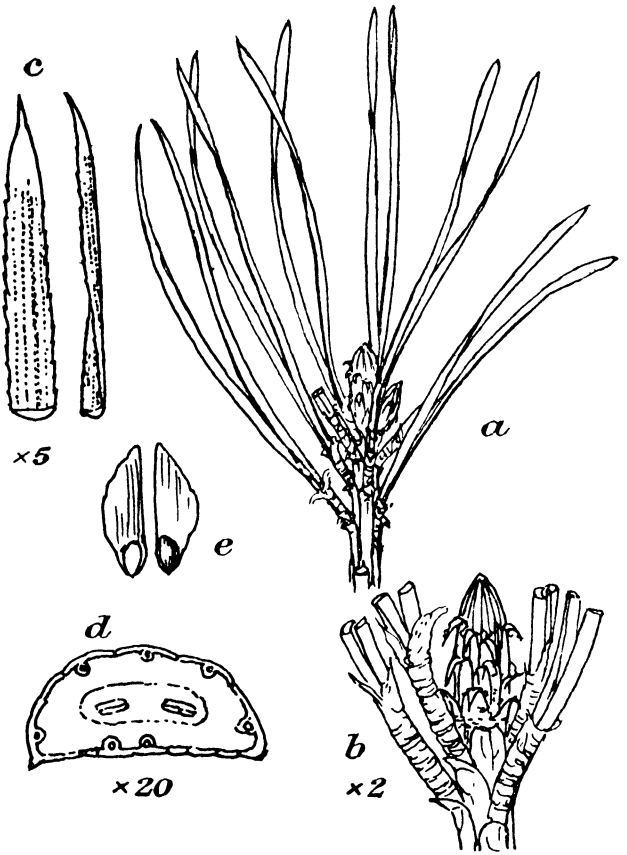

FIG. 100.—*PINUS SYLVESTRIS.*

a, branchlet, with winter bud; *b*, winter bud and bases of leaves; *c*, apex of serrulate leaf; *d*, section of leaf, showing marginal resin canals; *e*, seeds.

greyish or dull brown, 1–3 in. long, on short stalks; *scales* narrowly oblong, the exposed portion flat or protruding, often much more prominent on the outer than on the inner side of the cone, the apex terminated by a minute prickle or its remains. *Seeds* oval, ⅛–¼ in. long, blackish or dark grey, with a wing about three times the length of the seed.

The following varieties have been described, but do not appear

to be as well marked in character as their descriptions would indicate :—

Var. **engadinensis**, Heer.

P. lapponica, Mayr.

A small tree up to about 30 ft. high. *Leaves* short, 1–1½ in. long, stout and stiff, lasting 5 years. *Cones* 2 in. long, oblique at the base ; *scales* with the terminal portion convex on the outer side, apex blunt. Found in the Engadine Alps.

Var. **nevadensis**, Christ.

Leaves short, broad and stiff, white on their flat surfaces. *Cones* nearly sessile, oblique, the exposed portion of the scales pyramidal. Found in S. Spain.

Var. **reflexa**, Heer.

Cones long and slender, conic, with long hooks to the scales. Native of Switzerland and Prussia.

Var. **scotica**, Schott.

P. scotica, Willdenow.

Leaves more glaucous and shorter than in the type, 1½ in. long. *Cones* shorter, about 1½ in. long, symmetrical ; *scales* with the exposed portion flat near the base, tending to be pyramidal in the upper part of the cone.

Var. **virgata**, Caspary.

Main branches irregularly whorled, elongated, giving off a few tuft-like branchlets, only the outermost whorls of which are furnished with leaves. Found in France and Prussia.

The above are chiefly geographical varieties and they are practically indeterminable from hand specimens.

The following are garden varieties :—

Var. **argentea**, Steven.

Leaves more glaucous than in the type.

Var. **aurea**, Beissner.

Leaves golden. Usually a bush and not very robust. There are good specimens at Westonbirt.

Var. **fastigiata**, Carrière.

Habit stiff and erect, after the manner of the Lombardy Poplar. Not common.

Var. **globosa**.

A low, dense round bush similar to plants growing in alpine regions above the timber line.

Var. **microphylla**, Von Schwerin.

Leaves thin and sharply pointed, only about ½ in. long. A seedling form.

Var. **monophylla**, Hodgins.

A shrub with the needles in each sheath attached to each other throughout their length forming one leaf, but easily separated. It originated near Wicklow about 1830. Very uncommon.

Var. **nana**, Carr.

A variety rather similar to var. *globosa* but more dwarf.

Var. **pendula**, Casp.

A form with weeping branches and branchlets. It is said to have been originally noticed in a wood in E. Prussia, but trees with pendent branchlets are not uncommon.

Var. **pumila**, Beissner.

A low-growing form after the style of var. *nana*.

Var. **pyramidalis**, Hort.

A form with stiff, erect branches resembling var. *fastigiata*, but not so narrow as in that variety.

Var. **variegata**, Caspary.

Leaves variegated with creamy white. Of no special decorative value.

P. sylvestris may be distinguished from other two-leaved pines by its glaucous, twisted foliage, the reddish upper trunk and its characteristic habit in old age.

The Scots pine has a wider distribution than any other pine, being found wild throughout Europe and W. and N. Asia. It occurs on a great variety of soils and in regions of the most diverse climates. In the British Isles it is now only native in Scotland where the remains of a few natural forests may still be found. In ancient times it was widely spread in England and Ireland, as is evident from the remains of logs, stumps of trees and cones found in peat formations and in submerged forests.[1] It is now rapidly colonizing extensive tracts of heath land in the South of England.

Wood of excellent quality, moderately strong, resinous with prominent resin ducts, and with well-defined annual rings; heartwood and sapwood distinct. It varies in weight from 20–50 lbs. per cubic foot, but is usually from 23–38 lb. per cubic foot. It is easily worked, finishes with a smooth, satiny surface, holds nails

[1] Clement Reid *Origin of British Flora*, pp. 16–152 (1899).

well, takes glue excellently and can be painted or polished with ease. When used indoors it has excellent lasting qualities, but when exposed to weather changes, or when used in contact with the soil, it should be creosoted or treated with some other antiseptic. The uses of Scots pine wood are innumerable and it is the commonest wood in everyday use not only in the British Isles but in N. Europe. It is employed very extensively in house-building, from beams and rafters to window-frames, flooring boards, doors, cupboards and furniture; for heavy constructive work, fencing, boat and shipbuilding, masts and telegraph poles, scaffold poles and pit props and very extensively, when creosoted, for railway sleepers and street paving blocks. The best grades of wood, laid on a good concrete foundation, withstand very heavy wear, and on Westminster Bridge, London, where heavy traffic is fast and continuous, the same blocks remained in use for over 13 years. Wood used for fencing and farm buildings should be creosoted, particularly those parts that are in contact with the soil, also the lower parts of scaffold poles that may be buried, and floor joists or other timber that may be built into walls. As is the case with other soft woods, Scots pine is very susceptible to attack by "dry rot fungus" (*Merulius lacrymans*). Wherever there is a free circulation of air the fungus does not thrive, but in a stagnant atmosphere it develops with great rapidity unless the timber has been treated with a suitable antiseptic. After the timber has been worked to the necessary size, hot or cold creosote should be injected. Full particulars of the processes are given by Wallis-Tayler.[1]

Prejudice has often been at the bottom of the whole-hearted condemnation of home-grown timber, and during the late war many users were greatly surprised to find that Scots pine wood equal in quality to the best imported from Scandinavia was available in Britain, and especially in the forests of Scotland, although similar timber had for years been practically unsaleable at a remunerative price. Scandinavian merchants, by placing their timber upon the British market in an attractive manner, carefully graded and worked to standard sizes, saved the British agent and user considerable trouble; hence, to a great extent, the displacement of home-grown wood which was usually offered ungraded and in the round. In pre-war days the cost of import was often less than the railway freight of home-grown wood, and thus a combination of circumstances led to the disparagement of our timber, users gradually persuading themselves that their almost total dependence upon foreign-grown wood was due solely to the superior quality of the imported article. That home-grown Scots pine possesses all the necessary qualities for substantial buildings is emphasized by an examination of the

[1] *The Preservation of Wood* (1918).

Photo by F. J. Wallis

PLATE XXII. DOUGLAS FIR (*PSEUDOTSUGA DOUGLASII*).

woodwork of many old Scottish castles and mansions, which is entirely of Scots pine, and perfectly sound after standing for several centuries. Scots pine timber from N. Europe is usually imported by a measurement known as the St. Petersburg standard (165 cubic ft.), and prices are fixed on that measurement.

The nomenclature of *P. sylvestris* and of its timber has been subject to many alterations and there are few well-known trees bearing more synonyms. Contrary to our usual practice in this work, a number of continental names have been included amongst the synonyms in the early part of this description. Great confusion has been caused by the application of the name *fir* to this species, the term only being correct when connected with species of *Abies*. Amongst common names applied to the timber *yellow deal* is perhaps the most commonly used and probably therefore the most suitable. *Redwood* and *northern redwood* are, however, familiar names in the trade. The name of *deal* or *fir* with the prefix of a port or district often denotes a certain quality of timber, but this multiplicity of names is undesirable and the interests of the community would probably be better served by grading the timber under one common name as suggested above.

Turpentine, rosin, lampblack, charcoal, tar and other products are obtained by destructive and steam distillation of the wood and often of the roots ; stump oil and resin is obtained from the roots, Sweden, Norway, Finland and Russia being the chief seats of the industry. The wood has also been used for paper pulp, but is less valuable than Spruce wood for the purpose.

The fibre of the leaves has been manufactured into a stuffing material for cushions, mattresses, etc., under the name of *pine leaf wool*, whilst water used in the preparation has been utilized in Breslau and elsewhere for medicinal baths. Oil obtained from the leaves is sometimes used in medical practice. The wood of trees dug up from bogs has been split into shavings and utilized for coarse rope in Ireland.

The Scots pine is essentially a light-demanding species and a tree for light soils either on plains or mountains. In the European Alps, merchantable timber is often carried to an altitude of 6,000 ft., but the altitude is governed by both latitude and shelter. In the British Isles good timber rarely occurs at a higher altitude than 1,000–1,200 ft., and in exposed places the timber line may be much lower. In sheltered valleys at a higher elevation than 1,200 ft. good timber has been produced and it is possible that by carefully building up shelter a much higher timber line than at present obtains might be gained. Although it withstands a good deal of exposure it is not a first-class shelter tree as compared with Austrian pine, and trees growing in very exposed positions are usually poorly developed unless they are the remains of a former wood or plantation. It is sometimes

found as a well-developed tree on moderately heavy soil, but such soil must be well drained and not subject to flooding. Indifferently drained ground is quite unsuitable, and whilst the tree thrives on drained peat it is unsuccessful on wet peat. Neither is it suitable for limestone formations, but for well-drained sandy or rocky ground from the Highlands of Scotland to the Surrey heaths it is one of the most appropriate species to plant, for although the timber of fast-grown trees from the mild climate of the South of England may be inferior to that produced in the colder parts of Scotland, it is quite suitable for many kinds of work and the species will be found to be as remunerative for general planting as any other species of pine. Natural regeneration is going on in many parts of the country where the seedlings are protected from rabbits, hares and deer, but in places open to those animals few young trees are to be found. When grown close the Scots pine cleans its trunk well. As a rule it is planted 4 ft. by 4 ft. and thinned when necessary, the first thinning taking place from 10–15 years after planting. For further particulars of its habits when grown for sylvicultural purposes reference should be made to the publications upon this species prepared at the School of Forestry, University of Cambridge.[1]

The Scots pine has much to commend it as a decorative tree, not so much as a young tree, but as a mature specimen, for there are few more picturesque objects than old veterans, whose rugged and weather-beaten appearance have a charming effect in landscape and garden. As an inside shelter line Scots pine can be used, but where exposure is considerable the outer line of defence should be Austrian pine or some other species.

Even when the transplanting of well-developed trees can be undertaken with the aid of proper machinery, it is rarely a profitable undertaking, and small trees 12–18 in. high usually outgrow 12 ft. specimens that may have been transplanted.

Good seed years occur at irregular intervals, but a small crop of cones is borne every year. The indiscriminate collection and sowing of seed is deprecated, and it is advisable to make certain that seedling trees have been raised from seed grown under somewhat similar climatic conditions to those prevailing where young trees are to be planted. Thus trees raised from seed matured in Scotland are likely to give better results in the British Isles than others raised from seed grown in N. Russia or at a high elevation in the Alps. Moreover, it is desirable that seed should be collected from well-developed and healthy trees, rather than from those that are undersized or unhealthy.

Several diseases, fungus and insect, attack the Scots pine.

[1] Burdon, E. Russell and Long, A. P., *The Production and Utilization of Scots Pine in Britain*, Part i, Sample Plots at Woburn; Part ii, Sample Plots at King's Lynn (1913).

They are often more prevalent on young than old trees, the most critical period being the first 15 years.

Amongst insect pests some of the most destructive are the pine weevil (*Hylobius abietis*, Linnæus), a weevil that breeds in decaying stumps and roots. The mature insects feed on the bark of young trees and cause serious loss. Traps of freshly cut logs of Scots pine should be placed in the plantations, the weevils being collected from the traps twice daily. The pine bark beetle (*Myelophilus piniperda*, Linnæus) causes a good deal of injury to young and old trees by the mature beetles boring their way into the pith of young shoots and by making galleries and depositing eggs beneath the bark, the larvæ eventually forming other galleries in the bark and surface wood as they feed. The removal and burning of affected trees and trapping by means of logs laid for the purpose, are the best means of dealing with the pest. The cockchafer (*Melolontha vulgaris*. Fabr) is destructive to young trees, particularly to nursery stock, by the larvæ feeding on the roots. Previous to planting, nursery ground should be well worked and larvæ destroyed. Wireworms are the larvæ of species of *Agriotes*, beetles whose larvæ feed upon the roots of grasses, young trees and other plants. They are often very prevalent on newly turned grass land. Affected ground should be left fallow for several months and the surface frequently worked in order to expose the larvæ to birds. The pine-shoot tortrix moth (*Retinia buoliana*, Schiff) and resin-gall tortrix moth (*Retinia resinella*, Linnæus) cause trouble by the larvæ tunnelling into and feeding upon the pith of young shoots. Trees are frequently ruined in this way. Affected shoots should be collected and burned. The larvæ of the pine sawfly (*Lophyrus pini*, Linnæus) injure young shoots and leaves. The larvæ must be collected and destroyed. Pine aphis (*Chermes pini*), easily detected by a white, wool-like exudation, can be destroyed by spraying with paraffin emulsion.

Fungus Diseases.—Two common diseases are "tree-root rot fungus" or "collar-rot fungus" (*Armillaria mellea*, Vahl.) and *Trametes radiciperda*, Hartig, both of which attack the roots and bases of young trees. Trees planted too deeply are peculiarly susceptible to attack. Affected trees should be burnt and in the case of *Armillaria mellea*, a trench 1½–2 ft. deep should be dug around the affected area to prevent its spreading to other trees.

Pinus Tæda, Linnæus.

Loblolly Pine.

Pinus lutea, Walter; P. heterophylla, Small (not Sudworth). Bastard Pine; Black Pine; Black Slash Pine; Bull Pine; Cornstalk Pine; Foxtail Pine; Frankincense Pine; Indian Pine; Longschap Pine; Longshucks Pine; Longstraw Pine; Meadow Pine; North Carolina Pine;

Oldfield Pine; Sap Pine; Shortleaf Pine; Slash Pine; Spruce Pine; Swamp Pine; Torch Pine; Virginia Pine; Yellow Pine.

A tree usually 90–110 ft. high with a girth of 6–8 ft., but occasionally 130 ft. high and 12 ft. in girth. *Bark* reddish brown, broken by irregular fissures into broad, flat, scaly ridges. *Young shoots* without down, glaucous, becoming yellowish brown and strongly ridged. *Winter buds* conic, ¼–½ in. long, with light brown, fringed, non-resinous scales which are more or less reflexed at the apex and often persistent at the base of the shoot. *Leaves* in threes, lasting 3–4 years, rigid, slightly twisted, 6–9 in. long, 1/16 in. wide, margins minutely toothed, apex sharp and horny, pale green with stomatic lines on each surface, resin canals median, basal sheath nearly 1 in. long. *Cones* lateral, or sometimes sub-terminal, ovoid-oblong, 3–5 in. long, nearly sessile; *scales* oblong, about 1 in. long, the terminal portion light brown and rhomboidal with a transverse elevated ridge ending in a stout-based, reflexed spine. *Seed* rhomboidal, ¼ in. long, dark brown, mottled with black, distinctly ridged, wing about 1 in. long.

The species is recognized amongst three-leaved pines with non-resinous buds and persistent, reflexed bud scales, by its glaucous shoots and spiny cone scales.

Pinus Tæda is a native of the southern and eastern parts of the United States from S. New Jersey to S. Arkansas, Oklahoma, E. Texas and S.W. Tennessee. Like other pines of that region, it is not suited to the English climate and although introduced by Bishop Compton in 1741 it is rarely seen in pineta.

The *wood* shares with that of *P. palustris*, *P. echinata*, and *P. cubensis*, the common name of *yellow pine*, and although the timber of these trees varies considerably in strength and working qualities, their general appearance and microscopic characters are so similar that they cannot easily be separated. The best grade of Loblolly pine is distinctly inferior to good grades of *P. palustris*, although given first-class Loblolly pine and an inferior grade of *P. palustris*, the former would probably prove to be the better timber. Loblolly pine timber is soft, rather coarse-grained and resinous, with conspicuous resin ducts. The heartwood is light brown, the sapwood yellow, the proportion of the latter being greater than in *P. palustris*. Growing in the same region as *P. palustris*, Loblolly pine suffers by comparison, although the two are often mixed. Judged on its merits, Loblolly pine is a decidedly useful wood, and one that will find extended use in the future. It makes excellent lumber for general carpentry, is used for shipbuilding, masts, general construction and other purposes; but its chief use appears to be for railway sleepers, for, when creosoted, it is very suitable for the work. The trees are sometimes tapped for resin, but it is said that the resin flows less freely than that of *P. palustris* and that it thickens and becomes hard

more rapidly. The timber is exported largely from ports on the Gulf of Mexico. For further particulars see under *P. palustris*.

The Loblolly pine thrives in a variety of soils, but is better adapted for wet positions than most pines. It reproduces itself rapidly and is often the first tree to take possession of prairie swamps as soon as small hillocks rise above the general moisture. Farm land that has been allowed to go out of cultivation is soon covered by this tree, whilst its regular seeding and adaptable habits enable it to encroach on land occupied by other species and gradually oust them. It seems likely that in a generation or two it will cover a much larger area than at present and will possibly become the most important soft wood of the S.E. States of N. America. From United States reports it appears that very useful timber can be grown on a 40–50 years' rotation, and it is probable that no rotation need be carried further than 70 years. The climatic conditions obtaining in the British Isles are quite unsuitable for this species, and as it gives very poor results as an ornamental tree it would be useless to consider it from a forestry standpoint.

Zon. R., *Loblolly Pine in Eastern Texas*, Bull. 64, For. Ser., U.S. Dept. of Agric. (1905); Betts, H. S., *Properties and Uses of the Southern Pines*, For. Ser. Circular, 164, U.S. Dept. of Agric. (1909).

Pinus Teocote, Schlechtendal and Chamisso.

TWISTED-LEAVED PINE.

Pinus Bessereriana, Roezl; P. microcarpa, Roezl; P. Muelleriana, Roezl; P. Vilmoriniana, Roezl. Tecote.

A tree 90 ft. high with fissured scaly bark. *Young shoots* glabrous, glaucous. *Winter buds* cylindric-conic, about $\frac{3}{4}$ in. long, with resinous, fringed scales. *Leaves* usually in threes but sometimes in fives, lasting 3 years, spreading, rigid, 4–8 in. long, margins finely toothed, apex a sharp, horny point; stomatic lines on each surface; resin canals median; basal sheath about 1 in. long, persistent. *Cones* sub-terminal or rarely lateral, solitary or in pairs, spreading or reflexed, ovate-oblong, about $2\frac{1}{4}$ in. long, dull brown; *scales* numerous, $\frac{3}{4}$ in. long, $\frac{1}{3}$ in. wide, the terminal portion flat or swollen, transversely ridged. *Seed* small with a narrow wing.

P. Teocote may generally be distinguished by its small cone—although a large-coned form, var. *macrocarpa*, Shaw, occurs. From *P. leiophylla* it is distinguished by its biennial cone.

A native of the Sierras of Mexico, where it is associated with other warm temperate species including *P. patula*, and *P. leiophylla*.

P. Teocote has been known in cultivation in the mildest parts of the British Isles since 1826 when a single tree existed in

Lambert's garden at Boyton, Wilts. Other plants were raised from seed sent home by Hartweg in 1839. It is only suitable for the warmer parts of the country.

Shaw, *Pines of Mexico*, 16 (1909).

Pinus Thunbergii, Parlatore. (Fig. 101.)

BLACK PINE.

Pinus Massoniana, Siebold and Zuccarini (not D. Don., nor Gordon); P. Pinaster, Loudon (not Solander); P. sylvestris, Thunberg (not Linnæus, Loureiro, nor Miller); P. tabulæformis, Hort. Kuro-matsu.

A tree up to 130 ft. high and 20 ft. in girth in Japan, with stout short twisted branches forming an irregular crown. *Bark* greyish brown, deeply fissured. *Young shoots* light brown, glabrous, ridged, with the scale leaves persisting during the first year. Older branches roughened by leaf scars. *Winter buds* ovoid, sharply pointed, $\frac{1}{2}$–$\frac{3}{4}$ in. long, greyish white with closely pressed scales. *Leaves* in pairs, persisting for 3 years, densely crowded on the branchlets, more or less spreading, rigid, and twisted, 3–4 in. long, margins finely toothed, apex a stiff fine point; stomatic lines on each surface; resin canals median; basal sheath $\frac{1}{2}$ in. long, ending in two long filaments. *Cones* sub-terminal, spreading, solitary, a few together, or in large clusters of 40–60, ovate or ovate-conic, about $2\frac{1}{2}$ in. long, stalks short; *scales* wedge-shaped, the exposed portion nut or reddish brown, flat or curved, transversely keeled, with a minute, often rudimentary, prickle. *Seed* up to $\frac{1}{4}$ in. long with a narrow wing about $\frac{3}{4}$ in. in length. The inflorescences occasionally bear a combination of male and female cones.

P. Thunbergii is readily distinguished by its conspicuous white buds and rigid leaves. The long filaments of the basal sheath are common to this species and *P. densiflora*.

Native of Japan, where it has been so widely cultivated from early times that its original geographical range is difficult to define. According to some authorities it is only known in the wild state on the eastern coast.

Two varieties have been introduced, neither of any decorative importance:—

Var. **aurea.**

Clusters of golden leaves appear amongst those of normal colour.

Var. **variegata.**

Some of the leaves are variegated with pale yellow.

Wood very resinous with prominent resin ducts, coarser but very similar to that of *P. densiflora*, heartwood reddish, sapwood yellow. It works well, has good lasting qualities and is adapted

for creosoting for ground work. Amongst well-known timbers it is comparable with Scots pine of Europe and *P. resinosa* of N. America. Its many uses include building and engineering work, general indoor finish of houses, sleepers, box boards, firewood, torches, etc. Resin is obtained by tapping, and charcoal, tar and

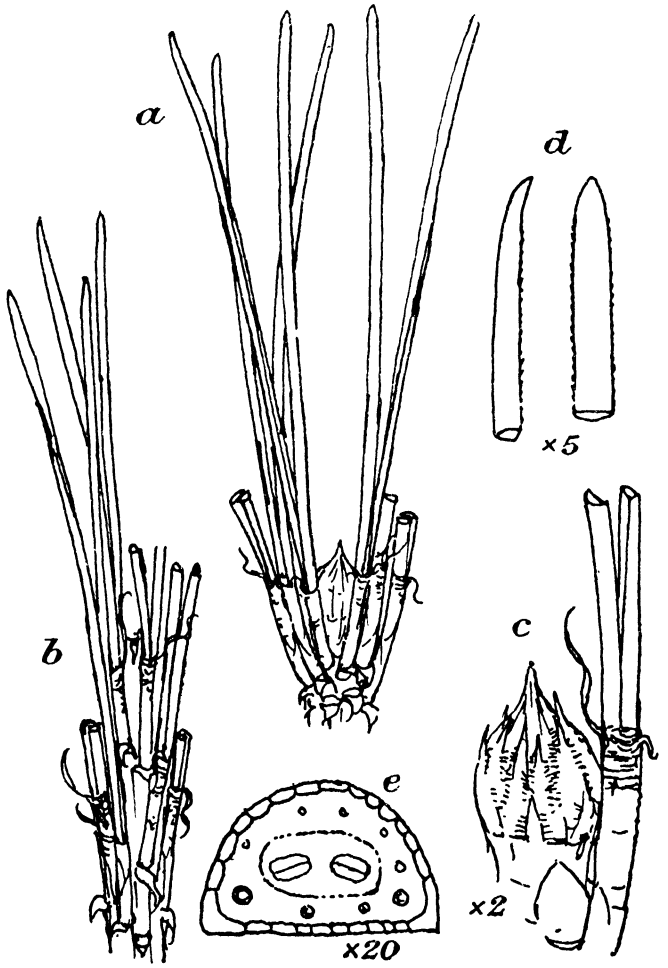

FIG. 101.—*PINUS THUNBERGII.*

a, end of branch with winter bud and leaves in pairs; *b*, portion of shoot with leaves in pairs, each pair with long curling tips to the sheaths; *c*, winter bud with base of leaf cluster; *d*, apex of leaves; *e*, section of leaf.

other products by destructive distillation of roots and waste wood.

P. Thunbergii is one of the most important timber trees of Japan and is largely used for reclaiming sand-dunes and for other protective work near the sea. In the British Isles it gives good

results in light, well-drained loam and also in sandy soil. It is well adapted for shelter plantations near the sea, and has been planted with success on sand-dunes in Ireland. Although not grown extensively at present, it is worth the attention of arboriculturists and foresters in both maritime and inland counties. Except in a young state it is a light-demanding tree. In the State forests of Japan it is grown on a 40–80 years' rotation, the maximum age being extended to 100 years in Imperial forests. *P. Thunbergii* is one of the species used by Japanese gardeners for dwarfing for pot culture and use in their famous miniature gardens.

Elwes and Henry, *loc. cit.* v, 1143 (1910); Wilson, *Conifers of Japan*, 27 (1916).

Pinus Torreyana, Parry.

SOLEDAD PINE.

Pinus lophosperma, Lindley. Del Mar Pine; Lone Pine; Torrey Pine.

A small tree 30–40 ft. high with short, stout branches or, in exposed places, a low tree, bush, or semi-prostrate shrub. *Bark* thick, irregularly and deeply fissured into broad, flat ridges covered by thin reddish scales. *Young shoots* light green, afterwards purplish with a distinct bloom. *Winter buds* cylindrical, tapering to a point, about ½ in. long, or in the case of the terminal bud sometimes very long - an instance is recorded by Jepson of a terminal bud 12 in. in length.[1] *Leaves* in fives, lasting several years, arranged in heavy tufts at the ends of the branches, dark green, slender, 7–10 in. long, upper part of the margin finely toothed, apex a horny point, stomata on all surfaces; resin ducts median; basal sheath persistent, about ¾ in. long. *Cones* broadly ovoid, symmetrical, dark brown, 4–5½ in. long and the same in width at the base, maturing during the third year; *scales* large, thick, woody, the exposed portion much thickened. *Seeds* oval, ½–⅝ in. long, dull brown, mottled, wing with a thickened rim almost surrounding the seed. They are sweet, oily and edible.

The Soledad pine is easily distinguished by its five-leaved clusters being surrounded by a long basal sheath, and by its broadly ovate symmetrical cones.

Distribution limited to small areas on Santa Rosa Island and the San Diego Coast.

Wood reported as soft, weak and brittle, and to be of little value except as fuel. The seeds are useful for food.

Young plants of *P. Torreyana* are occasionally seen in English gardens, but appear to be too tender for general cultivation in the British Isles although it might succeed in Cornwall and in Ireland. In certain Californian gardens it appears to grow better

[1] Jepson, *Silva of California*, 92 (1910).

than in its native habitat. Jepson records a plant which had been moved three times, as being 30¾ ft. high at 17 years of age, its annual growth in three successive years being 4 ft.

Pinus tropicalis, Morelet.

Pinus terthrocarpa, Shaw.

A tree 50–60 ft. high with a girth of 6 ft. *Bark* greyish, tinged with red, irregularly broken into large, oblong plates. *Branches* ascending and forming an open, rounded crown. *Young shoots* stout and rough. *Winter buds* stout with reflexed scales. *Leaves* in pairs or rarely in threes, very erect, rigid, 4–8 in. long, margins minutely toothed, resin canals very large, touching both endoderm and hypoderm and forming a septum. *Cones* erect or spreading, ovate-conic, symmetrical; *scales* orange-brown above, pyramidal, transversely keeled.

Closely allied to *P. caribæa*, but distinguished by its peculiar leaf section.

A tropical species growing at sea-level and confined to W. Cuba, the Isle of Pines, and the mainland in Florida. Not in cultivation in the British Isles.

Shaw, *Genus Pinus*, 52 (1914).

Pinus tuberculata, Gordon.

KNOBCONE PINE.

Pinus attenuata, Lemmon; P. californica, Hartweg (not Loiseleur). Narrow-cone Pine; Prickly-cone Pine; Sandy-slope Pine; Snow-line Pine; Tuberculated-cone Pine.

A small tree 20–50 ft. high, or occasionally taller, and 3–6 ft. in girth, often developing more than one trunk and a heavily branched head of dense foliage. *Bark* of old trees dark brown, about ½ in. thick, scaly. *Young shoots* prominently ridged, light brown, and free from down. *Winter buds* narrow, cylindrical, pointed, ¾–1 in. long with closely pressed resinous scales. *Leaves* in threes, lasting 3–4 years, grey-green, slender, 4–7 in. long, margins with rudimentary teeth, apex sharp-pointed, stomata on each surface; resin canals median; basal sheath persistent, about ½ in. long on the younger leaves, reduced to ⅛ in. on the oldest leaves. *Cones* variable in shape, usually narrowly conical, 3–5 in. long, lateral, solitary or in whorls, 2–3 whorls often appearing on the same year's growth, persisting unopened for many years, a single branch often bearing numerous clusters; *scales* thin, flat, the exposed part thickened and often elongated on the outer side of the cone, armed with sharp prickles. *Seed* oval, about ¼ in. long, black, wing 1 in. long.

The Knobcone pine appears to be most closely related to *P. radiata*, but can be distinguished by its greyish, not light green

leaves, longer and more cylindrical buds and narrower tawny-yellow cones with spine-tipped scales.

Distributed from S.W. Oregon and the Siskiyou Mountains, southwards along the western slope of the Cascades to the Sierra Nevada, the Coast Range of California, and the San Bernardino Mountains. It is most common in Oregon at an altitude of 2,500–3,000 ft., and is usually found in small groves. Discovered by Hartweg in 1847 and introduced about the same time.

Wood soft, weak and coarse-grained with conspicuous resin ducts. Heartwood light brown, sapwood pale yellow or almost white. Although often knotty it is occasionally employed for inferior kinds of carpentry and joiners' work. It is also used for fuel, but has little commercial value.

P. tuberculata is hardy in the British Isles and grows freely in light loamy soil, although never likely to form a large tree. Apart from its arboricultural interest it has no value. In America seeds are shed freely after forest fires and a dense growth of seedlings appears among the ashes. In order to make good progress the seedlings must be able to dominate other species at an early age.

The best tree in the British Isles is said to be growing at Bury Hill, Dorking. It divides into several trunks near the ground.

Jepson, *Silva of California*, 102 (1910).

Pinus virginiana, Miller.

Scrub Pine.

Pinus inops, Solander ; P. ruthenica, Hort. ; P. variabilis, Lambert (not Pursh). Bastard Pine ; Cedar Pine ; Jack Pine ; Jersey Pine ; New Jersey Pine ; Nigger Pine ; Oldfield Pine ; Poor Pine ; Poverty Pine ; River Pine ; Second-growth Pine ; Short Pine ; Short-leaved Pine ; Shortschat Pine ; Shortshucks ; Spruce Pine ; Yellow Pine.

A tree usually 30–50 ft. high with a short trunk 12–18 in. in diameter, but occasionally 100–120 ft. high with a diameter of 2–3 ft., or sometimes shrubby in habit. *Bark* thin, $\frac{1}{4}$–$\frac{1}{2}$ in. thick, scaly. *Young shoots* slender, purplish with a waxy bloom, which usually disappears with age. *Winter buds* $\frac{1}{3}$–$\frac{1}{2}$ in. long, ovate with a short point, resinous, with closely pressed scales. *Leaves* in pairs, lasting 3–4 years, rigid, twisted, $1\frac{1}{4}$–$2\frac{1}{2}$ in. long, margins with minute, irregular teeth, apex sharp-pointed, stomata on both surfaces ; resin canals median ; basal sheath $\frac{1}{6}$–$\frac{1}{4}$ in. long, persistent. *Cones* solitary or in pairs midway along the season's growth, oblong or conical, 1–$2\frac{1}{2}$ in. long, 1–$1\frac{1}{2}$ in. wide when expanded, on stalks $\frac{1}{3}$ in. long, which are hidden in the mature cones by the basal scales ; *scales* small, the exposed part greyish brown, terminated by a sharp prickle. *Seed* small, $\frac{1}{8}$–$\frac{1}{4}$ in. long, brown, mottled, with a wing about $\frac{1}{4}$ in. long.

P. virginiana is distinguished from all other two-leaved pines by its purplish young wood with a glaucous covering.

Native of E.N. America from Staten Island in New York to N. Alabama, and from the Atlantic coast to S. Alabama. In the northerly parts of its range it is found at sea-level and towards its southerly limit at a high altitude. It was introduced in 1739.

Wood light, soft, brittle, with a large percentage of orange or brownish heartwood, and narrow, yellowish sapwood. It is often knotty and only suitable for inferior work. The best quality is used for log huts, railway sleepers and fencing, but it is not regarded as a first-class sleeper wood for railways with heavy traffic, as the securing spikes are soon loosened. The wood is also used for common boxes, pit wood and paper pulp. It is, however, said to be more suitable for the chemical than the groundwood process of manufacture for the latter purpose.

The chief value of the species in American silviculture lies in the fact that it gives good results on heavy, clayey land where little else will grow, both on virgin soil and impoverished farm land, reproducing itself readily from natural seed distribution. It is not well adapted for light sandy soil. Suggestions have been made that it might be most profitably grown on a 30–40 years' rotation for pulp wood. It has no commercial value in the British Isles and possesses no special decorative merit. Good specimens exist in a few gardens, notably at Bayfordbury, Herts, and at Tortworth, Gloucestershire.

Sargent, *Silva of N. America*, xi, p. 123 (1897); Sterrett, *Scrub Pine* (*Pinus virginiana*), For. Ser. Bull., No. 94, U.S. Dept. of Agric. (1911).

PSEUDOLARIX, Gordon.

Pseudolarix Fortunei, Mayr. (Fig. 102.)

GOLDEN LARCH.

Pseudolarix Kæmpferi, Gordon; Abies Kæmpferi, Lindley; Larix Kæmpferi, Carrière; Laricopsis Kæmpferi, Kent; Pinus Kæmpferi, Parlatore. Golden Pine.

This, the only species of the genus, is a deciduous tree 100–130 ft. high and 5–8 ft. in girth in China. *Bark* light brown when young, reddish brown and fissured on old trees. *Branches* irregularly arranged, horizontal, flattened as in *Cedrus*. *Branchlets* of two kinds; long shoots and short, stunted, spur-like shoots. *Long shoots* without down, glaucous, brown with a reddish tinge the second year, roughened by the permanent bases of fallen leaves; *short shoots*, club-shaped, longer than in *Larix* with distinct constrictions between the annual rings which are surrounded by long-pointed, persistent scales. *Terminal buds* of long shoots ovoid, pointed, surrounded by long-pointed brown scales with free tips, which fall away soon after the leaves develop

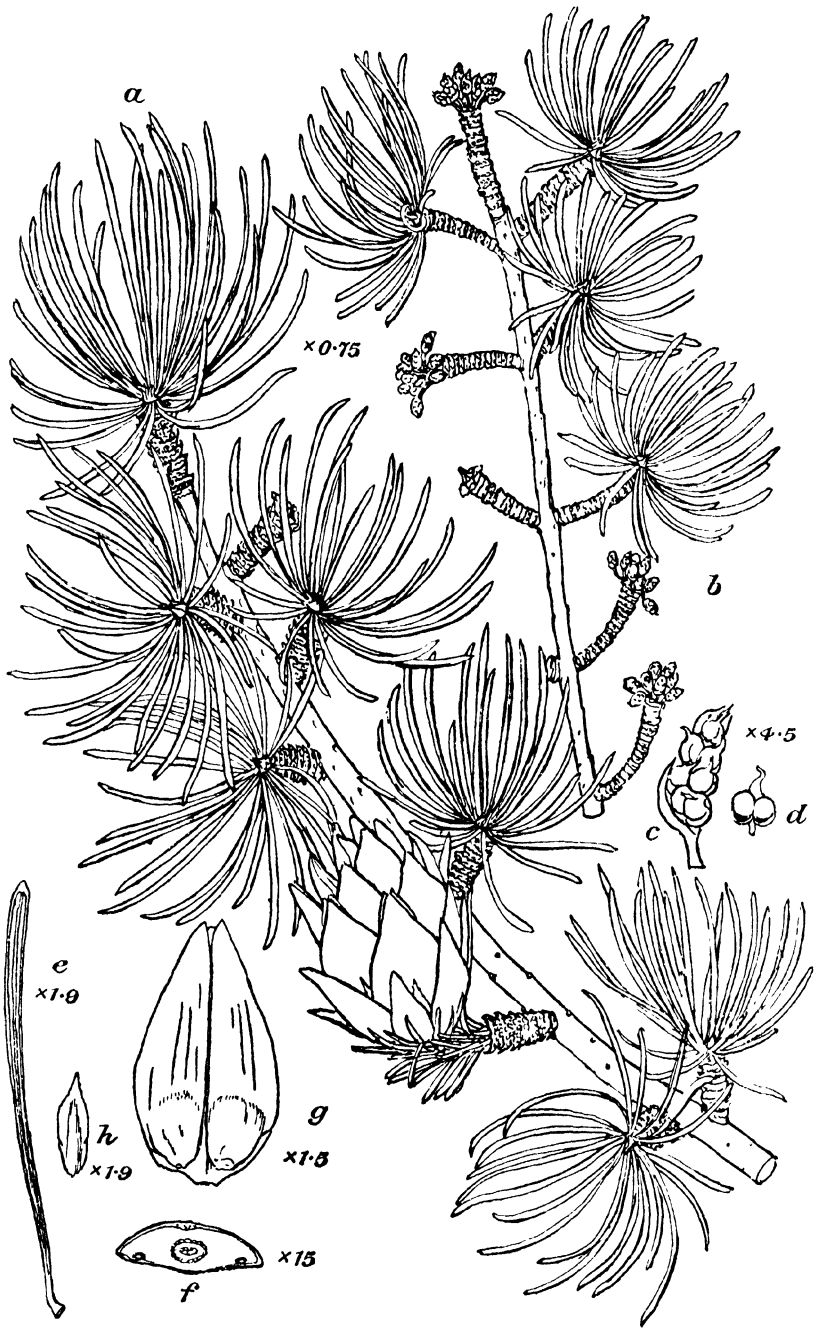

FIG. 102.—*PSEUDOLARIX FORTUNEI.*

a, branch with female cone; *b*, branch with clusters of male cones; *c*, male cone; *d*, stamen; *e*, leaf; *f*, section of leaf, showing two resin canals; *g*, cone-scale with two seeds; *h*, bract of cone-scale.

in spring. *Buds of short shoots* similar in shape with persistent scales. *Axillary buds* rounded with short-pointed deciduous scales. *Leaves* bright green in summer, golden in autumn, spirally arranged on the long shoots, in star-shaped clusters of 15–30 on the short shoots, 1–2 in. long, $\frac{1}{12}$ in. or less wide, pointed, rounded above, keeled beneath, margins very thin, stomata in two conspicuous grey bands on the under surface, resin canals three. *Male and female* flowers on different branches of the same tree, opening in May or June. *Male flowers* in slender, cylindrical, short-stalked, nodding catkins, 20–25 together in umbels at the points of short, leafless, spur-like shoots, each catkin bearing about 20 yellow, two-celled anthers with winged pollen grains as in *Pinus*. *Female flowers* oblong or cylindrical, $\frac{3}{4}$–1 in. long and about $\frac{1}{3}$ in. in diameter when the male flowers are open, terminating short, leafy branches from the points of short shoots; composed of numerous (up to 50) long-ovate scales, each fertile scale bearing two ovules. *Cones* ovoid, erect, those of mature native trees 2–3 in. long and $1\frac{1}{2}$–2 in. wide, those of cultivated trees in Britain $1\frac{1}{2}$–2 in. long, resembling a miniature inflorescence of a globe artichoke; *scales* broadly-ovate, $\frac{3}{4}$–$1\frac{1}{4}$ in. long, $\frac{3}{8}$–$\frac{3}{4}$ in. wide at the base, tapering to a blunt or notched apex, bending sharply inwards at the base and forming a shelf-like resting-place for the seeds; woody, green or purplish during summer, light brown when ripe, scurfy near the base, falling with the seeds when ripe. *Bract* triangular, clasping the base of the scale and falling with it. Orange-coloured resin sometimes exudes from the scales. *Seeds* white, about $\frac{1}{4}$ in. long and wide, with a well-developed, obliquely ovate wing as long as the scale and extending beyond the margins when the cones expand, usually $\frac{3}{4}$–$1\frac{1}{4}$ in. long, $\frac{1}{4}$–$\frac{1}{2}$ in. wide, the inner edge straight and in a line with the seed, the outer edge developed beyond the seed, gradually narrowing to a blunt, rounded apex; ripening the first autumn and shed as soon as ripe. *Cotyledons* 5–7.

Pseudolarix is easily distinguished from *Larix* by its longer, club-shaped short shoots with distinct annual rings and persistent scales, wide leaves, and by the cones breaking when ripe.

The golden larch is a native of E. China, where it occupies a restricted area in the provinces of Chekiang and Kiangsi. Fortune had noted it as a dwarfed plant in gardens during his early days in China, but it was not until the autumn of 1853 that he found it in a wild state near the monastery of Tsan tsin, at an elevation of 1,000–1,500 ft.[1] Some of the trees were 120–130 ft. high, with a girth of 5 ft. at 2 ft. from the ground, the trunk being carried with little loss of girth to the lower branches at 50 ft. above the base. A year later he was shown another group of trees about 20 miles westward near Quanting monastery, on a mountain slope, at 4,000 ft. altitude; one very fine specimen

[1] *Residence among the Chinese*, 1853–1856, 274.

standing alone was 130 ft. high and 8 ft. in girth, with symmetrical branches almost touching the ground. These trees were without cones, which are apparently borne in alternate years only. The Chinese call the tree " chin-lo-sung " (golden deciduous pine), or " ching-sung " (golden pine), on account of the rich golden colour which the leaves assume before they fall.

Although Fortune sent home numerous consignments of seeds in 1853 and subsequent years, very few seem to have germinated, and for some time the only plants living in England were those dug up by Fortune as seedlings and sent to England in a wardian case. The rarity of this beautiful conifer, which Fortune regarded as one of his most important introductions, is somewhat remarkable considering its hardiness, but it is of slow growth and needs to be planted in deep, well-drained, loamy soil. The trees at Kew occasionally produce cones, but the seeds are rarely, if ever, fertile. Even in China it appears to be too scarce to have any economic value, although the wood is of good quality and easy to work.

Seeds are difficult to obtain from China in a fresh state, but fertile seeds are frequently produced in Italy, and a fine tree, probably the largest in Europe, growing in Messrs. Rovelli's Nursery at Pallanza, Italy, produces plenty of seedlings beneath its branches. Good specimens are found in southern England, at Carclew and Penjerrick in Cornwall, at Tortworth Court in Gloucestershire, and at Kew. Dr. Lindley appears to have at first mistaken the tree for the Japanese larch (*Larix leptolepis*), which had also been called *L. Kaempferi*.

Elwes and Henry, *Trees of Great Britain and Ireland*, vi, 1477–1480.

PSEUDOTSUGA, Carrière.

Douglas Firs.[1]

A genus of evergreen trees of pyramidal habit, the main branches in whorls. *Bark* of young trees smooth, but covered with resin blisters, thick, corky and furrowed on older trunks, of alternating thick reddish brown and thin, whitish layers. *Young shoots* with raised, coloured, slightly prominent bases, more or less hairy. *Winter buds* spindle-shaped, sharp-pointed, resembling those of a beech, with shining brown scales. *Leaves* linear, narrowed at the base, furrowed on the upper surface with two bands of stomata separated by the midrib beneath ; resin canals two, marginal. *Male flowers* arising from the axils of the leaves, stalked, consisting of numerous, spirally arranged, shortly stalked, roundish anthers. *Female flowers* conical, terminal, or in the axils of the upper leaves, composed of numerous overlap-

[1] Henry and Flood, " The Douglas Firs," *Proc. Roy. Irish Acad.* xxxv, B. 5, 67 (1920).

ping rounded scales, which are much shorter than the three-lobed bract. *Cones* oblong, short-stalked, pendulous, maturing in one season when they open and release the seeds ; bracts conspicuous, three-lobed, the middle lobe awn-like. *Seed* resembling that of a larch, but with a pointed base ; wing large, rounded, partially enveloping the seed.

The Douglas firs were formerly placed in the genus *Abies*, but have since been separated on account of the persistent cone-scales. They may also be distinguished by their narrower leaves, soft to the touch, with coloured bases, and the beech-like buds. The cones with their persistent scales and trident-like bracts are easily recognized.

Seven species of *Pseudotsuga* have been discovered, three being natives of W.N. America, the remainder occupying a limited range in W. China, Japan, and Formosa.

The macroscopic characters of the wood resemble larch, heartwood and sapwood being well marked, and the difference between spring and summer wood very pronounced. The heartwood is reddish or brownish yellow, the sapwood yellow or cream. Under the microscope the tracheids are seen to differ from those of larch in having spiral thickening. The most important commercial species is *P. Douglasii*, which is one of the most valuable trees that have been introduced.

The Douglas firs are raised from seeds sown in beds of well-prepared soil in March or early April, the seeds being covered with about $\frac{1}{3}$ in. of fine soil. Small quantities of seed may be sown in pots or boxes in greenhouses or frames, but the seedlings so raised should be transferred to nursery borders at the earliest possible date. They are very successful in Britain, where the climatic conditions are moist and the soil moderately moist but well drained, but they also succeed where conditions are less favourable. In the West of England and in Scotland growth is very rapid, and *P. Douglasii* has been known to add from 4–5 ft. to its height in a single growing season.

Key to Pseudotsuga.

Leaves entire at the apex.

- Branchlets pubescent. Leaves thin, flat beneath, blunt or sub-acute, with fragrant pine-apple odour. Cones 3 to 4 in. long, with straight, erect bracts.—*P. Douglasii.*
- Branchlets glabrous. Thicker needles, and smaller cones, $2\frac{1}{2}$ in. long.—*P. Douglasii*, var. *cæsia.*
- Branchlets variable in pubescence, often glaucous. Leaves thick, rounded beneath, with strong turpentine odour. Cones 2 to 3 in. long, with reflexed bracts.—*P. glauca.*
- Branchlets variable in pubescence. Leaves thin, flat beneath, acuminate, ending in a cartilaginous point. Cones very

large, 3½ to 7 in. long, with straight, erect bracts.—*P. macrocarpa.*

Leaves bifid or notched at the apex.

Branchlets glabrous. Leaves about 1 in. long. Cones small, about 1½ in. long, with short reflexed bracts.—*P. japonica.*

Branchlets pubescent.

Leaves 1¼ in. long. Cones 2 in. long, with short reflexed bracts.—*P. sinensis.*

Leaves nearly 2 in. long. Cones 2¼ in. long, with long reflexed bracts.—*P. Forrestii.*

Leaves ¾ in. long. Cones 2 to 2½ in. long, with short reflexed bracts.—*P. Wilsoniana.*

Pseudotsuga Douglasii, Carrière. (Fig. 103.)

OREGON DOUGLAS FIR.

Pseudotsuga mucronata, Sudworth; P. taxifolia, Britton; Pinus taxifolia, Lambert; Abies Douglasii, Lindley; Abietia Douglasii, Kent. Cork-barked Douglas Spruce; Douglas Fir; Douglas Spruce; Douglas Tree; Oregon Pine; Puget Sound Pine; Red Fir; Red Pine; Spruce; Yellow Fir; Columbian Pine.

A tree attaining on the Pacific Coast 300 ft. or more in height and sometimes 40 ft. in girth.[1] *Upper branches* horizontal, lower branches depressed, often very long, sometimes sweeping the ground. *Bark* of old trees up to 12 in. in thickness, corky, deeply fissured into broad ridges. *Young shoots* yellowish green at first, becoming greyish with age, minutely hairy. *Winter buds* with little or no resin. *Foliage* fragrant when bruised. *Leaves* pectinate, with a V-shaped arrangement between the two lateral sets, deep green, straight, 1–1¼ in. long, thin, acute or rounded at the apex. *Mature cones* 3–4 in. long, 1½–2 in. wide, light brown with numerous thin scales which are ¾–⅞ in. wide, and slightly convex, minutely hairy on the outer surface; bracts straight erect, longer than the scales, three-lobed, with a central slender awn and two shorter, lateral lobes. *Seed* ¼ in. long, dark shining brown, mottled beneath.

Var. **anguina**, nobis.

Snaky Douglas Fir.

A small tree with much the habit of the snake spruce (Picea excelsa var. monstrosa). Branches few, long and rambling, branchlets few or none. Leaves longer, about 2 in. Endsleigh, Devon.

Var. **brevifolia**, Masters.

Leaves smaller than in the type.

[1] The well-known flagstaff at Kew, erected in 1919, consists of a single spar of Douglas fir, 214 ft. high, 2 ft. 9 in. in diameter at the base, and 12 in. at the top, its weight on shipment being 18 tons.

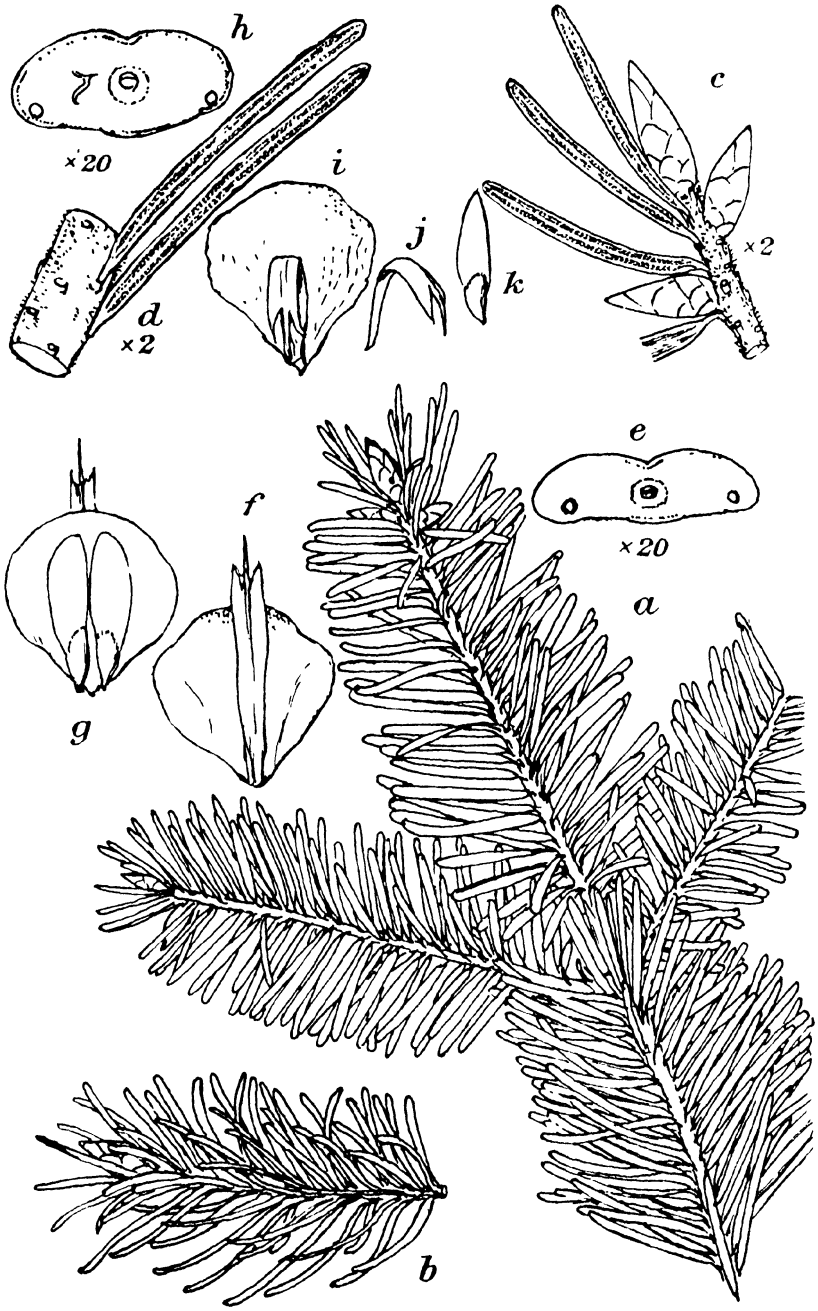

FIG. 103.—*PSEUDOTSUGA DOUGLASII* and *P. GLAUCA*.

Pseudotsuga Douglasii.—*a*, spray from above, *b*, from the side; *c*, winter buds and leaves, underside; *d*, part of shoot and under-leaf surface; *e*, section of leaf; *f*, cone-scale with straight bract; *g*, inner side of cone-scale with two seeds. *P. glauca.*—*h*, section of leaf; *i*, cone-scale with recurved bract; *j*, bract, side view; *k*, seed.

Var. **cæsia,** Schwerin.[1]

Intermediate between *P. Douglasii* and *P. glauca,* distinguished from the former by its glabrous or very slightly downy branches, and greyish foliage, which is only slightly fragrant, and smaller cones; and from *P. glauca* it differs chiefly in its pectinate foliage and erect cone-scales. It extends throughout the northern Rocky Mountain region of the Oregon Douglas fir.

Var. **fastigiata,** Carrière.

Branches erect, numerous, forming a compact pyramid. Leaves shorter; buds large; cones obtuse, red.

Var. **Fretsii,** Beissner.

Leaves short and broad, obtuse at the apex, resembling those of a *Tsuga* or a silver fir. This peculiar form first appeared as a seedling, and was distributed by Messrs. Frets, of Boskoop, Holland.

Var. **nana,** Hort.

A dwarf, compact plant of bushy habit, suitable for the rock-garden.

Var. **pendula,** Engelmann.

Branchlets exceptionally long and pendulous, slender with few secondary branchlets.

Var. **revoluta,** Hort.

Leaves curled.

Var. **Stairii,** Hort.

Foliage light golden yellow at first, becoming green in the autumn.

Var. **Standishii,** Masters.

Leaves silvery white below.

Var. **suberosa,** Lemmon.

Bark very corky.

Var. **taxifolia,** Carrière.

P. taxifolia Var. **brevibracteata,** Asch and Graebn.

Branchlets stouter, leaves longer and narrower than in the typical form. Cones blunter, bracts shorter, scarcely exceeding the scales in length. Recorded as a wild plant in Oregon.

[1] A manna composed of the rare sugar melezitose is found in considerable quantity as a natural exudation on the foliage and branchlets of this variety in British Columbia. *American Forestry,* Feb. (1920) and *Scientific American,* 165 (1920).

Var. **variegata**, Forbes.

Foliage variegated, appearing as if frost-bitten. It is of no decorative value.

P. Douglasii is distinguished from its nearest allies by its fragrant foliage and erect cone-bracts.

The Douglas fir covers immense areas in the Pacific Coast regions in S. British Columbia, Washington, and Oregon, from the Cascade Mountains to the sea and the coast ranges of California, extending south to the Santa Lucia Mountains. The finest trees occur in Washington and British Columbia on well-drained soil where there is an annual rainfall of 50–60 in.

The *wood* is very variable in character. It is usually coarse-grained, heavy and reddish, but is sometimes yellowish and fine-grained. Heartwood and sapwood are well marked, the former being red or brownish yellow, the latter yellow. Superficially the wood resembles larch, but it differs in internal structure. Resin ducts are present, and they are usually arranged in groups. The timber is strong, durable, usually straight-grained and suitable for purposes where great strength is required, as well as for minor work. It finishes with a good surface and takes paint and polish well. Good Douglas fir timber is almost equal in quality to good Pitch pine (*Pinus palustris*), but very careful grading is necessary, as the timber may vary a good deal in quality even in a single tree, and to ensure a regular market uniformity in quality and strength between the units of a consignment are essential. Figures contrasting the strength of the timber of *Pinus palustris*, and the Douglas fir have been published in America,[1] and these should be consulted by those who wish to use Douglas fir for important buildings. Amongst other uses the wood is employed for general constructive work such as house, ship, and bridge building, for piles, telegraph, and other poles, railway trucks and carriages, flooring, street-paving, cooperage, water-tanks, water-pipes, boxes, paper pulp, furniture, veneer, plywood, doors, and window-sashes. It is often beautifully figured, and such wood is valued for furniture and panelling. Large numbers of railway sleepers made from heartwood are laid, untreated, in the United States, where they are said to last from 6 to 9 years. Sleepers made from sapwood are usually treated with a preservative. Zinc chloride is used extensively for that purpose in America, but it is found to be more difficult to inject either that, creosote, or other preservatives into Douglas fir than into pine, and penetration of the heartwood is shallow. The Douglas fir is at the present time one of the most important coniferous woods, and enormous quantities of timber are available. In British Columbia alone the merchantable timber in 1918 was calculated

[1] *Prop. and Uses of Douglas Fir* : For. Ser. Bull. No. 48, U.S. Dept. of Agric. (1911).

as 76,000,000,000[1] board ft. and in the United States in 1919 as 525 billion board ft.[2]

Whitford and Craig[3] give some interesting figures of yield in the forests of British Columbia. The ordinary yield is from 20,000—50,000 board ft. per acre, but frequently on the better sites the yield is 100,000 board ft. per acre, and an instance is recorded where 5,000,000 board ft. was cut from 10 acres. Single mature trees ordinarily contain 2,000–5,000 board ft., but sometimes exceed 10,000 board ft. In the mountains the yield is usually less than in the coast forests. In this country small areas have produced a very heavy volume of timber, as the following quarter-girth measurements indicate.[4]

Estate and County.	Age.	Number of trees. per acre.	Mean height of dominant trees.	Volume of timber per acre over bark.	Average annual growth in volume per acre.
	Years.	No.	Feet.	Cu. Ft.	Cu. Ft.
Bagley, Oxford . . .	12	2,132	32	923	77
Llandinam, Montgomery	28	347	66	5,563	199
Tortworth, Gloucester .	29	206	66	3,690	127
Dunster, Somerset . .	33	350	74	4,975	151
Tortworth, Gloucester .	43	215	97	7,316	170
Taymount, Perth . .	52	149	88	6,640	128
Cochwillan, Carnarvon .	58	119	101	11,080	190

The "milder" and more easily worked timber is usually obtained from trees growing in particularly favourable positions, and constitutes the "yellow fir" of commerce, the coarser and deeper-coloured wood being known as "red fir." Timber can be procured from British Columbia in spars 90 ft. long by 17 in. side; selected slabbed spars up to 80 ft. long by 20 in. side; square timber 70 ft. long by 14 in. side, and 20 ft. long by 24 in. side; deals, planks, etc., to 40 ft. long; clear and select deals up to 32 ft. long. Three qualities are exported, clear, select and merchantable.

Oregon Douglas fir grows under a wide range of soil and climatic conditions, attaining its most luxuriant growth in deep, moist, well-drained, sandy loam, where the annual precipitation is high (40–60 in. in America). It, however, succeeds in light, gravelly loam, heavy loam and peat, provided the ground is not water-logged. The tree is well adapted for sandstone formations, but is not suitable for limy soils.

[1] Whitford and Craig: *For. of Brit. Columb.*, 192 (1918).
[2] N. C. Brown, *For. Prods., their Manufacture and Use* (1919).
[3] *Loc. cit.*
[4] *Journ. Board of Agric.* xx, 1087 (1914).

Naturally a light-demanding tree, it appears to be most satisfactory in this country when treated as a pure crop. Good results have, however, been obtained by mixing it with *Thuya plicata*. In America trees growing in dense forests are said to clean their trunks well. That, however, is not the experience of foresters in this country. Even when spaced 4 ft. apart each way the inside trees in a plantation keep their lower branches alive for many years, and after death they remain sound and do not fall naturally. Lower branches therefore must be pruned, and if pruning is necessary with close planting, it is just as well to adopt wider spacing, 5–6 ft., and allow the young trees to benefit by the extra light and air, thus saving the expense in plants and planting that will be necessary for pruning. It is probable that in the natural forests of W.N. America a very dense crop following regeneration helps the trees to clean their trunks. Young plants should not exceed 2 ft. in height at planting time. In America it is recommended that at 20 years of age the trees should stand about 990 to the acre ; at 30 years of age 580 ; and at 100 years about 115 to the acre.[1] It is probable that *P. Douglasii* may be most satisfactorily grown in this country on a 60–70 years' rotation. The Colorado Douglas Fir (*P. glauca*) grows at less than half the rate of the Oregon tree. Young trees of the Oregon Douglas fir seed freely in Britain, and self-sown seedlings are common in Hampshire and other places.

Both imported and home-grown seeds are often destroyed by the larvæ of an insect, *Megastigmus spermotrophus*. In order to check this enemy, infested seed should be fumigated with hydrocyanic gas. During the last few years the Oregon Douglas fir has been infested in many parts of the country with the Douglas Fir Chermes (*Chermes cooleyi*, Gillett),[2] an insect which passes part of its life-history on Douglas fir and part on Sitka spruce. The insect, however, attacks the leaves only of the Douglas fir, and probably will not cause serious harm.

Pseudotsuga Forrestii, Craib.[3]

FORREST'S DOUGLAS FIR.

A tree 60–80 ft. high in W. China. *Winter buds* slightly resinous. *Young shoots* reddish brown at first, assuming a greyish tinge with age, without down or with minute scattered hairs. *Leaves* pectinate, up to nearly 2 in. long, notched at the apex, upper surface furrowed from base to apex, lower surface with two narrow white bands of minute stomata. *Cones* about

[1] For. Ser. Circ. U.S.A., 175, *Growth and Management of Douglas Fir* (1911).
[2] *For. Comm. Bull.* (London), No. 4 (1922).
[3] *Notes Roy. Bot. Gard. Edinburgh*, xi, 189, t. 160 (1919).

2¼ in. long and 1¼ in. wide; *scales* about 1⅛ in. wide; bracts with the terminal portion reflexed over the scale below, with a long central awn and triangular, short-pointed, lateral lobes. *Seeds* about ⅜ in. long, dark shining brown above, mottled light brown beneath.

A native of Yunnan, W. China, where it was discovered by Forrest in the Mekong Valley at 10,000 ft. altitude. Young plants raised from Forrest's seeds are in cultivation at Edinburgh and at Leonardslee.

Pseudotsuga glauca, Mayr. (Fig. 103.)

COLORADO DOUGLAS FIR.

Pseudotsuga Douglasii, var. glauca, Mayr; Blue-leaved Douglas Fir.

A tree of smaller dimensions than the Oregon Douglas fir, rarely exceeding 150 ft. in height. *Young shoots* olive-green, or occasionally glaucous, becoming reddish brown with age, more or less hairy or with the terminal shoots sometimes glabrous. *Winter buds* resinous. *Foliage* with an odour of turpentine, especially when rubbed. *Leaves* mostly on the upper side of the shoot, more or less vertically arranged, similar to those of *P. Douglasii*, but usually of a more glaucous hue and of thicker texture, the upper surface being indistinctly grooved, the lower surface convex with two distinct bands of stomata. *Mature cones* 2–3 in. long, 1½ in. broad, light brown, composed of about 30 scales with reflexed bracts which are smaller than those of *P. Douglasii*. *Seeds* similar to those of *P. Douglasii*, but with a paler wing.

P. glauca is distinguished from the Oregon Douglas fir by its thicker leaves, which are glaucous in colour and convex beneath, and by its smaller cones with reflexed bracts.

The Colorado Douglas fir is found wild in the Cent. S. Rocky Mountains, ranging through Montana, Colorado, Utah, Arizona, New Mexico, and N. Mexico. It grows in a much drier climate than the Oregon species, which is found in the moist climate of the Pacific Coast region. The date of introduction into Europe is uncertain, but it appears to have been since 1884.

The Colorado Douglas fir is much hardier than the Oregon species, being rarely injured by frost in this country. It has no value for forestry purposes, however, its lack of vigour and slowness of growth making it useless as a timber-producer. As a decorative garden tree it is of value.

A curious fact connected with this species is its comparative immunity from attack in this country by the Douglas fir chermes (*Chermes cooleyi*), for although insects may be found on the tree the attack is never severe.

Photo lent by R. N. Chrystal, Esq.

PLATE XXV. DOUGLAS FIR (*PSEUDOTSUGA DOUGLASII*) AND WESTERN CEDAR (*THUYA PLICATA*), VICTORIA PARK, VANCOUVER.

Pseudotsuga japonica, Beissner. (Fig. 104.)

JAPANESE DOUGLAS FIR.

A tree attaining in Japan a height of 70–100 ft. with a girth of 6–15 ft. or more, the trunk clear of branches for about two-thirds the height of the tree. *Bark* dull reddish brown, becoming greyish on very old trees, fissured into narrow plates. *Winter buds* very conspicuous, spindle-shaped as in other species, with shining brown, non-resinous scales. *Young shoots* without down, grey, becoming darker with age. *Leaves* pale green, pectinate, straight or slightly curved, about 1 in. long, notched at the apex, upper surface grooved from base to apex, lower surface with two broad white bands of stomata. *Cones* the smallest of the genus, ovoid, 1½–1¾ in. long, 1 in. in diameter, brown with glaucous patches when young, chocolate-brown at maturity; *scales* 15–20, woody, about ¾ in. long, slightly concave, margin minutely toothed or entire; bracts short, with the three-lobed terminal portion strongly reflexed over the scale below, the central awn-like lobe narrower and longer than the short, blunt, lateral lobes. *Seed* ⅜ in. long, shining dark brown above, pale mottled brown beneath; wing short, broad, dark brown.

Distinguished from other species by its hairless shoots and small cones.

P. japonica is a native of S.E. Japan, where it is a rare and local tree restricted to a few localities in the provinces of Tosa, Kii, and Yamato. It grows in mixed forests between 1,000–3,000 ft. elevation.

It was introduced in 1910 by Mr. H. Clinton-Baker, on whose estate at Bayfordbury there are thriving young trees, the largest being now (1923) 11 ft. high and bearing cones. It is growing under similar conditions to the common Douglas fir.

Wilson states [1] that the tree is too rare to be of any commercial importance.

Pseudotsuga macrocarpa, Mayr. (Fig. 105.)

LARGE-CONED DOUGLAS FIR.

A tree attaining a height of 70–80 ft. with a trunk 3–4 ft. in diameter in California. *Bark* deep, reddish brown, deeply divided into broad, rounded ridges and thick closely pressed scales. *Young shoots* reddish brown in the first year, ultimately greyish, without down or slightly hairy, shallowly ridged. *Leaves* pectinate, pale green in colour, 1–1¼ in. long, usually tapering to a horny point, the upper surface indistinctly furrowed, the lower surface with two white stomatic bands. *Cones* the largest of the genus, 3½–7 in. long, 2–2½ in. wide, with numerous scales; bracts

[1] *Conifers of Japan,* 53 (1916)

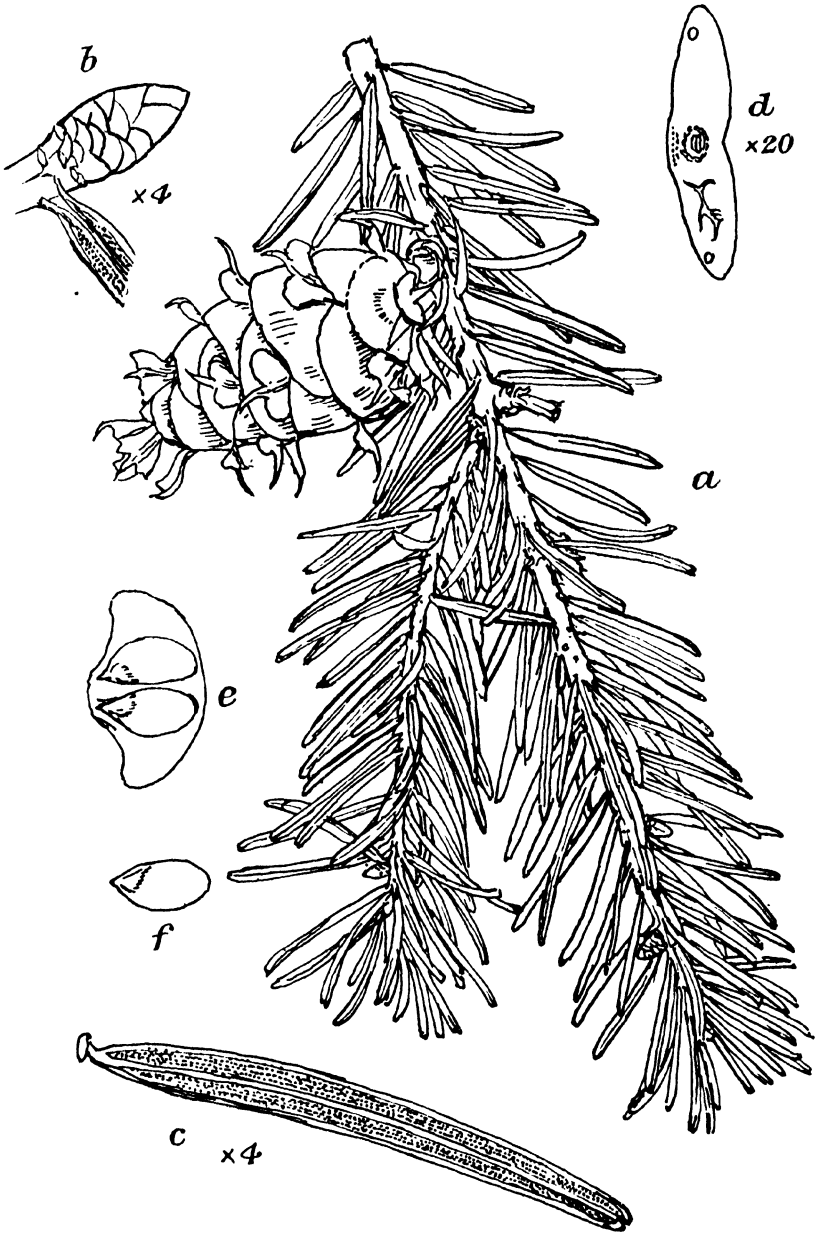

FIG. 104.—*PSEUDOTSUGA JAPONICA.*

a, spray with cone; *b*, winter bud; *c*, under-surface of leaf; *d*, section of leaf, showing two resin canals and an ideoblast; *e*, cone-scale with two seeds; *f*, seed.

slightly protruding, straight, not reflexed, with a short terminal awn and two sharp-pointed lateral lobes. *Seed* ½ in. long, dark

brown and shining above, whitish, mottled with brown beneath, wing broad and rounded.

Distinguished from all other species by its large cones.

This tree occurs wild on steep, rocky slopes in the mountains of S. California, forming open groves or associated with other species. It extends from the Santa Inez Mountains to the southern

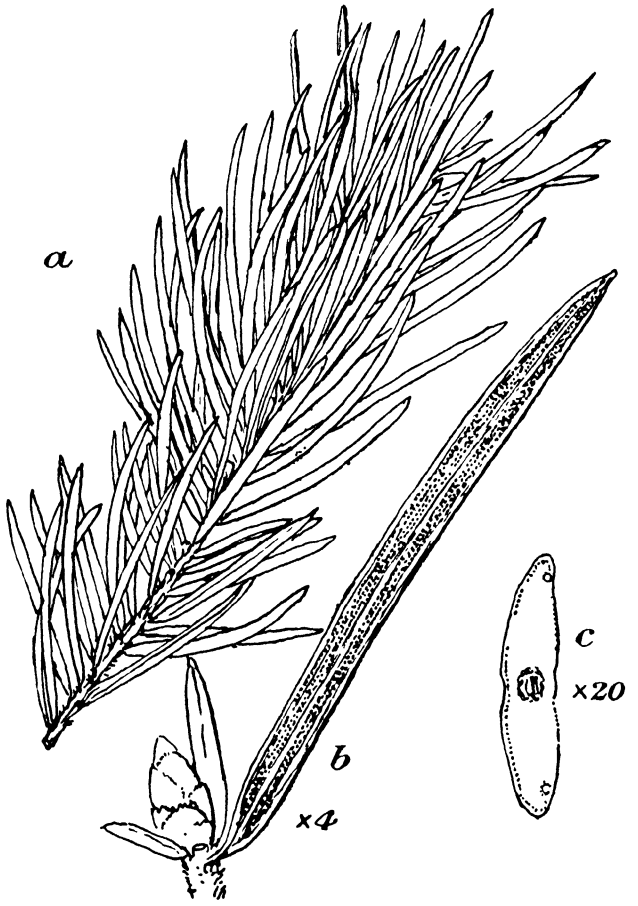

FIG. 105.—*PSEUDOTSUGA MACROCARPA*.
a, branchlet; *b*, winter bud and under-surface of leaf; *c*, section of leaf.

border of California, and is also found in Lower California.

P. macrocarpa was introduced into cultivation by Mr. H. Clinton-Baker, who raised seedlings at Bayfordbury in 1910, one of them being now (1922) 5 ft. high. This species is susceptible to injury by spring frosts, and appears to be unsuitable for general cultivation. Its economic importance is purely local, the timber being used for similar purposes to that of the Oregon Douglas fir.

Pseudotsuga sinensis, Dode.[1]

CHINESE DOUGLAS FIR.

A large tree in W. China. *Young shoots* reddish brown at first, becoming grey with age, covered with minute hairs. *Buds* non-resinous. *Leaves* pectinate in arrangement, 1–1½ in. long, notched at the apex; upper surface furrowed from base to apex, lower surface with a raised midrib and two narrow white bands of stomata. *Cones* about 2 in. long and 1¼ in. wide, consisting of about 20 large, thick, woody scales with short, reflexed bracts, the exposed portion of the scale much wider than in *P. Forrestii*; bracts shorter than the scales, reflexed near the apex with a long central awn and two short lateral lobes. *Seed* ⅓–1 in. long, including the wing.

A rare species found by Père Maire on a limestone formation at 8,500 ft. elevation at Che-hai and Tung-chuen.

We have seen no specimens, but seedlings were raised by M. Chenault at Orleans in 1912, and one of these plants, sent to Leonardslee, Sussex, was 2½ ft. high in 1918.

Pseudotsuga Wilsoniana, Hayata.

FORMOSAN DOUGLAS FIR.

A little-known species recorded only from Mount Morrison, Formosa, at 9,000 ft. altitude. We have not seen specimens, but from the available descriptions it is evidently closely allied to *P. sinensis*, from which it chiefly differs in its shorter leaves. It is not in cultivation.

Icon. Plant. Formosa, v, 204, t. 15 (1915).

SCIADOPITYS, Siebold and Zuccarini.

A monotypic genus of *Pinaceæ*, easily distinguished by its united pairs of glossy-green leaves or cladodes, which are arranged in definite whorls, like the ribs of an umbrella.

Sciadopitys verticillata, Siebold and Zuccarini. (Fig. 106.)

UMBRELLA PINE.

Taxus verticillata, Thunberg; Pinus verticillata, Siebold. Parasol Pine; Koya-maki.

An evergreen tree 70–120 ft. high, with a trunk 3–10 ft. in girth, in Japan, of pyramidal habit when young, with short horizontal branches. *Bark* thin, grey or greyish brown, reddish brown beneath, exfoliating in long strips. *Young shoots* at first green, later brown, without hairs, bearing small, closely pressed, persistent, scale-like leaves. *Leaves* of two kinds: (1)

[1] *Bull. Soc. Dendr.* France, 1912, p. 58. See also Craib, *Notes Roy. Bot. Gard. Edinburgh*, xi, t. 161 (1919).

FIG. 106.—*SCIADOPITYS VERTICILLATA.*

a, shoot with whorls of scale leaves, and of needle leaves united in pairs; *b*, branchlet with male cones; *c*, female cone; *d*, section of leaf, showing eight resin canals and an ideoblast; *e*, cone-scale with ovules; *f*, seed.

small, scale-like, triangular, $\frac{1}{8}$–$\frac{1}{4}$ in. long, the base green, the tip blunt, membranous, and reddish brown, becoming wholly brown before the second year; (2) leaf-like shoots or cladodes which perform the functions of leaves.[1] These are arranged in whorls of 10–30, surrounded by a ring of scale-leaves. They are 2–5 in. long, $\frac{1}{16}$–$\frac{1}{8}$ in. wide, linear, rigid, dark green and glossy above, paler beneath, grooved on both surfaces, the margins thickened, the apex slightly notched, stomata on the lower surface. *Male and female flowers* borne on the same tree; the former in compact, terminal clusters, each flower $\frac{1}{4}$–$\frac{3}{8}$ in. long. *Female flowers* in terminal cones with conspicuous, lance-shaped, membranous bracts attached to small scales. *Cones* oblong ovoid, on short stalks, $2\frac{1}{2}$–4 in. long, $1\frac{1}{2}$–2 in. wide, ripening during the second year; *scales* woody, soon outgrowing the bracts, broadly wedge-shaped or fan-shaped, $\frac{1}{2}$–$\frac{3}{4}$ in. across, green when growing, brown at maturity, upper margin rounded, recurved and thin, surfaces furrowed, the outer convex, the inner concave, the inner surface and the concealed part of the outer surface covered with fine down which is most prominent on mature scales. *Seeds* 5–9 on each fertile scale, oblong or elliptical, $\frac{1}{3}$–$\frac{1}{2}$ in. long and $\frac{2}{5}$ in. wide, including the surrounding, narrow, membranous wing.

Two distinct forms are in cultivation, one usually producing a single erect trunk, the other of slower growth, dividing into a number of stems near the ground.

Var. **pendula**, Bean.

Branches pendulous.

Var. **variegata.**

Some of the "leaves" are yellow.

Sciadopitys is restricted in a wild state to the valley of the Kiso-gawa in central, and to Koya-san and its immediate neighbourhood in east central Hondo, the best trees being found in steep, rocky, sheltered situations. Wilson[2] says that it is common and sometimes forms pure forests in the provinces of Mino and Shinano between 1,800–3,300 ft. altitude.

The umbrella pine was discovered by Thunberg in 1775–76, and it was early introduced to Java by the Dutch. In 1835 Thomas Lobb obtained a plant for Messrs. Veitch from the Buitenzorg Botanic Garden, but it soon died. Seeds were, however, sent to England by both Veitch and Fortune in 1861.

Wood nearly white when freshly cut, darkening on exposure,

[1] The nature of these structures, which are peculiar to the genus, has given rise to much discussion. One group of botanists regards them as cladodes and another group as double leaves or needles. Instances of shoots arising from them have been recorded.

[2] *Conifers and Taxads of Japan*, 64, 65 (1916).

the heartwood becoming brownish yellow, the sapwood yellow. In general appearance it resembles clean pine, known commercially as "mild pine," being slow-grown, straight-grained, easily worked, and strong. Resin ducts are not found in normal wood, the medullary rays are regular and fine. The timber is a regular article of commerce in the province of Mino, Japan, and is floated in rafts down the Kisogawa to Osaka, where it is usually consumed.[1] It is durable, stands water well, and is used for boats, bath-tubs, etc.

The fibrous bark is made into oakum, and used for caulking boats, packing joints of steam pipes, etc. A sample of oakum is exhibited in Museum iii, at Kew.

The umbrella pine, on account of its unique and interesting character, is a valuable tree for collections, but has no value for silviculture in Britain. It is of extremely slow growth, and even in Japan seedlings raised in nurseries are not ready to plant out under 5 or 6 years of age. There is a great tendency for the tree to form several leaders, both in its native country and under cultivation. It does best in sweet, open, and good soil containing little or no lime. Moist medium loam, to which a little peat or leaf mould has been added, suits it well. It is easily raised from seeds which are regularly matured in this country.

Botanical Magazine, t. 8050 (1905).
Masters, *Journ. Linn. Soc.* (Bot.) xxvii, 276 & 320 (1890) and xxx, 21 (1893).

SEQUOIA, Endlicher.

Mammoth Trees.

Evergreen trees attaining gigantic proportions in California, pyramidal in habit when young, with horizontal or slightly drooping branches; the branches of old trees spreading, with a downward tendency. Old trees strongly buttressed. *Bark* of two kinds, the outer thick, spongy, and fibrous, the inner thin, close, and firm. *Young shoots* green, afterwards brown, without down; lateral branchlets slender and deciduous. *Winter buds* small, in one species hidden by the loose, scale-like, terminal leaves. *Leaves* of three kinds: (A) linear or lance-shaped; (B) awl-like; (C) short and oblong; spirally arranged, but in (A) pectinate by reason of a basal twist. *Male* and *female flowers* on the same tree, the buds formed near the points of the shoots in autumn, opening in spring. *Male* flowers in small, dense catkins. *Cones* pendulous, with woody scales, persistent after shedding the seed; bracts adhering to the scales. *Seeds* small, surrounded by a narrow membranous wing, 5–7 beneath each scale.

Wood dull and odourless normally without resin-ducts, the sapwood white, the heartwood red. The timber is light, not

[1] Sarg. *For. Fl. of Japan*, 77 (1894).

strong, but durable in contact with the soil or when exposed to the weather; is easily worked and polishes well.

Sequoia belongs to the Taxodineæ group of *Pinaceæ*, and consists of two species which differ from *Taxodium* in their evergreen leaves, persistent cone-scales, small, thin-coated, winged seeds and highly coloured wood. The name *Sequoia* was probably founded in honour of the distinguished Sequoyar tribe of Cherokee Indians. Although only two living species are known, numerous fossil remains of *Sequoia* have been found, indicating that the genus is of very ancient origin. About 40 fossil species have been described.

Sequoia gigantea, Decaisne. (Fig. 107.)

BIG WOOD.

Sequoia Wellingtonia, Seemann; S. Washingtonia, Sudworth; Taxodium Washingtonianum, Winslow; Washingtonia californica, Winslow; Wellingtonia gigantea, Lindley.

Mammoth Tree; Wellingtonia.

A giant tree 150–320 ft. high, with a tapering trunk sometimes 90 ft. in girth above the buttressed base, clear of branches for half or more than half of its height, with a dense, rounded crown much broken in aged trees. Young trees are of conical outline. *Bark* ½–2 ft. thick, deeply furrowed, fibrous, bright brown. *Branches* drooping suddenly at the trunk. *Young shoots* without down, green by reason of attached leaf-bases, becoming brown. *Winter buds* minute without scales, hidden by late leaves. *Leaves* persisting about 4 years, crowded, spirally arranged, lance-shaped, the flat base adhering to the branch, the free tip ⅛–$\frac{3}{16}$ in. long, sharp-pointed, stomata on both surfaces. *Male flowers* in short, terminal catkins, ¼–⅓ in. long, arising at the points of the shoots. *Cones* terminal, solitary, ovoid, 2–3 in. long, 1–1½ in. wide, reddish brown, maturing the second autumn, persisting after the fall of the seeds; *scales*, 35–40 in number, apex woody, four-sided, ¾–1 in. across with a central depression. *Seeds* numerous, flat, thin, oblong, margined by a narrow membranous wing.

There are several garden varieties, of which the most important are:—

Var. **argentea.**

Shoots and leaves silver-variegated.

Var. **aurea**, Nichols.

Shoots yellow.

Var. **glauca**, Otto.

Leaves glaucous.

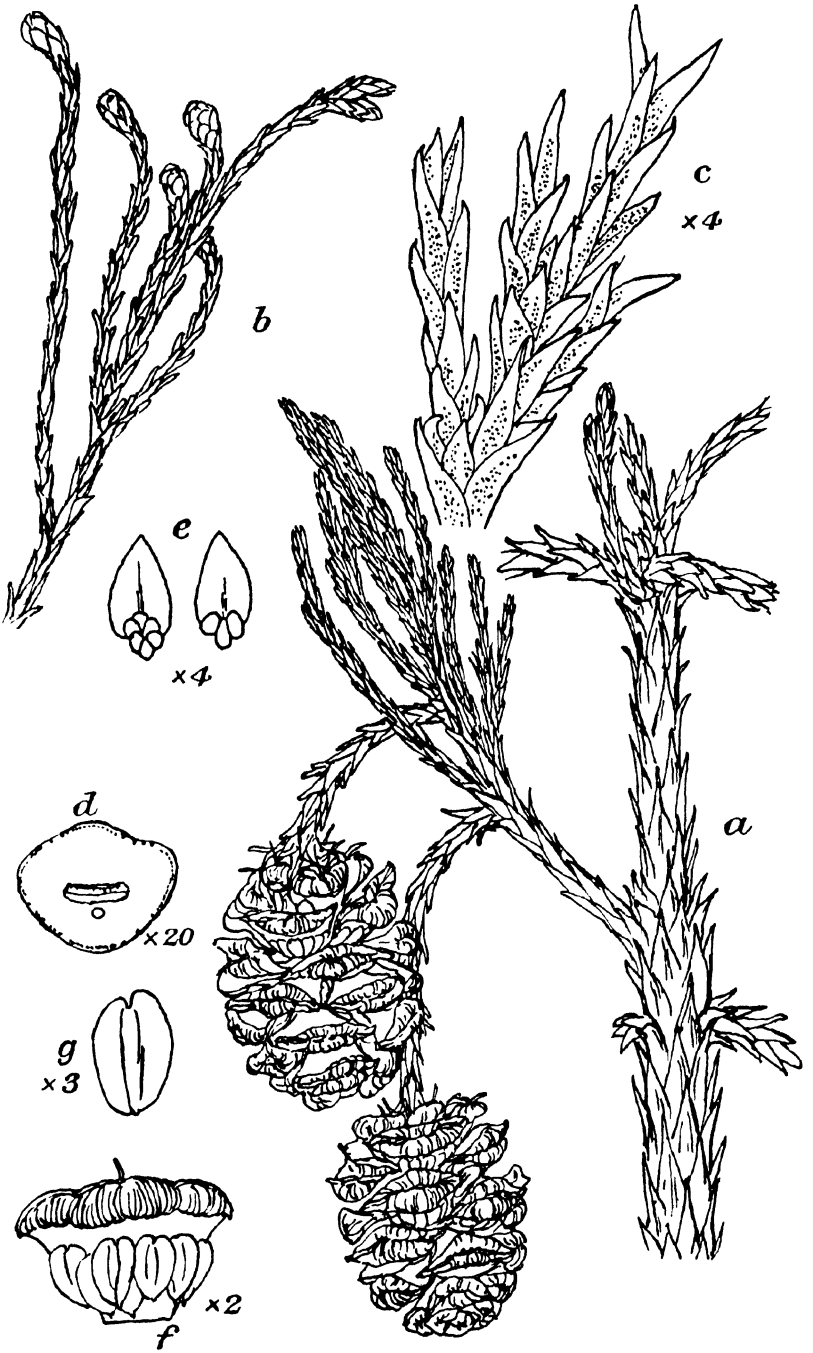

FIG. 107.—*SEQUOIA GIGANTEA.*

a, spray with two female cones; *b*, spray with male cones; *c*, branchlets; *d*, section of leaf; *e*, stamens; *f*, cone-scale with seven seeds; *g*, seed.

Var. **pendula**, Lav.

Main branches hanging almost parallel with the trunk.

Var. **pygmæa**.

Of dwarf, bushy habit.

S. gigantea is distinguished from *S. sempervirens* by the different shape and arrangement of its leaves and by its larger cones.

It inhabits the western slope of the Sierra Nevada from Placer County to Tulare County, in an interrupted belt of about 250 miles, at altitudes of 4,300–8,000 ft., separated by other conifers. It is restricted to groves of limited extent, the most famous of these being the much-visited Calaveras grove, situated near the northernmost limit of the species, where the mammoth tree was discovered by John Bidwell in 1841. This grove contains about 100 trees. It is here that most of the largest specimens are found, and several of them bear the names of distinguished men. Photographs of a number of these famous trees are to be seen in Museum iii, at Kew. One fallen tree in this grove which has been hollowed out by fire is so huge that a mounted horseman may ride through it.

Many fanciful and erroneous speculations have been made as to the age of this species. Jepson, who has made a special study of Californian trees, considers the average age of adult trees to be from 400–1,500 years. Sudworth, who has also paid the trees of this region a great deal of attention, says that it is safe to assert that some of the largest trees are at least 4,000 years old. A section of timber exhibited at Kew shows 1,335 annual rings. *S. gigantea* has been described as the grandest of all trees in the American forest, and the oldest living thing in the world.

The wood is light, straight-grained, soft, more brittle than redwood and rather more difficult to work; heartwood red, sapwood white. The timber is very durable in contact with the soil, and fallen logs have remained sound in the forest for centuries. It is used for posts, farm buildings, shingles, vine stakes, and other purposes, but is not in general use owing to the limited number of trees available. Timber is produced quickly in Britain, but that from ornamental trees is very soft.

The best trees in California are found on moist land where the annual rainfall is 45–60 inches. Jepson states that in this region snow lies on the ground to a depth of 2–10 ft. for 3–6 months of the year, and that the temperature often falls below zero. The thick bark prevents serious injury by forest fires. When the seeds fall upon a suitable seed-bed germination is good, but the deep layer of fallen leaves and branches beneath the trees usually prevents germination in the immediate neighbourhood of the parent trees. It has been planted widely in Britain as an orna-

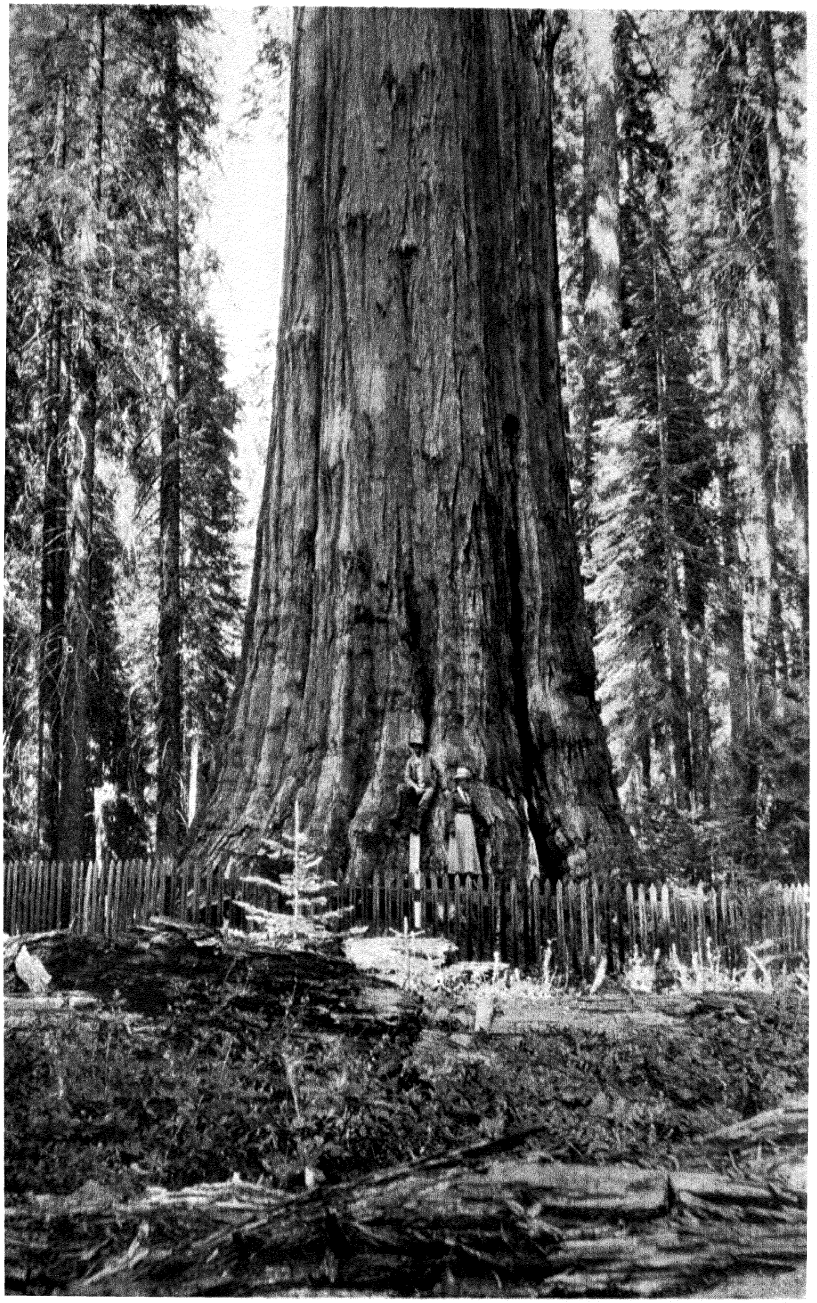

Photo by F. R. S. Balfour, Esq.

PLATE XXVI. WELLINGTONIA (*SEQUOIA GIGANTEA*) ABOVE KAWEAH RIVER VALLEY, SIERRA NEVADA, CALIFORNIA.

mental tree and for avenues, and there are numerous fine specimens in the moister parts of the country from Cornwall to the Highlands of Scotland, which exceed 100 ft. in height. One of the finest avenues is at Strathfieldsaye, the seat of the Duke of Wellington. A few trees, planted many years ago in a wood, on the Long Ashton estate of Lady Smythe, near Bristol, look very promising, the trunks being clean and of good development. The best results are obtained in this country by planting the tree in good moist soil, in sheltered valleys, where there is a fairly heavy rainfall. Seeds are frequently ripened.

For a full account of the Big Trees of California, see Jepson, *Silva of California*, 139–141, and Sudworth, *Bulletin* 28, U.S. Dept. of Agriculture (1900).
Bot. Mag. tt. 4777, 4778 (1854) (as *Wellingtonia gigantea*).

Sequoia sempervirens, Endlicher.

CALIFORNIAN REDWOOD. (Fig. 108.)

Schubertia sempervirens, Spach ; Taxodium sempervirens, Lambert.

A tree 130–340 ft.[1] high and 8–25 ft. in diameter, often clear of branches for $\frac{1}{3}$–$\frac{1}{2}$ of its height. *Young trees* pyramidal, old trees with a narrow head. *Base* of *trunk* strongly but irregularly buttressed, the taper above the buttresses gradual. *Bark* fibrous, spongy, 3–12 in. thick, reddish brown, deeply furrowed, inner bark thin. *Branches* drooping, lateral branchlets deciduous. *Young shoots* without down, greenish at first, brown later. *Winter buds* small, solitary, surrounded by loose scales which turn brown and remain at the base of the young shoot for at least a year. *Leaves* of two kinds, spirally arranged : (A) on lateral branchlets appearing pectinate by reason of a basal twist, linear or lance-shaped, $\frac{1}{4}$–$\frac{3}{4}$ in. long, about $\frac{1}{16}$ in. wide, shortly pointed, upper surface dark green, slightly furrowed, under-side with a whitish band of stomata on each side of the midrib ; (B) on leading and cone-bearing shoots arranged in several ranks, short, spreading, up to $\frac{1}{4}$ in. long, oblong, with an incurved horny point ; upper surface green with irregular lines of stomata ; lower surface as in (A). *Male flowers* small, arising at the points of the shoots. *Female flowers* with 14–20 ovate bracts tipped with short points. *Cones* oval or elliptical, reddish brown, $\frac{3}{4}$–$1\frac{1}{2}$ in. long, $\frac{1}{2}$–$\frac{7}{8}$ in. wide ; *scales* with a woody apex about $\frac{1}{3}$ in. across, narrowing into a slender stalk. *Seeds* light brown, $\frac{1}{16}$ in. long, wings much narrower than in *S. gigantea*, ripening at the end of the first season.

Var. **adpressa**, Carrière.

Tips of shoots creamy white. (B) type of leaf prevails. Common in cultivation.

[1] A redwood accurately measured by Prof. Sargent as 340 ft. high is said to be the tallest tree in the world.

Var. **appressa.**

Compact in growth and foliage. Not well known.

FIG. 108.—*SEQUOIA SEMPERVIRENS.*

a, spray with female cone; *b*, under-side of branchlet with male cone; *c*, section of leaf, showing three resin canals; *d*, male cone; *e*, stamens; *f*, female cone; *g*, seeds.

Var. **gracilis.**

Branchlets slender. Not well known.

Var. **glauca**, R. Smith.

Leaves ¼ in. long, glaucous.

Var. **pendula.**

Branches pendulous.

Var. **taxifolia.**

Leaves broader than in the type.

S. sempervirens is distinguished from *S. gigantea* by the pectinate leaf arrangement on the lateral branches, and by the distinct winter buds.

The redwood gives its name to a belt of humid coast territory about 450 miles long and 20 miles wide, extending from the S.W. corner of Oregon to Monterey County in S. California, where it is the dominant tree amongst other conifers. In Oregon it is known in two isolated groves only. Its greatest development is attained at its northernmost limit in Humbolt and Del Norte counties, especially on the moist bottom lands of Smith River and the Main Eel. There the forests are most impressive, the trees being of enormous size and in very dense stands.

The redwood was discovered by Archibald Menzies in 1795, but Hartweg appears to have sent the first seeds to England about 1846. It had, however, been introduced to Europe some three years earlier.

The wood has well-marked resin-ducts; the heartwood is red and the sapwood yellowish white. It is soft, fine-grained, easy to work (or in some localities it may be coarse-grained and gritty), is obtainable in long lengths up to 6 ft. or more wide, free from defects. It lasts well when exposed to weather or soil, and has many uses, including general building and carpentry work, boxes, furniture, panelling, railway sleepers, telephone poles, street paving, pipe-lines, piles, shingles, and fence-posts. Curly redwood and burry redwood are obtained from the bases of trees, and from burrs on the trunk respectively. Such wood is finely figured and is used in a polished state for cabinets, furniture, and panelling. The commercial importance of Californian redwood can be estimated by statistics collected from United States Forest Service literature and other sources by Nelson Courtlandt Brown.[1] Thus in 1909 one hundred billion board feet were available for cutting. Three years later 2,439,000 board ft. were used for boxes. The cut in 1916 was 490,850,000 board ft. In 1915 563,685 railway sleepers were made from the wood, the life of unpreserved sleepers being 8–14 years, or fifth in a test of 26 species. In a pole test it was found to be one of the three best timbers of twelve tried. Redwood shingles last 12–25 years against 15–25 years for chestnut. For fence posts redwood is one of the most popular of Californian woods; posts extracted after being in the ground 35–40 years were found to

[1] *Forest Prods.: their Manuf. and Use* (1919).

be quite sound. Timber produced by ornamental trees in the British Isles is soft and too quickly grown to be of good quality. Wood from forest-grown trees would probably be serviceable for many purposes. As firewood its fuel value is low. There is a large export trade from California to Europe, China, Japan, and other countries.

S. sempervirens lives to a great age, many trees ranging between 400–800 years with a sprinkling of older trees. It grows on rocky slopes where there is little soil, and in moist valleys with a considerable alluvial deposit. In the drier parts it is mixed with other species, but in moist situations it forms pure forests. The best trees are found in places where there is considerable soil and atmospheric moisture, particularly where dense mists prevail, even though the soil may not be rich. It is one of the few conifers that reproduce themselves by sprouts from the bases of felled trees, and cleared areas are partly or wholly restocked by this means. Seeds are borne freely, but the fertility percentage is low, and as seedlings are intolerant of shade, they only succeed where there is plenty of light, and where there is a favourable seed-bed. Owing to the thick, fibrous outer bark, trees are rarely killed by forest fires, although branches may be burned away. After the branches have been killed a dense growth of short shoots may appear from the trunk, making the tree a column of greenery. The same thing may happen to forest-grown trees that have been isolated. The redwood thrives in many parts of Britain, the best trees being found in moist valleys where there is a generous deposit of soil. Specimens over 100 ft. high are to be found from Cornwall to Inverness-shire, their height being limited through lack of shelter. Propagation is usually effected by seeds, although erect shoots from the base of a tree may be rooted. The species is not troubled by insect pests in England, but in California it has several insect and fungus enemies.

Jepson, *Silva of California*, 128 (1910); *The Redwood*, U.S. Dept. of Agric. Bureau of Forestry Bulletin, No. 38; Sudworth, *Trees of the Pacific Slope*, 145 (1908).

TAIWANIA

Taiwania cryptomerioides, Hayata.[1]

This remarkable conifer resembles *Cryptomeria* in habit, and appears to be closely allied to *Cunninghamia* in the structure of the cone. It chiefly differs from that genus, however, in having 2 ovules instead of 3 to each fertile scale.

An evergreen tree of conical form nearly 200 ft. high and 20 ft. or more in girth in Formosa. *Trunk* bare of branches for about 60 ft. from the ground, with a spreading head and dense foliage. *Adult leaves* about ½ in. long, thick, leathery, triangular,

[1] *Journ. Linn. Soc.* xxxvii, 330, pl. 16 (1906).

incurved at the shortly pointed apex, keeled above and below, overlapping, pressed to the branchlets for about half their length ; bands of stomata on all four surfaces ; leaves of young trees narrowly linear, sickle-shaped, compressed, keeled above and below. *Cones* shortly cylindric, ½ in. long, with numerous, overlapping, rounded, mucronate scales, each with a minute bract at the base. *Seeds* two on each scale, oblong, broadly winged.

Discovered on the western slope of Mount Morrison, Formosa, at 6,000–8,000 ft. elevation, by Konishi in 1904, and introduced to Kew in 1920, where there are small plants in the Temperate House.

TAXODIUM.

Taxodium distichum, Richards. (Fig. 109.)

DECIDUOUS CYPRESS.

Bald Cypress ; Black Cypress ; Gulf Cypress ; Louisiana Cypress ; Marsh Cypress ; Red Cypress ; Southern Cypress ; Swamp Cypress ; White Cypress.

A deciduous or, in one variety, a semi-evergreen tree 100–150 ft. high, and 4–6 ft. in trunk diameter, of pyramidal habit when young, but developing a wide and often flattened crown when old. When growing on well-drained land the trunk usually tapers from base to summit, but when in marshy ground or surrounded by water the base becomes conspicuously buttressed or enlarged, and is usually hollow internally. In wet and swampy places, woody, cylindrical, or oval protuberances, known as "cypress knees," often arise from the roots ; these projections are sometimes several feet high, more than a foot in diameter, and hollow. *Bark* of old trees reddish-brown, fibrous, ridged, peeling off in long strips. On the young wood the bark is at first green or glaucous green, afterwards bright brown and roughened by circular scars left by the fall of deciduous branchlets. *Branchlets* at the points of shoots persistent, lateral branchlets falling with the leaves in autumn. *Buds* near the tip of the shoot rounded, with overlapping, sharp-pointed scales. Smaller lateral buds are also present, and from them leafy, budless branches arise which fall in autumn. *Leaves* spirally arranged on the branchlets, but on the deciduous shoots appearing in two ranks owing to a twist near the base, narrow, short pointed, ⅓–¾ in. long where they appear in two ranks, shorter and scale-like on the persistent branches, delicate green in spring, yellowish green in summer, rich brown in autumn, with greyish stomata on the under-surface. *Male and female flowers* appearing on the same tree in spring, the former in slender, purplish, tassel-like clusters, 3–6 in. (rarely

9–11 in.) long, at the end of the preceding year's shoots. *Male flowers* stalked, consisting of 6–8 stamens and surrounded at the base by ovate scales. *Female flowers* scattered, near the ends of the branchlets of the preceding year, solitary or several together,

FIG. 109.—*TAXODIUM DISTICHUM.*

a, spray; *b*, foliage; *c*, section of leaf; *d*, spray with male flowers; *e*, male flower; *f*, stamen with three pollen sacs; *g*, female cone; *h*, two seeds, dorsal view; *i*, seed; *k*, transverse section of seed; *l*, shoot of var. *pendulum*.

consisting of numerous overlapping pointed bracts adhering below to the fleshy scales, each of which bears two ovules. *Cones* globular or slightly obovate, resinous, ½–1¼ in. in diameter,

purplish, on stalks about $\frac{1}{8}$ in. long; *scales* few, four-sided, narrowing abruptly to a long, slender stipe, breaking away irregularly as soon as ripe. *Seeds* irregularly triangular, with thick, horny, warted coats.

Var. **pendulum,** Carrière. (Fig. 109.)

UPLAND CYPRESS.

Taxodium distichum, var. imbricarium, Sargent; Glyptostrobus pendulus, Endlicher.

Differs from the type in its smaller size, denser habit, stiffer, more erect main branches, and shorter, narrower, often scale-like leaves, which are closely pressed to the twigs except at the apex. It is usually found in drier situations than the type.

Var. **mucronatum.**

MEXICAN CYPRESS.

Taxodium mucronatum, Tenore.

Differs from the type in being deciduous, semi-evergreen, or evergreen, according to situation, in its relatively longer male inflorescences, and in the time of flowering, which is autumn. There appear, however, to be intermediate forms, and it has more claims to varietal separation from a geographical than from a botanical standpoint. It is more tender than the type, and should only be planted in the warmest parts of the British Isles.

T. distichum is closely allied to *Glyptostrobus heterophyllus*, but differs in the cones and seeds. The cones of *Glyptostrobus* have stalks $\frac{1}{2}$–$\frac{3}{4}$ in. long, are distinctly pear-shaped or obovate, and have smaller and thinner obovate scales. The seeds of *Glyptostrobus* also are oval or oblong, $\frac{3}{16}$–$\frac{1}{4}$ in. long, thin-coated, and terminated by a wing $\frac{1}{8}$ in. long.

The deciduous cypress, which is one of our most beautiful conifers, is widely distributed in wet ground from Florida, through the Gulf States, to Mexico, where it is represented by the var. *mucronatum*. It extends northwards along the Mississippi Valley to Missouri and Indiana. In some regions it forms dense, practically pure stands, elsewhere it is mixed with Nyssas and other trees. The species was introduced by John Tradescant about 1640, and was described by Parkinson in his *Theatrum Botanicum*, p. 1477.

Wood soft, weak, straight-grained, easily worked, not subject to serious shrinkage, and has a characteristic sour odour. The sapwood is white or yellowish white, and the heartwood varies from red to almost black. It is comparatively free from flavouring matter, is not liable to insect attacks, and is very durable in wet places. For greenhouse construction, vats, cooperage, water-tanks, water-pipes, general carpentry, furniture, fencing, ventila-

tors, and other purposes where a soft, non-shrinking wood is required, it will be found suitable. Lumbermen recognize three kinds of timber—black, red, and white cypress. Black wood is most durable. Deciduous cypress wood is obtainable in large quantities from ports on the Gulf of Mexico. *A resin* obtained from the cones is said to be used as a healing application to wounds.

T. distichum thrives in moist, loamy soil throughout the midland and southern counties of England and Ireland. Trees over 100 ft. high are known to exist in several gardens, notably at Syon House, Brentford, where, in a low-lying position on the bank of a lake the knee-like growths from the roots (peculiar to the species) are very prominent. At Kew a tree has been growing in a pond for many years. The deciduous cypress should be propagated by seeds, which, if not quite fresh, should be soaked in warm water before sowing. Young plants are rather tender, and it is wise to protect them from frost for one or two years, otherwise the points of the branches may be killed. Although only grown as an ornamental tree in Britain it is probable that it would prove successful as a forest tree in the south and west of England, particularly in marshy ground.

TETRACLINIS, Masters.

A monotypic genus allied to *Callitris* and *Widdringtonia*, differing from both by the flattened Thuya-like divisions of the branchlets and by the four-ranked leaves. From *Callitris* it also differs by the cones being composed of 4 instead of 6 or 8 scales.

Tetraclinis articulata, Masters.

ALERCE.

Callitris quadrivalvis, Vent.; Frenela Fontanesii, Mirbel; Thuya articulata, Vahl. Thuya; Cedar.

An evergreen tree of pyramidal habit, 40–50 ft. high, with a trunk 2–4 ft. in girth. *Branches* erect, compact, branchlets divided into flat, jointed spray. *Leaves* in fours, the lateral larger than and partly covering the facial, the bases long and attached to the shoot as in *Callitris*, the free tips scale-like and pointed. *Cones* terminal, solitary, rounded, ⅓–½ in. in diameter; *scales* 4, thick, woody, glaucous, triangular, two blunt and two pointed at the apex, deeply grooved on the outside, with a small spiny process near the apex. *Seeds* oval, with two broad wings which widen above the seed.

Native of Algeria, Morocco, Mogador, and Malta, where it occupies positions subject to considerable periods of drought.

Wood fragrant, brown, reddish or yellowish in colour, short-grained, hard, and often beautifully marked as in "bird's-eye maple." It has been popular for cabinets and furniture for

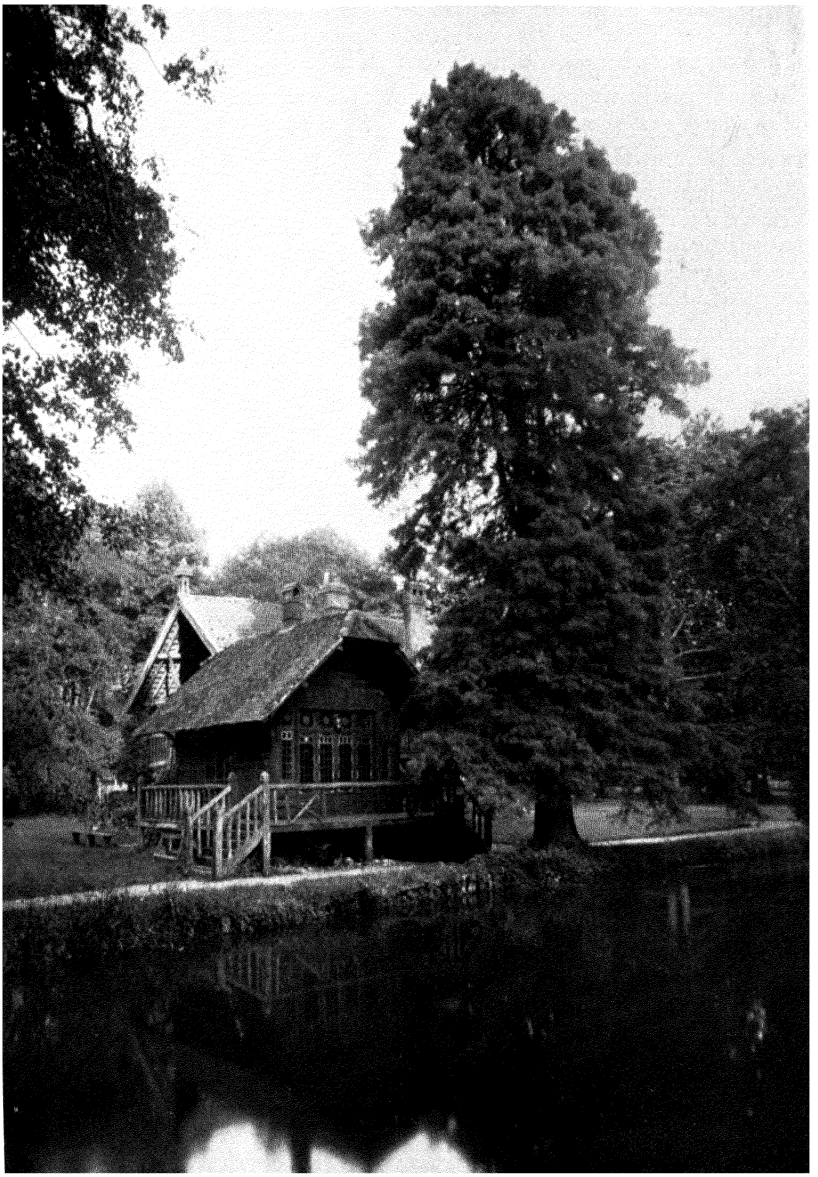

Photo from negative lent by Dr. A. H. Hill.

PLATE XXVII. Deciduous Cypress (*Taxodium distichum*), River Colne, Cassiobury Park, Watford.

many centuries, and is reputed to be the " citrus wood " of the ancient Romans, who esteemed it above all others for roofing temples, and for tables and cabinets. It is still in demand for fancy cabinet-work, and various articles manufactured from the wood are to be seen in the Museums at Kew. A hard resin known as " Sandarac " exudes from the trunks and large quantities are exported annually from N. Africa, mostly to Britain, where it is used for varnish-making. For centuries it has been one of the stock resins for pale spirit varnishes.

T. articulata is a useful tree for hot and dry countries, and steps are being taken by the French Forest Service to extend its sphere of usefulness in their N. African colonies. It is doubtfully hardy even in the milder parts of Britain.

THUYA, Linnæus.

ARBOR-VITÆ.

Biota, Endlicher ; Thujopsis, Siebold ; Thuja.

Evergreen trees and shrubs belonging to the tribe Cupressineæ. Seven species, natives of China, Japan, Formosa, and N. America, are known. They form trees of shapely pyramidal outline. *Bark* thin, fissured on old trees, outer bark scaling in patches of irregular shape ; inner bark fibrous. *Branches* horizontal or ascending. *Branchlets* slender, tough, flexible, divided near the apex into fine spray, smaller branchlets deciduous with the leaves after several seasons. *Buds* hidden by leaves. *Leaves* small, scale-like, overlapping, in 4 ranks of 2 opposite sets, the upper and lower ranks flattened or grooved, the side ranks rounded or keeled ; those on the main axis dying and remaining in position for several years afterwards, those on lateral branchlets smaller and falling with the shoots. *Leaves* of seedling plants and of some varieties needle-like and spirally arranged. *Male and female flowers* on different branchlets of the same tree, opening in March and April. *Male flowers* reddish, cylindrical or globular, from branchlets near the base of the shoot, composed of 3–6 pairs of stamens. *Female flowers* cone-like, arising from short terminal branchlets, very small, green or purple-tinged, composed of a few opposite pairs of leaf-like scales. *Cones* solitary, $\frac{1}{3}$–$\frac{2}{3}$ in. long, made up of 3–10 pairs of scales, which are in most species thin and flexible. *Seeds* small, winged or wingless, 2–3 or 5 on each fertile scale, usually 2–3 pairs fertile.

The species are divided into three sections :—

1. EUTHUYA.—*Branches* horizontal, branchlets flat, more or less in the same plane. *Cones* conical, with thin, tapering scales, the points turning outwards when mature, green when young,

brown or yellow when ripe, the middle scales only fertile. *Seeds* small, thin, winged on each edge, 2–3 to each fertile scale. *T. japonica, T. koraiensis, T. occidentalis, T. plicata, T. sutchuenensis.*

2. THUJOPSIS.—Branches erect or horizontal, branchlets horizontal, flattened, stout. *Cones* rounded or globular, composed of 8–10 woody, wedge-like scales. *Seeds* 5 to each fertile scale, rounded, thin, winged on each edge. *T. dolabrata.*

3. BIOTA.—Branches and branchlets erect, arranged at right-angles to the trunk, the edges of the branchlets pointing outwards and towards the trunk. *Cone-scales* fleshy when young, woody when mature, each one bearing a strong recurved or rolled hook near the apex; the lower scales only fertile. *Seeds* thick, rounded, wingless, 2–3 to each fertile scale. *T. orientalis.*

Thuya resembles most closely the *Chamæcyparis* group of *Cupressus*, from which it principally differs in the shape of the cones and usually larger leaves. In *Cupressus* the cones are rounded and the scales are usually four-sided with a distinct boss in the centre of each.

Wood light in weight, soft, fragrant, easy to work, very durable, yellowish, yellowish brown, or reddish brown; autumn and spring wood well defined; the distinction between sapwood and heartwood usually clear; resin canals absent. rays very small and difficult to see with a lens. It is widely used for building purposes, telegraph and telephone poles, shingles, furniture, etc. As furniture wood it is said to be rarely harmed by insects, and when used for drawers it is reputed to keep away moths. The slender branches are sometimes woven into baskets and ropes; the bark, removed in large sheets, is used for roofing houses and sheds, whilst the fibrous inner bark has been employed for the manufacture of mats, baskets, cordage and fibre for stuffing upholstery, mattresses, etc.

The *Thuyas* are quite hardy and are easily grown in Britain. One species is sometimes planted under silvicultural conditions, but their more general use is for decorative garden work and for hedges. The best results are obtained by planting in moist but well-drained loamy soil, but they also thrive in light, sandy soil, provided it is moist, and in peat. The species are propagated by seeds and cuttings, the varieties by cuttings and grafts. Cuttings should be inserted in sandy soil in a close frame or under a handlight in July or August; grafting is practised indoors in spring; in most instances propagation by cuttings is preferable to grafting. Hedges should be cut in summer, a knife or secateurs being preferable to shears for the work.

Thuyas are sometimes attacked by scale insects. They may be cleansed by spraying them once every eight days over a period of six weeks, from the middle of April or early May, with a

paraffin wash made by dissolving 1 lb. of soft soap in two gallons of boiling water, adding two pints of paraffin, stirring well and making up to 16 gallons with clear water before use. Quite recently (in 1922) a bark beetle *Phlœosinus thujæ*, Perris, has been found upon *Thuya orientalis* and *Cupressus pisifera* at Kew. Although known to exist on the Continent, it had not previously been recorded in Britain. It is very dark brown or almost black in colour, about $1\frac{1}{2}$ in. long, and is related to the ash-bark beetle.

Key to Thuya.

I. Main axes of branchlet systems roundish. Glands on foliage inconspicuous or absent.
  1. Leaves ending in long fine free points which are parallel to the axis. Under-surface of foliage marked with white streaks. Foliage aromatic.—*T. plicata.*
  2. Leaves ending in short thick rigid triangular points directed outwards at an acute angle. Under-surface of foliage marked with white streaks on the lower half. Foliage not aromatic.—*T. japonica.*
  3. Leaves as in *T. japonica*, but more distinctly glaucous beneath. Branches sometimes prostrate.—*T. koraiensis.*

II. Main axes of branchlet systems roundish. Foliage marked with longitudinal glandular depressions.
  4. Branch systems in vertical planes. Under-surface of foliage pale green. Cones woody with recurved spines. Seeds without wings.—*T. orientalis.*

III. Main axes of branchlet systems flattened. Glands on foliage large and conspicuous.
  5. Leaves ending in long fine points parallel to the axis. Under surface of foliage pale green. Foliage aromatic. *T. occidentalis.*

IV. Main axes of branchlet systems flattened. Glands absent.
  6. Branchlet systems stout. Foliage with conspicuous white markings beneath. *T. dolabrata.*

Thuya dolabrata, Linnæus. (Fig. 110.)

Hiba.

Dolophyllum sp., Salisbury; Platycladus dolabrata, Spach; Libocedrus dolabrata, Nelson; Thujopsis dolabrata, Siebold and Zuccarini; T. dolabrata, var. australis, Henry. Asunaro; Asuhi.

An evergreen tree 40–100 ft. high, or occasionally of shrubby habit. *Trunk* usually curved at the base and sometimes dividing into two or more branches near the ground. *Bark* thin, reddish brown, greyish in old or exposed trees, fissuring into long narrow strips, the outer bark sometimes scaling in thin papery layers.

Branches horizontal or erect; branchlets horizontal, stout, flattened. *Terminal buds* of main shoots distinct and pointed, covered by leaves, those of lateral shoots smaller and rounded. *Leaves* on the main axis rounded or short-pointed, only slightly

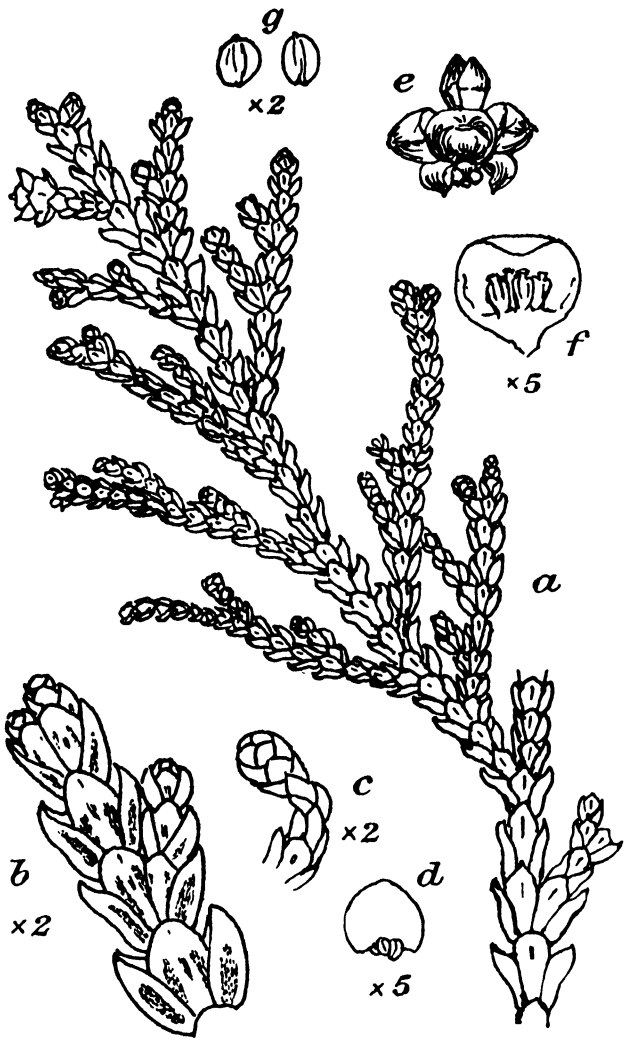

FIG. 110.—*THUYA DOLABRATA.*

a, spray with young female cone; *b*, under-side of branchlet; *c*, male cone; *d*, stamen; *e*, expanded female cone; *f*, cone-scale with four erect ovules; *g*, seeds.

larger than those of lateral branches, broader in comparison to length than in any other species, those of the upper and lower ranks pressed more closely to the branch and smaller than the side ranks; shining dark green above, all except the upper rank hollowed

below, marked with a broad, white patch of stomata; surface without resin glands, giving off a faint odour of turpentine when bruised. *Cones* ½–¾ in. long; *scales* wedge-shaped, leathery or woody, with a prominent, triangular, pointed and often hooked boss near the apex. *Seeds* five at the base of each fertile scale, thin, rounded, winged on each edge.

Two well-marked forms of this conifer occur wild in Japan:—

Var. **australis**, Henry.

A tree 40–50 ft. high with a slender trunk and drooping branches, or occasionally found as a shrub in the shade of other trees. *Branchlets* flat, the lateral leaves with curved, hooded points. *Cones* broadly ovoid, the scales thickened at the apex, which ends in a blunt, triangular process.

This is the form known in cultivation and may be regarded as the type.

Var. **Hondai**, Makino.

A tree attaining 100 ft. in height with a trunk up to 10 ft. or more in girth. *Branchlets* more closely set and overlapping and leaves smaller and more crowded than in the preceding, the lateral leaves blunt and not curved inwards at the apex. *Cones* globular; *scales* not thickened at the apex, the boss reduced to a narrow ridge or short point. *Seed wings* broader than in var. *australis*. This is the northern form of the species.

Of the garden forms the most noteworthy are:—

Var. **nana**, Carrière.

Var. latævirens, Lindley.

Dwarf and compact in habit with slender, much-divided branchlets and bright green foliage. Introduced by J. G. Veitch, in 1861.

Var. **variegata**, Fortune.

Leaves variegated with creamy white, the variegation often occurring in patches. It is less effective than the normal forms. Introduced by Fortune in 1861.

T. dolabrata is easily distinguished from all other *Thuyas* by its stouter branches with distinct pointed terminal buds, by its larger leaves, which are conspicuously white beneath, and by there usually being five seeds to each fertile scale.

It is an important forest tree in Japan. Wilson[1] saw the type growing wild near Toge Station at about 2,700 ft. altitude on the borders of Uzen and Iwashiro provinces, around Yumoto in the Nikko region, and in the valley of the Kiso-gawa. In the

[1] *Conifers and Taxads of Japan*, 72–73.

latter region it forms large forests at an altitude of 3,500–6,000 ft. He met with the variety Hondai on the Adzuma-san Mountain, on the border of Iwashiro and Uzen provinces at elevations varying from 3,500–5,500 ft., which appeared to be the dividing line between it and var. *australis*. In Mutsu, the most northerly province of Hondo, it is common from sea-level to an elevation of 2,000 ft. in pure forests, also on Yake-yama Mountain up to 1,700 ft. The forest on Yake-yama has been known for more than 200 years.

The species was first collected by Kæmpfer in 1712, but it was not introduced to Britain until 1853, when Thomas Lobb sent a small plant from the botanical garden Buitenzorg, Java, to Messrs. Veitch of Exeter, which died, but the species was reintroduced by Captain Fortescue, R.N., in 1859. Further plants were received in 1861, including the variety *nana*.

Wood light, soft, not strong, fragrant, durable, without resin, yellowish, easily worked but liable to crack if not carefully seasoned. It is used for building and engineering purposes, bridges, conduits, etc., and is a useful wood for railway sleepers, lasting 12–15 years in Japan without preservative treatment. Small boxes made of thin wood of this tree may be seen in the Kew Museums, but it is said not to wear well as thin boards.

T. dolabrata is one of the celebrated "five trees" of Kiso. When the Tokugawa family started the government in Edo in the middle of the seventeenth century much attention was paid to forest administration, and there were considerable restrictions to felling, certain species being rigorously preserved.[1]

These facts account for the preservation of handsome forests in certain districts. *T. dolabrata* is said to constitute 1·4 per cent. of the State forests of Japan, and has a rotation period of 130–150 years; the rotation period in the Imperial forests, however, is 80–160 years. It is also largely planted in Japanese gardens.

In Britain it is only valued as an ornamental tree, and the best specimens are found in the milder and moister parts of the country, such as the south and south-west counties of England, Wales, Ireland, and W. Scotland, although it succeeds in other parts. It requires sweet, permanently moist soil and appears to be better adapted to sandstone than to limestone formations. Plants raised from seed exhibit considerable variation in habit and develop very slowly for a number of years, some never getting beyond the bush stage. For this reason it is best to propagate it by cuttings taken from free-growing plants, leading shoots from erect branches being preferable for this purpose. The Japanese recognize the difficulty in obtaining uniform stock from seed and prefer to raise their trees from cuttings for the

[1] *For. of Japan* (1910).

formation of new forests. In Britain it is remarkably free from insect pests, and when planted under favourable conditions few evergreens are more effective.

Elwes and Henry, *loc. cit.* ii, 202.

Thuya japonica, Maximowicz.

JAPANESE ARBOR-VITÆ.

Thuya gigantea var. japonica, Franchet and Savatier; T. Standishii, Carrière; Thuyopsis Standishii, Gordon. Nezuko.

A small tree 30–40 ft. high with a trunk 3–7 ft. in girth, frequently forked at a short distance from the ground. *Bark* thin, reddish brown with grey patches, the outer bark peeling off in papery rolls. *Branches* horizontal with the branchlets in the same plane, 3–4 pinnate, drooping, not aromatic when bruised. *Leaves* on the main axis triangular, blunt and thickened at the apex; those of the lateral branchlets smaller, yellowish green on the upper side, grey-green or glaucous in the lower half of the leaf beneath; surface without resin glands; *cones* oblong, greenish-yellow when young, light brown when mature; *scales* 4–5 pairs, thin, flexible, the middle ones fertile. *Seeds* small with a thin membraneous wing on each side, extending beyond the apex and forming a cleft.

T. japonica differs from *T. plicata* in its shorter, blunter, glandless leaves, which are yellowish green above and more distinctly glaucous beneath, and by the absence of a distinct odour when bruised.

A native of the mountains of Cent. Japan, where it is now one of the rarest of the useful ornamental trees. In feudal times it constituted with four other conifers, *Thuya dolabrata*, *Cupressus obtusa*, *C. pisifera* and *Sciadopitys verticillata*, the famous "five trees of Kiso" which were strictly preserved as "Tome-ki" (the preserved tree).[1] The largest natural groups of this species are said to occur at elevations between 900 and 1,800 metres in the provinces of Yumoto, Bungo, Satsuma, Omi, Iwashiro, Shimotsuke and Uzen. It is also said to be wild in N. Corea. Wilson says [2] that the only place in which he saw the tree wild in quantity was in the ascent of Adzuma-san from Toge on the borders of Uzen and Iwashiro provinces, where on steep slopes it is common beyond the hot springs between 1,000–1,300 m. altitude. He records its highest altitude as 1,800–2,300 m. around Yumoto in the Nikko region. Fortune discovered it in gardens at Tokio in 1860, and it was sent by him to Standish's nursery at Ascot.

Wood soft, light, easily worked, durable; heartwood pale

[1] *Forestry of Japan*, 27 (1910).
[2] Wilson, *Conifers of Japan*, 75 (1916).

brown, sapwood lighter. The timber is cut into thin boards for the linings of walls and ceilings, sliding doors, boxes and bent woodwork. It is not, however, plentiful enough to possess much commercial value.

T. japonica succeeds in the British Isles under similar conditions to *T. plicata*, but is a less vigorous tree, being apparently of slow growth. Its yellowish green foliage makes it a useful plant for positions where the more sombre hues of darker-leaved evergreens would be out of place.

Thuya koraiensis, Nakai.

Thuya kongoensis, Nakai.

This recently introduced species varies in habit from a low or trailing shrub to a slender, graceful, narrow-pyramidal tree. It is allied to the Japanese *T. japonica*, from which it appears to differ by its coarser foliage, which is wholly glaucous on the under-surface.[1] The cones are said to be broader than in the Japanese species and the cone-scales thicker.

It is a native of Corea and small plants are in cultivation at Kew.

Wilson in *Journ. Arnold Arb.* i, 186 (1920).

Thuya occidentalis, Linnæus. (Fig. 111.)

AMERICAN ARBOR-VITÆ.

Thuya obtusa, Moench; T. odorata, Marshall; T. sibirica, Hort. Cupressus Arbor-vitæ, Targ. Tozz. Arbor-vitæ; Northern White Cedar; White Cedar.

A tree 50–60 ft. high and usually 4–9 ft. but occasionally 18 ft. in girth, the trunk often forked from near the ground and prominently buttressed. *Bark* ¼–⅓ in. thick, reddish brown or orange-brown, and fissured into narrow ridges, the thin outer bark scaling off in small rolls. *Branches* horizontal, turning upwards at the ends; branchlets much divided, the lateral ones small. *Leaves* dark green above, pale green below, emitting a tansy-like odour when bruised; those on leading shoots about ⅛ in. long, sharp-pointed, rounded on the back, with conspicuous resin glands; those on lateral shoots smaller, about $\frac{1}{10}$ in. long, rounded or bluntly pointed with the glands very small or absent. *Cones* oblong, ⅓–½ in. long, yellowish and erect when young, brown and pendent when mature at the end of the first summer; *scales* in 4–5 pairs, the second and third pairs larger than the others and fertile; thin, leathery, the apex a short triangular point, the thickened process within less pronounced than in *T. plicata*. *Seeds* ⅛ in. long with thin marginal wings.

A large number of forms have been given varietal names.

[1] The lower half only of the under-surface of leaves of *T. japonica* is glaucous.

Some are doubtfully distinct and become difficult to distinguish from the type with age.

They include :—

Var. **aurea**, Hort.

Leaves golden in colour.

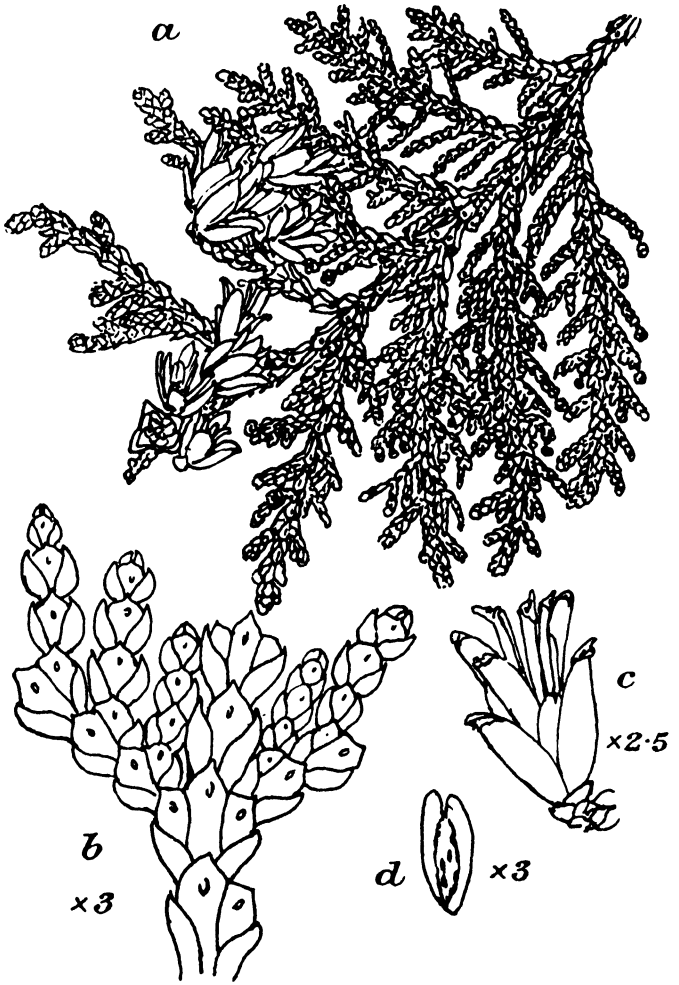

FIG. 111.—*THUYA OCCIDENTALIS.*

a, spray with male and female cones ; *b*, branchlets, under-surface ; *c*, expanded cone ; *d*, seed.

Var. **aurea spicata**, Beissner.

A luxuriant form with shining golden leaves.

Var. **Bodmeri**, Hort.

A monstrosity with short abnormal thick often four-sided

recurved branches with thickly overlapping, scale-like leaves analagous to *Cupressus obtusa*, var. *lycopodioides* from which it is distinguished by the green under-surface of the leaves and by the characteristic odour when bruised.

Var. **Boothii**, Hort.

A low compact bush with dense and rather large leaves.

Var. **Buchanani**, Hort.

Branchlets long, slender, whip-like, the lateral divisions far apart and the leaves sparse. Foliage grey-green.

Var. **columnaris**, Hort.

A narrow columnar tree of compact habit, leaves dark green.

Var. **compacta**, Beissner.

An erect tree with a narrow compact branch system.

Var. **cristata**, Hort.

Dwarf and distinct, the final branch divisions being densely arranged in small clusters resembling a cock's comb.

Var. **densa**, Hort.

A dwarf, compact rounded bush.

Var. **Dicksoni**, Hort.

A tree of slender erect habit with bright green leaves.

Var. **dumosa**, Hort.

A dwarf plant 2–3 ft. high of rounded and dense habit.

Var. **Ellwangeriana**, Beissner.

Retinispora Ellwangeriana, Hort.

A large shrub with trailing branches and slender curving branchlets often becoming top-heavy. Some of the branchlets bear normal adult leaves, others the needle-like leaves of the juvenile stage.

Var. **Ellwangeriana aurea**, Spæth.

Habit as above, leaves yellowish. Not a desirable variety for decorative work.

Var. **erecta**, Hesse.

A tall tree of stiff pyramidal outline.

Var. **erecta viridis**, Hort.

Habit as in the last, leaves bright green, doubtfully distinct.

Var. **ericoides**, Beissner and Hochst.

Retinispora dubia, Carrière.

The foliage retains the juvenile character and is soft and needle-like. The plant remains dwarf, but forms a large number of branchlets quite unlike other varieties in appearance. The leaves are greenish purple during summer and brown or purple in winter. When crushed, the shoots have the characteristic tansy-like odour of the type.

Var. **filiformis**, Beissner.

Var. Douglasii, Rehder.

Main branches long and slender, leafy branchlets in compact clusters.

Var. **globosa**, Beissner.

A dwarf rounded bush 2–3 ft. high.

Var. **globosa compacta**, Hort.

A very compact form of the above.

Var. **Hovei**, Veitch.

A dwarf plant doubtfully distinct.

Var. **lutea** Gordon.

Young branchlets yellow or greenish yellow, especially in winter, becoming green the second spring.

Var. **plicata**, Masters.

Branches rigid, arranged very like those of *T. orientalis*. Leaves brownish green with a very strong odour. This must not be confused with the species *T. plicata*.

Var. **pendula**, Hort.

Branchlets pendulous.

Var. **pulverulenta**, Hort.

Patches of leaves greyish or white in colour.

Var. **recurva nana**, Hort.

A dwarf bush with recurved branchlets.

Var. **Spæthii**, P. Smith.

T. occidentalis, var. Ohlendorfi, Beissner; T. tetragona, Hort.

A dwarf form with four-sided branches, the upper ones with needle-like leaves.

Var. **Vervæneana**, Henk and Hochst.

Branchlets and leaves yellowish when young, brown the first winter, green the second year. More dwarf in habit than var. *lutea*.

Var. **Victoria**, Hort.

T. occidentalis, var. albo-spicata.

A free-growing tree, the tips of the shoots variegated with white, especially prominent in winter.

Var. **Wagneriana**, Hort.

A freely branched shrub of loose habit, but oval outline.

Var. **Wareana**, Beissner.

T. occidentalis caucasica, Hort.; T. occidentalis robusta, Carrière; T. Wareana, Hort.; T. sibirica, Hort.

A tree of compact pyramidal habit, the branches sometimes vertical and the spray neat and close.

Var. **Wareana lutescens**, Hesse.

As in the last-named, but the sprays and leaves are golden during the first year.

T. occidentalis differs from *T. plicata* in its smaller leaves, which are pale green and not streaked with white on the lower surface, and have conspicuous resin glands. The cones have only 4 fertile scales, not 6 as in *T. plicata*.

The tree is widely distributed in E.N. America, from Nova Scotia and New Brunswick, north-westward to the mouth of the Saskatchewan and S. through the northern states to S. New Hampshire, Cent. Massachusetts and New York, N. Pennsylvania, Cent. Michigan, N. Illinois and Cent. Minnesota, and along the high Alleghany Mountains to S. Virginia and N.E. Tennessee, being very common in the north but less abundant and of smaller size southwards.[1] It occupies extensive tracts of swampy ground, where it often forms dense forests, particularly in the northerly part of its range.

Wood white or yellowish brown, heartwood rather darker than the sapwood and sometimes reddish, soft, brittle, coarse-grained, durable even in contact with the soil. Used extensively for fence, telegraph and telephone poles, railway sleepers, shingles, building purposes and for boats and canoes. Hough (*American Woods*, i, p. 74) says that it is the best American timber on account of its lightness as well as for other good qualities for the siding of skiffs, canoes, etc., which must be light in order to be easily carried over portages. He mentions one 10½ lb. in weight which was large enough to carry one man and baggage over quiet

[1] Sargent, *Manual of the Trees of N. America*, 67 (1922).

waters. The wood of ornamental trees makes good posts. A decoction prepared from the leaves is sometimes used in medicine in cases of intermittent fevers, coughs, scurvy and rheumatism; mixed with lard it is used as an ointment in cases of rheumatism. A volatile oil extracted from the shoots and leaves is sometimes used as a vermifuge.[1]

T. occidentalis was introduced into Britain in 1596, and has been widely planted for decorative purposes. As many of the so-called varieties are not very distinct from the type, they should be seen growing before they are purchased. Light moist loamy soil suits this conifer best, although it also succeeds in peat and heavy loam. It is sometimes effectively used as a hedge plant but has no value in this country as a forest tree. When growing on dry soils or where the atmospheric conditions are fairly dry it is subject to attack by scale insects. These may be destroyed by spraying the plants once in eight days during May and early June with a paraffin wash.

Thuya orientalis, Linnæus. (Fig. 112.)

CHINESE ARBOR-VITÆ.

Biota orientalis, Endlicher; Thuya acuta, Moench; Cupressus Thuya, Targ. Tozz. Platycladus stricta, Spach.

A bush or small tree 30–40 ft. high of dense habit, often branching into several stems from near the base or occasionally of columnar habit. *Bark* thin, reddish brown. *Branches* erect, often as long as the central stem, branchlets erect, the secondary ones arranged obliquely. *Leaves* smaller than those of the other species, distinctly grooved on the back, those on the main axis about $\frac{1}{12}$ in. long, triangular, ending in a blunt point, not pressed close to the shoot, those on the finer spray about two-thirds as long, closely pressed, green on both surfaces, bearing minute stomata, giving off a slight resinous odour when bruised. *Cones* egg-shaped, fleshy and glaucous before ripening, with usually six, sometimes eight scales, the lower ones fertile, each with two or three seeds; *scales* thick, woody, with a strong hooked or rolled boss near the apex, ultimately gaping widely and releasing the seeds. *Seeds* oblong, about $\frac{1}{8}$ in. across, wingless.

T. orientalis is easily known by the vertical arrangement of its branchlets and by the strongly hooked cone scales.

It is a native of N. and W. China and is in cultivation in many other Asiatic countries. The date of its introduction to Britain is doubtful, but it was in cultivation here early in the eighteenth century. In some gardens the species is still found under the generic name of *Biota*.

A large number of forms have been given varietal names,

[1] Sargent, *loc. cit.*

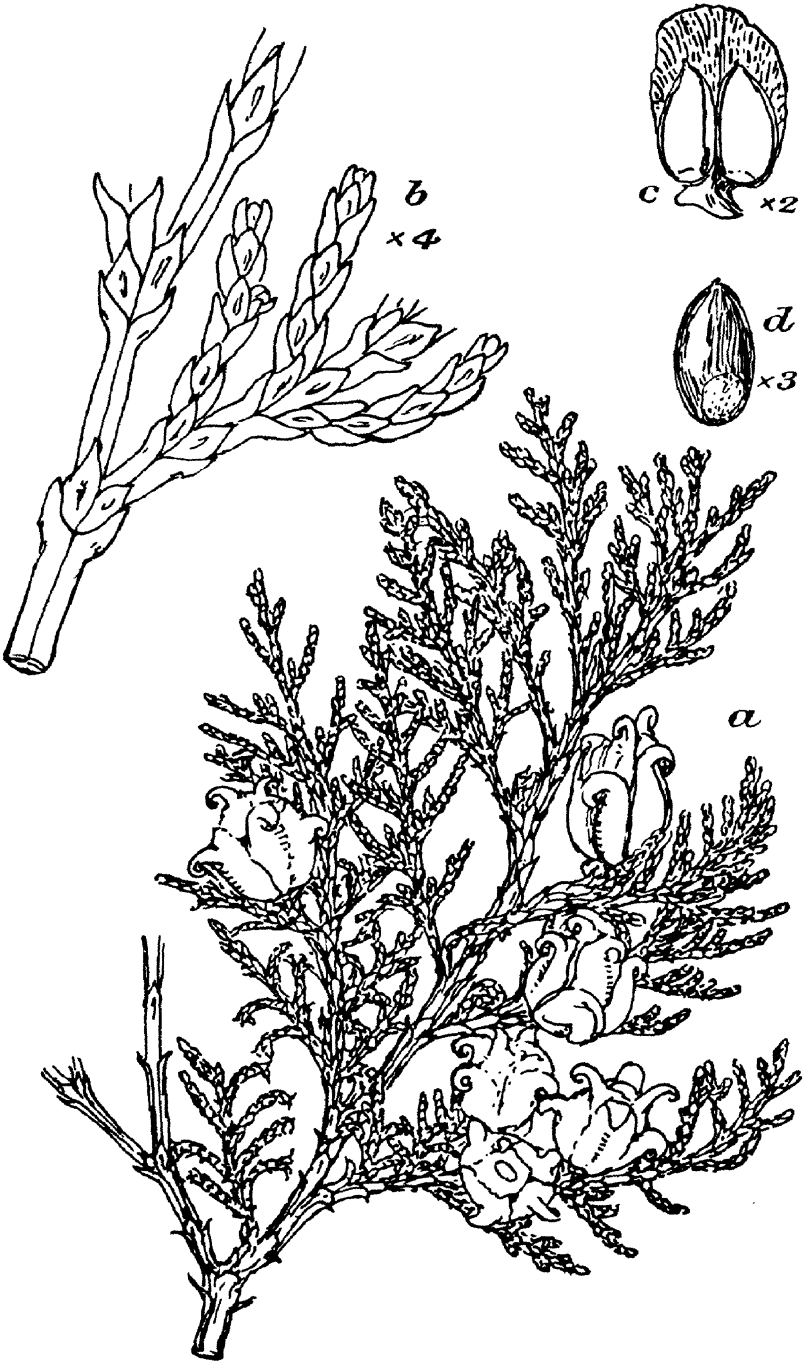

FIG. 112.—*THUYA ORIENTALIS.*

a, spray with cones; *b*, branchlets; *c*, cone-scale with two seeds; *d*, seed.

but many of them are of little horticultural value. The following list is not exhaustive :—

Var. **argenteo-variegata**, Hort.

Biota orientalis argentea.

Young shoots creamy white at the tips with patches of silvery or white branchlets.

Var. **athrotaxoides.**

Biota orientalis, var. athrotaxoides.

A stout form with dark green foliage, the branchlets irregularly spreading.

Var. **aurea**, Dauvesse.

Biota orientalis nana ; Thuya aurea, Hort. ; T. nana aurea, Hort. ; T. nana compacta aurea, Hort.

A compact broadly pyramidal bush, the stem branching almost from the base, the branches more or less spreading. Branchlets dense. *Leaves* yellow-green, short, thick, overlapping.

Var. **aureo-variegata**, Hort..

Biota orientalis variegata, Gordon ; Thuya orientalis aureo-variegata, Hort. ; T. variegata, Hort.

Leaves yellow during the first year, the yellow shoots sometimes in patches.

Var. **compacta**, Beissner.

Biota japonica ; B. orientalis nana, Carrière ; B. o. Sieboldi, Endlicher ; B. Zuccarini, Siebold ; Thuya compacta, Hort. ; T. nana, Hort. T. Zuccariniana, Hort.

A dwarf bush of dense, pyramidal habit.

Var. **decussata**, Beissner and Hochst.

Biota orientalis decussata ; B. Sieboldi ; Chamæcyparis decussata ; Frenela glauca, Hort. (not Mirbel) ; Juniperus glauca ; Retinispora flavescens ; R. juniperoides ; R. rigida ; R. squarrosa, Hort. (not Zuccarini).

A dense broadly pyramidal bush with erect branches and slender round branchlets bearing awl-shaped leaves like those of seedlings, in opposite and alternate pairs. Very distinct from the typical form.

Var. **densa.**

Biota orientalis densa glauca.

A dwarf plant of dense habit with slightly glaucous leaves.

Var. **elegantissima**, Gordon.

Biota elegantissima.

A dwarf form of stiff erect habit with the young leaves golden yellow during the first summer.

Var. ericoides.

A small plant bearing leaves like those of the seedling, differing from a similar form of *T. occidentalis* by the absence of a strong odour when the shoots are bruised.

Var. falcata.

Thuya falcata.

Of dense conical habit, 10–12 ft. high. Spines on the cones sickle-like.

Var. falcata nana.

More dwarf than the last named.

Var. glauca.

Leaves of a glaucous hue.

Var. globosa.

A bush of dwarf, dense, rounded habit.

Var. gracilis.

Thuya frenceloides, Hort.; T. nepalensis, Hort.; Biota orientalis japonica, Hort.

A distinct variety of globose habit, the lower branches wide spreading, the apex tapering abruptly. The leaves are longer and less closely pressed than in the type, some being awl-shaped.

Var. Hoveyi, Hort.

A variety of dense, compact habit.

Var. incurvata, Hort.

Branches curving inwards and forming a dense, compact bush.

Var. intermedia, Carrière.

Biota orientalis intermedia, Carrière; B. intermedia, Hort.; B. pendula, Endlicher; Thuya intermedia, Hort.

A transitional form. Branches elongated, pendent. Leaves of two kinds; scale-like and appressed, and oval lanceolate, acute and spreading. Cones small, seldom produced.

Var. meldensis, Carrière.

Biota meldensis, Lawson ex Gordon; Retinispora meldensis, Hort.; Thuya hybrida, Hort.; T. meldensis, Hort.

A low pyramidal tree with flexible branches bearing juvenile and occasionally adult leaves which are bluish-green, changing to brown in winter. It is said to have originated at Meaux, France, about 1853 and was for a long time regarded as a hybrid between *T. orientalis* and *Juniperus virginiana*.

Photo by F. R. S. Balfour, Esq.

PLATE XXVIII. NEW RAILWAY CUT THROUGH PRIMEVAL FOREST IN STATE OF WASHINGTON, *THUYA PLICATA* PREPONDERATING.

Var. **mexicana**, Dümmer.[1]

Cupressus thurifera, Humboldt, Bompland and Kunth; Chamæcyparis thurifera, Endlicher.

Cones smaller and more globose than in the typical form, light brown in colour, not glaucous; the scales without the horn-like processes; seeds smaller than those of the type and not bevelled.

Cultivated in Mexico.

Var. **minima**, Hort.

Biota orientalis minima glauca, Hort.

A very dwarf plant with glaucous leaves.

Var. **nana stricta**, Hort.

A dense fastigiate bush with yellowish leaves.

Var. **pendula**, Masters.

Biota orientalis pendula, Parlatore; B. pendula, Endlicher; B. pendula recurvata, Gordon; Cupressus filiformis, Hort.; C. patula, Persoon; C. pendula, Thunberg; C. pendulata, Hort.; Thuya Douglasii pendula, Hort.; T. filiformis, Loddiges; T. flagelliformis, Hort.; T. pendula, Lambert.

A very distinct but unattractive variety with long, slender, whip-like branchlets without spray, the leaves opposite, in alternate sets and rather wide apart.

Var. **pyramidalis**, Tenore.

Biota orientalis expansa, Endlicher; B. o. tatarica, Endlicher; B. tatarica, Lindley; Thuya australis, Hort.; T. orientalis cupressoides, Hort.; T. o. stricta, Loudon; T. o. tatarica, Loudon; T. pyramidalis, Tenore; T. tatarica, Forbes.

A broadly pyramidal tree typical of one section of the species.

Var. **semperaurescens**, Nichols.

Biota orientalis semperaurea; B. o. nana.

Foliage and terminal growth yellow.

Var. **Zuccariniana**, Veitch.

A dense, dwarf, rounded bush with bright green leaves.

Wood more compact and closer grained than that of other species; odorous, often knotty, heartwood dark brown, sapwood white or cream. The timber is suitable for posts and for articles of furniture, but is not known in commerce.

The value of *T. orientalis* in Britain is solely decorative and it is planted extensively in parks, gardens and cemeteries. The outer branches of large specimens often become top-heavy, which renders them liable to be deranged by wind. To prevent this

[1] *Journal of Botany*, 1914, 236.

it is usual to tie all the main branches together. A better method is to shorten the shoots a little now and then, commencing when the plants are young, in order to induce sturdier branches. The Chinese arbor-vitæ can be grown as a hedge plant, and stands cutting well. It can be increased by cuttings and by seeds, the varieties by cuttings and by grafting upon stocks of the type. Light sandy loam suits it, but it can be grown on a variety of soils. Some of the dwarf varieties make excellent plants for the rockery.

Thuya plicata, D. Don. (Fig. 113.)

WESTERN ARBOR-VITÆ.

Thuya gigantea, Nuttall; T. Menziesii, Douglas; T. Lobbi, Hort.; T. Craigiana, Hort. Canoe Cedar; Red Cedar; Western Red Cedar.

In N. America this tree attains a height of 150–200 ft. with a trunk 12–20 ft. in girth above the broadly buttressed base, which is sometimes 50 ft. in girth near the ground. *Bark* light cinnamon red or brown, $\frac{1}{2}$–$\frac{3}{4}$ in. thick, divided into wide ridges by irregular shallow fissures, the surface broken up into small plates which are shed irregularly. *Branches* horizontal, often pendent at the ends; branchlets in the same plane, much divided, the small lateral shoots falling after two or three years. *Leaves* on leading shoots parallel to the axis, ovate, long-pointed, each with an inconspicuous resin gland on the back, up to $\frac{1}{4}$ in. long, the points free; those on the ultimate divisions smaller, about $\frac{1}{8}$ in. or less long, ovate, short and bluntly pointed, closely overlapping and often without glands, dark green above, usually faintly streaked with white beneath but on some branchlets remaining green; emitting a tansy-like odour when bruised. *Cones* about $\frac{1}{2}$ in. long, erect and green when young, reflexed and brown when mature at the end of the first summer; *scales* in 5–6 pairs, thin, flexible, with a thickened process on the inner side near the apex and immediately above the thin, triangular, reflexed point. *Seeds* thin, about $\frac{1}{4}$ in. long, winged, 2–3 on each fertile scale.

The following are the chief variations from the type:—

Var. **atrovirens**, Sudworth.

A form very like the type with rich glossy leaves.

Var. **aurea**, Hort.

Leaves yellowish, patches of yellow foliage sometimes occurring at irregular intervals over the tree.

Var. **compacta**, Hort.

Habit dwarf and dense.

Var. **fastigiata**, Schneider.

Habit resembling that of a Lombardy poplar.

Var. **gracilis**, Hort.

The spray of the branchlets much lighter and finer than in the type.

Var. **pendula**, Schneider.

Branches pendulous.

FIG. 113,—*THUYA PLICATA*.

a, spray with female cones, and short broad branchlets from which male cones have fallen; *b*, branchlet, showing bands of stomata on under-surface of leaves; *c*, expanded cone; *d*, seed.

Var. **pumila**, Hort.

A dwarf plant 2–3 ft. high, very dense in habit.

Var. **pyramidalis**, Hort.

Denser and narrower in habit than the type.

Var. **recurvata**, Hort.

Branches much twisted.

Var. **semperaurescens**, Hort.

Young shoots and leaves with a golden tinge.

Var. **zebrina**, Hort.

Foliage variegated with bands of green and gold.

T. plicata differs from the other N. American species, *T. occidentalis*, in its larger leaves, fewer resin glands on the foliage, and by the silvery marks on the leaves on the underside of the shoots. The cones have usually six fertile scales.

It is widely distributed in W.N. America from sea-level to an altitude of 6,000 ft., from Alaska, through British Columbia, W. Oregon and Washington, to Mendocino County, California, in the west, and eastwards to N. Montana and Idaho, occurring singly or in groves amongst Douglas fir and other trees on moist lands or near the banks of streams. Introduced by Lobb in 1853.

Wood light, soft, brittle, fragrant, durable, easily worked, heartwood light brown or reddish brown, sapwood paler. Used very extensively for shingles, telegraph and telephone poles, railway sleepers, building purposes and cooperage. The Indians use the split trunks for the totem poles of their villages, of which one is to be seen in Museum No. iii, at Kew. In British Columbia, Washington, and Oregon immense quantities of wood are cut each year, the tree being only second to Douglas fir in importance. The wood is very durable and seedlings have been known to spring up on fallen trunks, come to maturity and after being cut down it has been found possible to utilize the wood of the original fallen tree for shingles and other purposes.

The following tests on green material were made by the U.S. Department of Agriculture[1]:—

Weight green (moisture 25 per cent., wood 75 per cent., 26 lb. per cubic ft.

Tension, strength across the grain, 210 lb. per square in.

Compression, strength across grain at elastic limit, 310 lb. per square in.

Compression, crushing strength with the grain, 2,840 lb. per square in.

Shearing, strength with the grain, 720 lb. per square in.

Bending, modulus of rupture (breaking strength), 5,200 lb. per square in.

Bending, modulus of elasticity (stiffness), 950,000 lb. per square in.

Hardness, weight required to half-imbed a 0·444 in. steel ball, 345 lb.

[1] *Catalogue of the Empire Timber Exhibition* (1920).

The quantity of timber available for cutting in the United States alone in 1919 was given as 160 billion board ft. The annual production of shingles in the United States is from 8,000,000,000 to 12,000,000,000, and of this quantity 70 to 80 per cent. is made up of wood of *Thuya plicata*. This tree, with *T. occidentalis*, furnishes about 65 per cent. of the wood used for telegraph and telephone poles and for piling in the United States; the number of poles made of these two trees in 1915 is given as 2,521,769. Box-wood absorbs a very large quantity of timber, whilst a good deal is used for boat and house-building, etc. In addition to the timber in the United States, British Columbia estimates her standing timber of this species at 77,968,000,000 board ft.[1] The wood can be obtained in the rough, or in a partly manufactured or manufactured state, from Vancouver and other British Columbia ports and from the Western United States. The Indians have hollowed out the trunks and used them for canoes for a very long period, whilst after macerating and beating the inner bark, they obtained fibre which they wove into mats, baskets, hats and other articles. The flexible young branches have also been used for basket work, and the roots for fish hooks.

T. plicata is used in Britain as an ornamental tree, for hedges, and also for sylvicultural purposes. In parks and gardens, either as clumps or as isolated specimens, it is a beautiful object, its leafy branches being retained to the ground-line. As a hedge plant it provides good shelter and stands annual pruning well. It is promising as a timber tree, and an idea of its value for the purpose can be obtained from its behaviour in Claudy House Wood Plantation, Gairletter, Benmore, Argyllshire.[2] This plantation was made during the autumn of 1876 and 1877. It was originally 5 acres in extent, the soil being chiefly morainic in character, overlying rocks which are chiefly mica-schists and schistose grits, at altitudes of 12–130 ft. above sea-level. The ground was thinly covered with oak. About 15 oak trees per acre were left and underplanting was carried out with a mixture of Douglas fir, *Thuya plicata* and a few larch spaced 4 ft. apart; 2-year seedlings and 2-year and 1-year transplants were used, and the notching method of planting adopted. The oaks were eventually removed, causing some injury to the young crop, and following their removal there was a serious loss in one part of the plantation by wind-blown trees. In 1912 the average height of the Douglas fir was 70 ft. and of the *Thuya* 60 ft. The stems numbered about 890 to the acre and the volume of timber per acre, according to quarter-girth measurement to 5 in. diameter,

[1] Whitford and Craig, *Forests of British Columbia*, p. 241 (1918).

[2] *Transactions of the Royal Scottish Arboricultural Society*, xxviii, pt. i, p. 107 (1914).

deducting 1 in. for bark, worked out at Douglas fir, 5,000 cubic ft. per acre; *Thuya plicata* 2,430 cubic ft. per acre, thus giving the high total of 7,430 cubic ft. per acre for 36 years' growth. Whether *T. plicata* is a suitable forest tree for the warmer parts of the country is not certain, for timber produced by ornamental trees in the mild climate of Falmouth has been found to be worthless. In seasoning, considerable shrinkage occurred. The shrinkage was chiefly in the summer wood and it was so great that it caused triangular openings to appear between the annual rings, the openings being $\frac{1}{4}$–$\frac{1}{3}$ in. across. The autumn wood was not fractured, but the shrinkage took place in the summer wood throughout the log. In cooler parts of the country the wood is normal.

T. plicata withstands a good deal of shade and may be employed for underplanting thin woods. Its dense branch system makes it a suitable tree for the outskirts of plantations. Whilst trees 5–6 ft. high may be moved successfully, it is an advantage to place young trees in permanent places as early as possible and even for gardens, trees 3 ft. high are often more satisfactory than larger ones; it is not, however, so difficult to re-establish as are many conifers. It succeeds on good loams, peat, and wet clayey soils, and withstands considerable cold. Diseases are rare in this country, but young trees have been known to be killed in large numbers by a fungus, apparently *Botrytis cinerea*.

Elwes and Henry, *loc. cit.* i, 184 (1906).

Thuya sutchuenensis, Franchet.

This species is not in cultivation and little is known about it. A description of the tree appeared in *Journ. de Bot.* (1899), p. 262, and from that the following notes have been taken:—

"A shrub or tree with a dense head of spreading branches and flattened branchlets. *Leaves* very short, the lateral ones curved at the apex, obtuse, boat-shaped, without glands, the facial leaves grooved. *Cones* terminating short branchlets; *scales* 8, overlapping, obovate, apex scarcely free, only slightly thickened. Mature cones not seen."

A very elegant species distinct from *T. plicata* by its more closely arranged and overlapping branchlets, and by the shorter leaves and the absence of glands. It also differs from *T. japonica* in branches and leaves.

T. sutchuenensis is a native of N.E. Szechuen, Cent. China, and was collected by Père Farges at an altitude of 1,400 metres near Tchen-Kiœ.

Masters, *Journal Linnæan Society* (Botany), xxvi, p. 540.

PLATE XXIX. Western Hemlock (*Tsuga Albertiana*).

TSUGA, Carrière.

Hemlock Spruces.

This genus includes nine species of evergreen trees of pyramidal habit found in temperate N. America, Japan, Formosa, China, and the Himalaya. *Branches* horizontal, the branchlets numerous, slender, often pendulous at the tips. *Winter buds* both terminal and lateral arising from the leaf axils of the current year's shoots. *Leaves* short, linear, usually blunt, thrown into a two-ranked arrangement by the twisting of the leaf-stalks, or spreading round the shoots, persistent for several years, closely set on shining, cushion-like projections which are separated by grooves; resin canals one in each leaf situated between the vascular bundle and the lower surface. *Male and female flowers* on different branches of the same tree. *Male catkins* in the axils of the previous year's shoots, consisting of rounded clusters of spirally arranged, two-celled anthers. *Female flowers* terminating the lateral shoots of the previous year, with roundish scales which are slightly longer than the bracts. *Cones* solitary, small, pendulous, ripening during the first year, but remaining on the tree until the following summer or autumn of the second year after the release of the seeds; *scales* leathery, overlapping; bracts inconspicuous, usually concealed beneath the scales. *Seeds* two on each scale with resin vesicles, winged.

The slender drooping shoots taken in conjunction with the usually two-ranked arrangement of the leaves which have only one resin canal and the slender leaf-stalks pressed against the shoot are good distinguishing marks of *Tsuga*.

The genus may be naturally divided into two sections as follows :—

i. Hesperopeuce.

Branchlets not all in one plane. Leaves spreading all round the shoot, rounded or keeled above, bearing stomata on both surfaces. Cones oblong cylindric, composed of numerous scales.

ii. Micropeuce.

Branchlets all in one plane. Leaves pectinate, flat, grooved above, bearing stomata on the lower surface only. Cones ovoid, small, composed of few scales.

Wood normally without resin ducts, brownish, heartwood rather darker than sapwood, variable in quality and sometimes brittle, at other times of good quality and easy to work. Good qualities are suitable for building purposes and for joinery, whilst much is used for box-making. The bark is rich in tannin and that of some species is used extensively in tanning operations.

The Hemlock spruces thrive in places where the atmospheric

and soil conditions are on the moist side and are best planted in loamy soil. Propagation of the species is effected by sowing seeds in prepared beds out of doors or in pots or boxes in frames. Varieties can be increased by cuttings inserted in sandy soil in a close frame in July or by grafting in spring upon stocks of their respective types. The *Tsugas* form handsome decorative trees or bushes and *T. Albertiana* is sometimes grown under forest conditions in Britain. The Japanese and Chinese species may be utilized as substitutes for yew in decorative planting with a less sombre effect.

KEY TO TSUGA.

Leaf margins entire or obscurely toothed near apex, bearing stomata on both surfaces.
- Leaves rounded or keeled on upper surface, greyish.—*T. Pattoniana.*
- Leaves flattened and grooved on upper surface.—*T. Jeffreyi.*

Leaf margins entire, bearing stomata on one surface only.
- Young shoots glabrous, leaves notched at apex.—*T. Sieboldi.*
- Young shoots hairy, leaves notched at apex, ¼–½ in. long.—*T. diversifolia.*
- Young shoots hairy, leaves with a rounded entire or slightly notched apex, up to ¾ in. long.—*T. caroliniana.*
- Young shoots hairy, leaves up to 1 in. long, apex notched, stomata inconspicuous.—*T. chinensis.*

Leaf margins distinctly toothed (at least when young), bearing stomata on one surface only.
- Leaves ¼–⅔ in. long, tapering from base to apex, stomata well defined.—*T. canadensis.*
- Leaves ¼–¾ in. long, uniform in width, stomata bands ill-defined.—*T. Albertiana.*
- Leaves 1–1¼ in., tapering from base to apex, stomata well defined.—*T. Brunoniana.*
- Leaves ½–1 in., tapering from base to entire apex, stomata well defined.—*T. yunnanensis.*

Tsuga Albertiana, Sénéclauze. (Fig. 114.)

WESTERN HEMLOCK.

Tsuga heterophylla, Sargent; T. Mertensiana, Carrière; Abies Albertiana, A. Murray; A. Bridgesii, Kellogg; A. Mertensiana, Lindley and Gordon; A. Pattoniana, McNab (not Parlatore); Pinus canadensis, Bongard; P. Mertensiana, Bongard. Alaska Pine; Hemlock; Hemlock Spruce; Prince Albert Spruce; Western Hemlock Spruce; Western Spruce.

A tall, stately tree of narrowly pyramidal habit with a slender, spire-like crown, attaining in N. America a height of 200–250 ft. with a trunk up to 20 or more ft. in girth. *Bark* of old trees

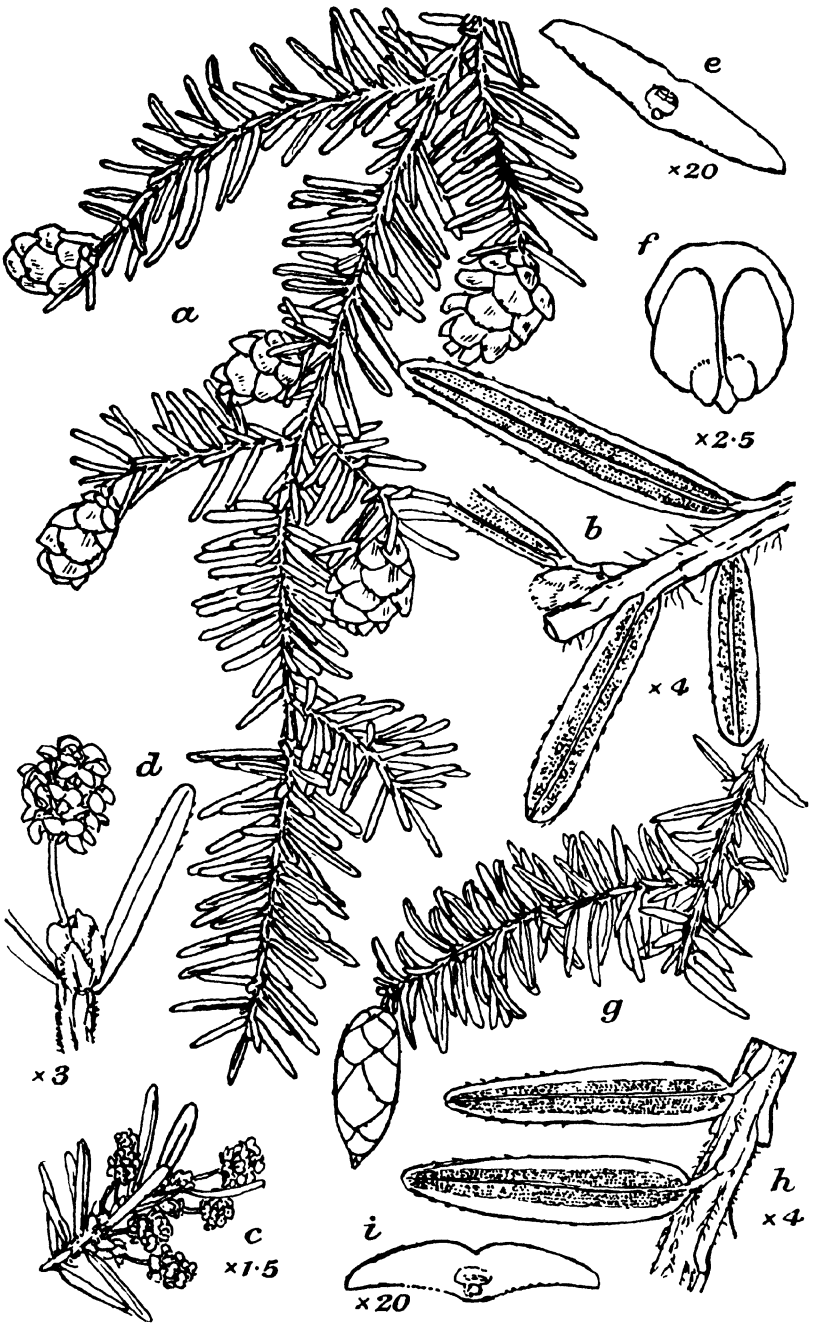

FIG. 114.—*TSUGA ALBERTIANA* and *T. CANADENSIS*.

Tsuga Albertiana.—*a*, spray with female cones; *b*, under-side of shoot with bud and leaves showing bands of stomata; *c*, branchlet with cluster of male cones; *d*, male cone; *e*, section of leaf with central resin canal below the vascular bundle; *f*, cone-scale with two seeds. ***T. canadensis.***—*g*, branch with cone; *h*, under-side of shoot and leaves; *i*, section of leaf.

reddish, 1 in. or more thick, deeply furrowed into scaly ridges. *Young shoots* slender, drooping at the tips, greyish, hairy with long and short hairs intermixed. *Winter buds* minute, ovoid, greyish brown. *Leaves* spreading, arranged in two ranks, the shorter ones on the upper side of the shoot, narrowly oblong, ¼–¾ in. long, uniform in width, the margins with minute spine-like teeth, grooved on the upper side, two ill-defined stomatic bands beneath. *Cones* without stalks, ½–1 in. long; *scales* few, spatulate, nearly twice as long as broad, margin entire, bevelled; *bracts* small, concealed, lozenge-shaped. *Seed*-wing about threequarters the length of the scale.

Allied to *T. canadensis*, but differing in its unforked trunk, spire-like leader, uniform width of leaf, and less clearly defined stomatic lines.

This beautiful conifer is a native of the W. Coast of N. America, extending from S.W. Alaska, where it forms the greater part of the coast forest, to British Columbia and N. California, the finest trees being found in the coastal region of British Columbia, Washington, and Oregon. It was introduced by Jeffrey in 1851 and named *Abies Albertiana* in 1863 by Andrew Murray in honour of the Prince Consort.

Wood hard, tough, close-grained, durable, holds nails well, and takes a good polish; heartwood yellowish brown, sapwood paler. Used for general carpentry and joinery work in buildings, also for boxes, and extensively for railway sleepers, shingles, and for paper pulp. The wood is superior to that of other American hemlocks and the quantity available for cutting has been estimated as 100 billion board ft. in the United States alone.

The following results of tests on green material were obtained by the U.S.A. Department of Agriculture[1]:—

Weight green (moisture 25 per cent., wood 75 per cent.), 31½ lb. per cubic ft.

Tension, strength across the grain, 260 lb. per square in.

Compression, strength across the grain at elastic limit, 350 lb. per square in.

Compression, crushing strength with the grain, 2,890 lb. per square in.

Shearing, strength with the grain, 810 lb. per square in.

Bending, modulus of rupture (breaking strength), 6,100 lb. per square in.

Bending, modulus of elasticity (stiffness), 1,190,000 lb. per square in.

Hardness, weight required to half-imbed a 0·444 in. steel ball, 485 lb.

The demand for western hemlock is increasing and it can be procured in square timber up to 24 in. side and upwards of 20 ft.

[1] Catalogue, Empire Timber Exhib. (1920).

long, whilst it is also procurable as deals and planks up to 32 ft. in length, for railway sleepers, and other sizes as desired. It is shipped from Vancouver and other British Columbian ports and from the Western United States, In addition to its value as lumber, it is used extensively for pulping for paper manufacture. The quantity of hemlock wood used in the United States for paper manufacture during 1916 amounted to 760,226 cords. Of this amount 647,738 cords were manufactured by the sulphite process, 84,116 cords by the mechanical process and the remainder by the sulphate process. These figures probably include wood of three species, *T. Albertiana*, *T. canadensis* and *T. Pattoniana*. Hemlock takes second place to spruce in the quantity consumed by paper manufacture. The tenacious properties of hemlock wood enable it to hold nails well, hence its peculiar value as a box-wood. In 1912 the United States of America used 203,526,091 board ft. for this purpose and in 1916 the amount increased to 1,690,000,000 board ft.[1] Hemlock railway ties (sleepers) in 1911 were manufactured to the number of 3,686,000. In 1905 Kellogg compiled a list of mine timbers for the U.S.A. Government. This shows that the annual use of hemlock for the purpose amounted to 4,155,800 cords of round and 60,802,000 board ft. of sawn timber. Hemlock wood is used for fuel in many places. Its relative fuel value per unit value of dry wood is 61 against 100 for hickory, and 1½ cords of western hemlock is regarded as being the equivalent of 1 ton of coal.

Hemlock bark is generally rich in tannin and the bark of the American species is used very extensively in the tanning industry. Western hemlock is richer in tannin than the eastern American species, the figures being given as 10–12 per cent. and 8–10 per cent. respectively. Hemlock bark is stated to supply about two-thirds of the requirements of tanneries in W.N. America. Broken and ground bark for tanning purposes may be seen in the Kew Museums. An interesting exhibit at Kew is that of " bread " made by the N. American Indians in times of scarcity from the inner bark of the western hemlock. It forms a reddish brown, fibrous, unappetising mass. A resinous-looking extract used in medicine, and halibut hooks made from roots are other interesting examples of the uses of hemlock.

Western hemlock is a favourite decorative tree in Britain, where it gives excellent results from the South of England to the Scottish Highlands. Its value for this purpose lies in its graceful habit and spire-like crown, the branches being made up of innumerable branchlets which are lighter and more graceful than those of pine, spruce or fir. It is sometimes planted under forest conditions in Britain, but there are no plantations old enough

[1] Nelson, Courtlandt Brown, *Forest Products, their Manufacture and Use*, 251 (1919).

to enable a correct estimate to be made of its worth for forestry; the presumption is, however, that it will prove inferior to better known trees for that purpose. *T. Albertiana* succeeds in a great variety of soils, from sandy loam to that approaching stiff clay. It also succeeds in peaty soil. The best results are obtained in deep loam of moderate density that never becomes very dry, in places where the atmospheric conditions are on the moist side and free from impurities. For these reasons, exceptionally fine and rapidly grown specimens are found in the valleys and glens of Wales, N. England and Scotland, whereas growth in the neighbourhood of manufacturing towns is less satisfactory. The mistake is sometimes made of planting this tree in the small gardens of suburban residences, where it is quite out of place. To be seen at its best it must have ample space for development. Seeds form the best means of propagation, although cuttings can be rooted. Bark beetles sometimes injure this tree in America, but in this country it is singularly free from insect pests.

Sargent, *Silva N. America*, XII.

Tsuga Brunoniana, Carrière. (Fig. 115.)

HIMALAYAN HEMLOCK.

Abies Brunoniana, Lindley; A. dumosa, Loudon; Pinus Brunoniana, Wallich; P. decidua, Wallich; P. dumosa, D. Don. Fragrant Fir; Himalayan Hemlock Spruce; Himalayan Hemlock Fir; Indian Hemlock Fir.

A tall pyramidal tree with gracefully drooping branches, attaining in the Himalaya a height of 120 ft., with a trunk girth of 28 ft. *Bark* thick and rough. *Young shoots* light brown, hairy. *Winter buds* rounded, flattened at the apex, with downy scales. *Leaves* 1–1¼ in. long, narrow linear, tapering gradually from the base to the apex which is acute and recurved, margins toothed, upper surface dark green and grooved, lower surface silvery white with two broad bands of stomata. *Cones* ovoid, sessile, ½–1 in. long, made up of rounded, striate, shining scales. *Seed* with the oblong wing two-thirds the length of the scale.

T. Brunoniana is distinguished amongst other species by its drooping habit and long, slender leaves.

In the Himalaya it forms a beautiful and stately tree extending from Kumaon to Bhotan at elevations ranging from 8,000–10,000 ft. It was discovered by Captain Webb in N.W. Nepal and was introduced to England in 1838. One of its coniferous associates in the Himalaya is *Picea morindoides*, while with it grow *Rhododendron grande*, *R. Falconeri* and other species.

The economic properties of this species are not of great importance. The timber is inferior in quality to that of several other Himalayan conifers and it is probably too far removed

from a marketable centre to give it any special value as a pulp wood. It is employed to some extent for shingles and the bark is used for roofing purposes. Incense is also obtained from the tree. Wallich's name of *Pinus decidua* was given on account of the early fall of the leaves from broken or cut branches.

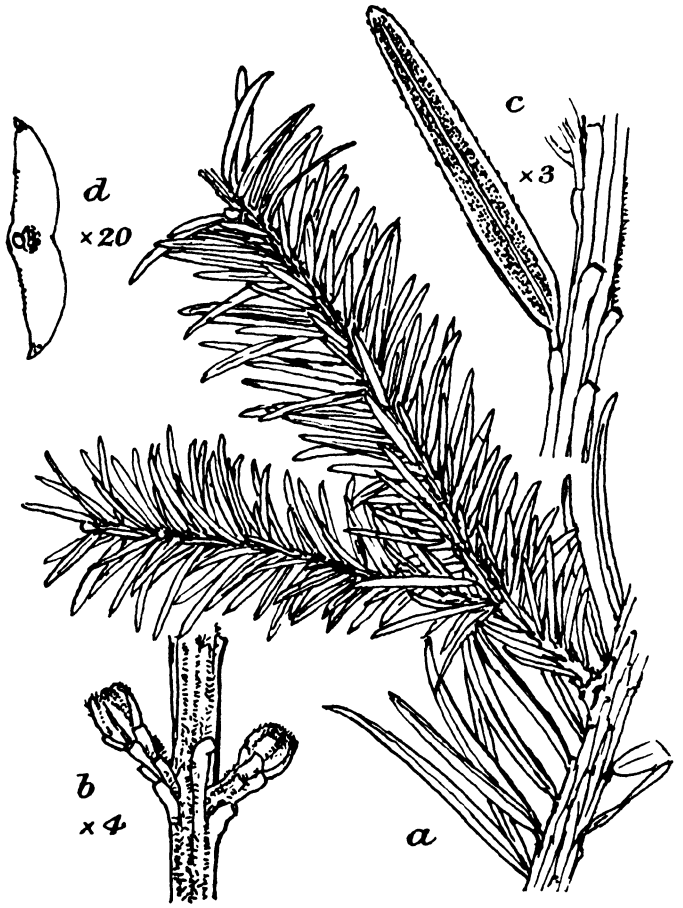

FIG. 115.—*TSUGA BRUNONIANA.*

a, spray; *b*, pubescent upper side of shoot with winter buds; *c*, glabrous under-side of shoot and leaf; *d*, section of leaf.

Its cultivation in Britain is restricted, owing to its being tender. Good specimens are occasionally seen in the milder parts of the country and there is one 50 ft. or more high at Bocconoc, Cornwall. It should be grown more in gardens in the south-west counties of England, for it is a very beautiful tree.

R. S. Troup, *The Silviculture of Indian Trees*, iii, 1155 (1921).

Tsuga canadensis, Carrière. (Fig. 114.)

EASTERN HEMLOCK.

Abies americana, Marshall; A. canadensis, Michaux; A. curvifolia, Salisbury; Picea canadensis, Link; Pinus americana, Duroi; P. canadensis, Linnæus. Canadian Hemlock; Hemlock Spruce; New England Hemlock; Spruce; Spruce Pine.

A tree 60–100 ft. high and 9–12 ft. in girth in its native country, with the trunk often forked near the base, and a rounded head of branches. *Bark* of old trees brownish, deeply furrowed, scaly. *Young shoots* slender, greyish brown, very hairy. *Winter buds* minute, ovoid, with hairy scales. *Leaves* with a comb-like arrangement, the shorter ones on the upper side of the shoot, ¼–⅝ in. long, tapering slightly from the base to the blunt or rounded apex; lower surface with two well-defined white bands of stomata. *Cones* ovoid, ½–1 in. long on slender stalks; *scales* few, roundish, striated, with entire margins, the concealed part minutely downy; *bracts* small, concealed. *Seed* small with an oblong wing; ripening the first autumn.

Var. argentea.

T. canadensis, var. albo-spica.

Tips of young shoots white.

Var. macrophylla.

Leaves larger than in the type.

Var. milfordensis.

Of compact habit with weeping branches.

Var. parvifolia, T. Smith.

A shrubby form with stout branches and very short leaves about ¼ in. long.

Var. pendula, Beissner.

A shrub or small tree with a dense mass of pendulous branches.

Var. Sargentii.

Branches short, pendent, forming a dense flat-topped mass of foliage. Found on the Fishkill Mountains, New York.

T. canadensis differs from *T. Albertiana* in its forked trunk and in the leaf being more conspicuously narrowed towards the apex with paler and more clearly defined stomatic lines.

The eastern hemlock is a native of Canada, east of the Rocky Mountains, and of the E. United States, extending from Nova Scotia and New Brunswick westwards through Ontario to E. Minnesota, southwards to Delaware, S. Michigan, and Cent.

Photo. by L. J. Wallis

PLATE XXX. EASTERN HEMLOCK (*TSUGA CANADENSIS*).

Wisconsin. It is also found on the Appalachian Mountains as far south as Alabama. It was introduced by Peter Collinson in 1736 and has been widely planted in Europe as an ornamental conifer.

Wood rather soft, inclined to splinter, often knotty, durable, holds nails well, heartwood pale yellow or sometimes brownish, sapwood a little lighter in colour, but the distinction not great. Used for telegraph and telephone poles, sleepers, for inferior building purposes, boxes, crates, paper pulp, and other purposes. It is less generally useful and coarser than western hemlock. The timber is exported from Quebec, Montreal and other E. Canadian ports in boards and planks up to 16 ft. long. The Canadian Forest Products Laboratory tests on green material are recorded as follows :—

[1] " *Weight green* (moisture 25 per cent., wood 75 per cent.), 30 lb. per cubic ft.

Tension, strength across the grain, 423 lb. per square in.

Compression, strength across grain at elastic limit, 350 lb. per square in.

Compression, crushing strength with the grain, 2,930 lb. per square in.

Shearing, strength with the grain, 910 lb. per square in.

Bending, modulus of rupture (breaking strength), 6,475 lb. per square in.

Bending, modulus of elasticity (stiffness), 1,124,000 lb. per square in.

Hardness, weight required to half-imbed a 0·444 in. steel ball, 475 lb."

The bark contains 8–10 per cent. of catechol and is much used for tanning purposes. See also under *T. Albertiana*.

T. canadensis thrives throughout the British Isles and gives excellent results as an ornamental species up to a high altitude in the Scottish Highlands. It thrives in a variety of soils, but is most satisfactory in moist but open loam. As a forest tree it is inferior to *T. Albertiana* and is not utilized here for commercial planting.

Sargent, *Silva of N. America*, xii, 63 (1898).

Tsuga caroliniana, Engelmann.

CAROLINA HEMLOCK.

Abies caroliniana, Chapman. Crag Hemlock ; Hemlock ; Southern Hemlock.

An elegant tree of compact, pyramidal habit attaining, in N. America, a height of 70 ft. and a trunk girth of 6 ft. *Bark* reddish brown deeply-fissured, scaly. *Young shoots* shining grey with scattered, short hairs in the furrows between the leaf bases.

[1] *Catalogue of the Empire Timber Exhibition*, London (1920).

Winter buds ovoid with downy scales. *Leaves* arranged in two opposite ranks, those on the upper side of the shoot, the shortest, $\frac{1}{4}$–$\frac{3}{4}$ in. long, with a rounded apex, dark shining green and grooved above with two well-defined white bands on the lower surface. *Cones* on the short shoots oblong cylindric, 1–1½ in long, with

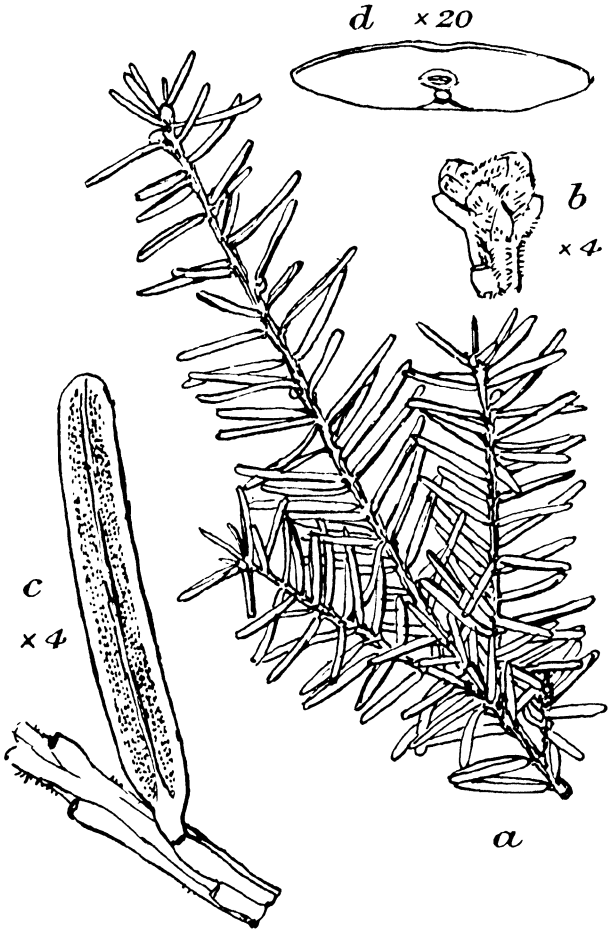

FIG. 116.—*TSUGA CAROLINIANA.*

a, spray; *b*, winter bud and pubescent upper side of shoot; *c*, glabrous under-side of shoot and leaf; *d*, section of leaf.

oblong, rounded, downy scales which spread widely when the cone is mature. *Seed* with a long wing.

This species closely resembles *T. diversifolia*, but has longer leaves which are scarcely notched at the apex.

As a native tree it has a limited range, being only known from the S. Alleghany Mountains, where it is found at an elevation of

2,500–3,000 ft. It was introduced in 1886, but grows very slowly in this country, and we know of no specimens of any size.

T. caroliniana has similar economic properties to *T. canadensis*, but is not plentiful enough to be of much value. Cultivation similar to that of *T. canadensis*.

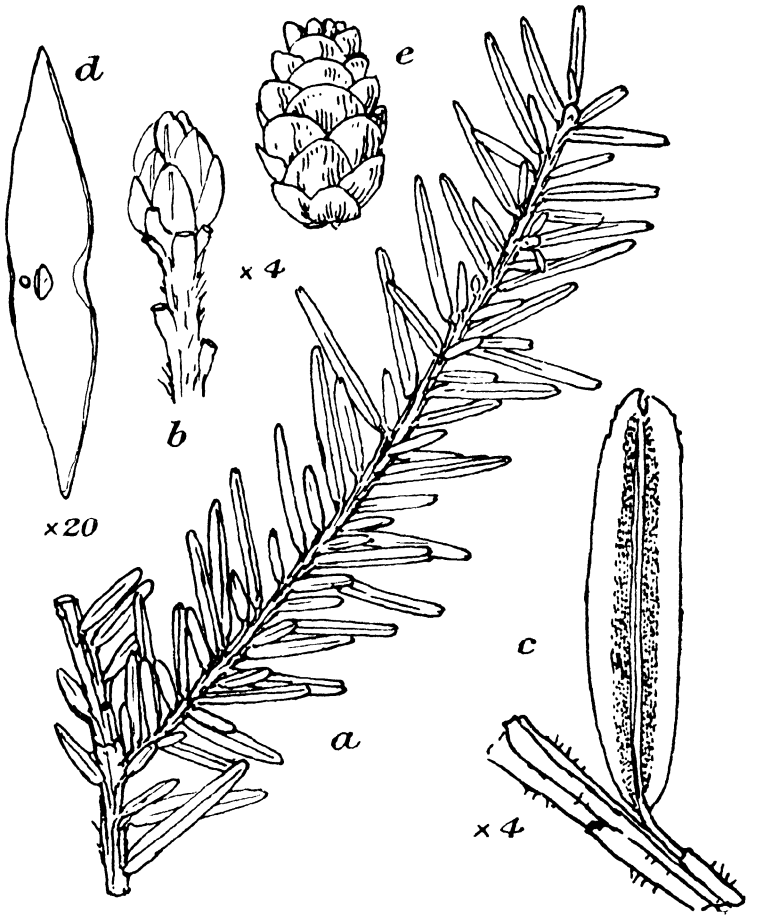

FIG. 117.— *TSUGA CHINENSIS*.

a, branchlet; *b*, winter bud, *c*, under-side of leaf and shoot; *d*, section of leaf, showing single resin canal; *e*, cone.

Tsuga chinensis, Pritzel. (Fig. 117.)

CHINESE HEMLOCK.

Tsuga yunnanensis, Masters (in part); Abies chinensis, Franchet.

A hemlock 100 or more ft. high in China, or occasionally a small, densely pyramidal tree. *Young shoots* with a yellowish tinge, more or less hairy. *Leaves* up to 1 in. long, rounded and minutely notched at the apex in adult trees, with inconspicuous

lines of stomata on the lower surface, margins entire or with minute short teeth in young plants. *Cones* ovoid, about 1 in. long and broad, with polished rounded scales which are turned inwards at the summit.

Distinguished from *T. diversifolia* by its longer and wider leaves, and from *T. Sieboldi* by its hairy shoots. A tree of wide distribution in Cent. and W. China, being fairly abundant in the extensively forested regions of W. Szechuen. The wood is there used for shingles and for building purposes. Introduced by Wilson for Messrs. Veitch in 1900, but it appears to be of slow growth as none of the cultivated plants are of any size.

Masters, *Gardeners' Chronicle*, 1906, p. 236, fig. 93 (as T. yunnanensis); Wilson, Plant s Wilson s ii, 37 (1914). Bot. Mag. t, 9193 (1930).

Tsuga diversifolia, Masters. (Fig 118.)

NORTHERN JAPANESE HEMLOCK.

Tsuga Sieboldi, var. nana Carriére.

A tree of pyramidal outline, similar to *Tsuga Sieboldi* in habit but usually of smaller dimensions, height 50–80 ft. with a trunk up to 7 ft. in girth. *Bark* red. *Young shoots* hairy. *Buds*, pear-shaped, minutely downy. *Leaves* arranged like those of *T. Sieboldi*, but usually shorter and less polished, ¼–½ in. long, with entire margins. *Cones* with very short or rudimentary stalks, ovoid, with rounded-oblong, polished scales which have bevelled margins. *Seed wing* short, not decurrent.

Distinguished from all the other hemlocks by its hairy shoots, and leaves with entire margins.

A native of Japan, where it has a more northerly distribution than *T. Sieboldi*. Wilson [1] states that it is a common inhabitant of the forests of nearly all the mountains of Cent. and S. Hondo. Although introduced into cultivation as long ago as 1861, it has never attained any size in this country and specimens more than a few feet high are rare. Sargent [2] says of this tree: "The great forest which covers the Nikko Mountains at an altitude of more than 5,000 ft. is composed almost entirely of the northern hemlock, *Tsuga diversifolia*, which is distinguished by its bright red bark, small leaves and small cones. This hemlock forest, which is the only forest in Hondo which seems to have been left practically undisturbed by man, is the most beautiful which we saw in Japan."

Cultivation and economic uses similar to those of *T. Sieboldi*.

Tsuga formosana, Hayata.

FORMOSAN HEMLOCK.

A new species of hemlock described by Hayata, and based on specimens found on Mount Morrison, Formosa, by S. Nagasawa

[1] *Conifers of Japan*, 50 (1916). [2] *Forest Fl. of Japan*, 81 (1894).

in 1905. *Young shoots* slender, pale yellowish, without down. *Buds* with obtuse scales. *Leaves* about ½ in. long, rounded, entire or minutely notched at the apex, margins without teeth, lower surface with indistinct lines of stomata. *Cones* about ¾ in. long; *scales* roundish, pale brown, *bract* very short. *Seed* with a wing twice its length.

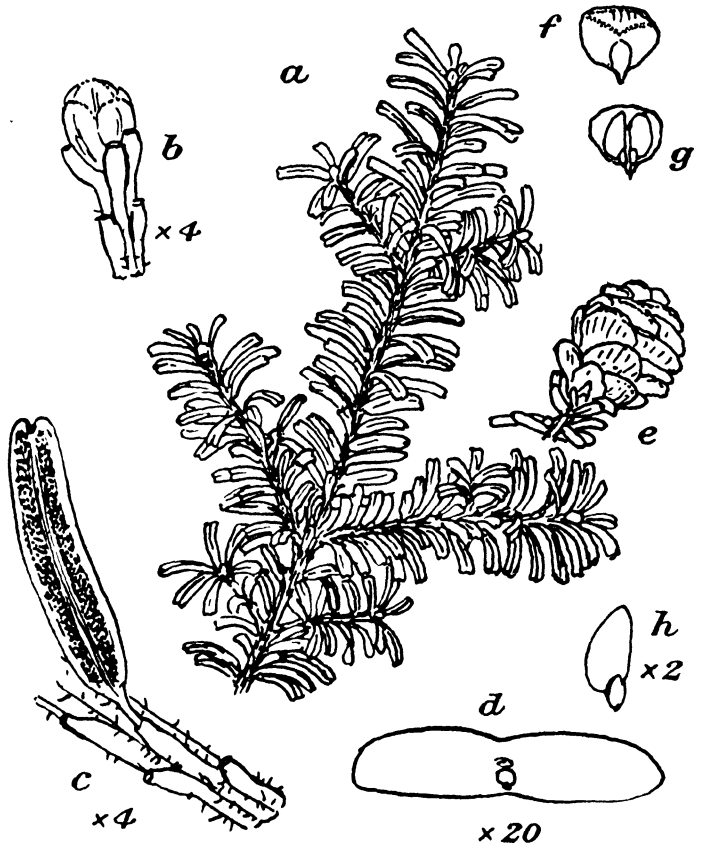

FIG. 118.—*TSUGA DIVERSIFOLIA.*

a, spray; *b*, winter bud; *c*, under-side of shoot and leaf; *d*, section of leaf, showing single resin canal; *e*, cone; *f*, cone-scale with small bract; *g*, cone-scale, inner side, with seeds; *h*, seed.

Tsuga Jeffreyi, Henry.

JEFFREY'S HEMLOCK.

Tsuga Pattoniana, var. Jeffreyi, Elwes and Henry; Abies Pattonii, Jeffrey.

This tree was for a long time regarded as a form or variety of *Tsuga Pattoniana*, but differs markedly from that plant in the following characters. Foliage dull or dark green not grey or glaucous green. *Leaves* spreading at right angles to the shoot

and not pointing forwards, about ½ in. long, and 1/16 in. or less broad, margins usually finely but obscurely toothed in the upper half; upper surface flattened, distinctly grooved almost to the rounded apex, lower surface with lines of stomata the whole length of the leaf, upper surface with a few broken lines of stomata near the apex.

According to A. Murray[1] this hemlock was raised at Edinburgh [2] in 1851 from seeds collected on the Mount Baker range in British Columbia by Jeffrey, but the dried specimens received subsequently from him are the ordinary grey-leaved form of *T. Pattoniana*. *Tsuga Jeffreyi* was only known as a cultivated tree until a few years ago, when a young plant identical with it was discovered by Mr. M. Hornibrook among some seedling conifers which had been dug up when a few inches high in the mountains behind Cowchan Lake, Vancouver, and sent to him for cultivation at Knapton, Queen's County, Ireland.

T. Jeffreyi appears to occupy a position midway between *T. Albertiana* and *T. Pattoniana*, and the latest view expressed by Henry [3] is that it is a hybrid between these species. This view is supported by the fact that both the assumed parents are found growing together on Mount Baker range, and in Vancouver.

There are small trees of this hemlock, evidently of considerable age, at Kew, Woburn and Westonbirt, and younger plants elsewhere. It will perhaps prove to be not uncommon when looked for, having probably been passed over as a green-leaved form of *P. Pattoniana*.

This plant is of no economic importance. In cultivation it may be treated as other hemlocks.

McNab, *Proceedings of the Royal Irish Academy*, ii, 209 (1875); *Journal of the Linnæan Society*, xix, 208 (1882).

Tsuga Pattoniana, Sénéclauze.

MOUNTAIN HEMLOCK.

Tsuga Hookeriana, Carrière; Abies Pattoniana, Jeffrey; A. Williamsoni, Newberry; Hesperopeuke Pattoniana, Lemmon; Pinus Pattoniana, Parlatore. Alpine Hemlock; Patton's Hemlock; Weeping Spruce.

A tree occurring at high elevations in W. N. America, where it occasionally attains a height of 150 ft. with a girth of 15 ft., its average height being below 100 ft. *Bark* dark reddish brown, scaly, very thick and roughly corrugated in old trees. *Young shoots* brownish grey, densely hairy. *Branchlets* unequal in length, the shorter ones arising on the upper side of the longer, forming a tufted spray of foliage. *Leaves* closely set, spreading

[1] *Proceedings Horticultural Society*, ii, 202 (1863).

[2] The original tree in the Edinburgh Botanic Garden is dead, but a seedling, now about four feet high, has since appeared as a casual along with a species of Rhododendron sent from the Selkirks.

[3] "Notes on Hybrid Conifers" (*Proceedings of the Royal Irish Academy*, September, 1919, p. 56).

all round the shoot, more or less curved and pointing forwards, ¾–1 in. long, with a rounded or short-pointed apex; upper surface convex and keeled towards the tip, lower surface rounded and grooved towards the base, with inconspicuous lines of stomata on each surface, giving the foliage a greyish or glaucous tinge. *Cones* sessile, oblong, cylindrical, slightly narrowed at the base and apex, up to 2½ in. long, and 1 in. wide when expanded; *scales* thin, broader than long, downy, margin irregularly toothed, spreading when ripe. *Seeds* bright brown, $\frac{3}{16}$ in. long, with a wing up to $\frac{7}{16}$ in. long, and ¼ in wide.

T. Pattoniana may be distinguished by its spirally arranged greyish or glaucous leaves, and by its cylindrical cones which are larger than those of any other species.

This tree has a similar distribution to *T. Albertiana* in W.N. America, but extends farther south in California. It is generally an alpine species, occasionally reaching 11,000 ft. altitude, when it becomes very stunted, and has erect cones. In the Pacific region it is found at sea-level. In British Columbia it ascends to an altitude of 2,000–3,000 ft. It was introduced into cultivation in 1854 by Wm. Murray, who found it on Scott's Mountain, British Columbia; but it grows slowly in this country, and specimens 40 ft. high are rare.

Wood light, soft, close-grained, rather brittle, polishes well; heartwood brown, with a pinkish tinge, sapwood lighter; takes polish well. Used for building purposes, fencing, fuel, etc.

T. Pattoniana forms a handsome decorative plant, its shapely habit, dense branch system, and glaucous leaves combining to make it an attractive and useful evergreen, but it is more at home amidst the hills of Wales and Scotland than on low ground near smoky towns. Soil conditions similar to those recommended for *T. Albertiana* are suitable for this tree. Its only value here is as a garden or park specimen.

Tsuga Sieboldi, Carrière.

JAPANESE HEMLOCK.

Tsuga Tsuja, A. Murray; Abies Araragi, Loudon; Abies Tsuga, Siebold and Zuccarini; Pinus Araragi, Siebold; P. Tsuga, Antoine. Japanese Hemlock Spruce; Tsuga.

A tree 100 ft. high and 12 ft. in girth in its native localities, but of much smaller dimensions in cultivation. *Bark* thin, grey, furrowed. *Young shoots* light, shining brown, without down. *Buds* small, ovoid, reddish. *Leaves* mostly arranged in two opposite ranks, variable in size, ¼–½ in. long, the shorter ones usually on the upper side of the shoot and spreading outwards at right angles to it, shining dark green and grooved above, entire, notched at the rounded apex with two well-defined bands of stomata on the lower surface. *Cones* ovoid, ½–¾ in.

long; *scales* rounded, glossy, with a bevelled margin; *bracts* concealed, very short with a cleft apex. *Seed wing* decurrent.

Recognized by its polished, notched, yew-like leaves and hairless shoots.

This hemlock occurs wild in the mountain forests of S. Japan, where it has much the same distribution as *Abies firma*. According to Wilson the finest trees are found in the moist, rich mountain forests of Shikoku, S. Hondo, and Kyushu.

Wood, light, slow-growing, moderately hard; heartwood, reddish brown, sapwood lighter. It is sometimes prettily marked and such timber is esteemed for furniture. Its chief uses, however, are for building purposes and paper pulp. The bark is rich in tannin, and it is one of the chief tanning barks of Japan.

In Britain its use is confined to ornamental planting, and it is generally seen as a bush or a small tree of dense habit. The yew-like foliage is less sombre than that of the common yew, and the habit less stiff, therefore it can be planted with advantage as a change from that tree. It succeeds in any good garden soil where the atmospheric conditions are suitable, and is increased by seeds or cuttings.

Tsuga yunnanensis, Masters. (Fig. 119.)

YUNNAN HEMLOCK.

Tich sha.

A tree 100 or more ft. high in China with a trunk up to 20 ft. in girth, and stout branches. *Young shoots* reddish grey, covered with dense, stiff hairs above. *Leaves* ½–¾ in. long, rounded or acute, and entire at the apex with two conspicuous white bands of stomata beneath. *Cones* ovoid, ½–¾ in. long; *scales* few, roundish, slightly reflexed at the apex.

Native of Yunnan and W. Szechuen. According to Wilson it is a much more local tree than *T. chinensis*, from which it is readily known by its narrower leaves, which are entire and not notched at the apex, and by its smaller, dull-coloured cones. Plants have been introduced under this name, but they are not large enough yet to determine whether they are true to name. The wood is used for shingles, and for building purposes in China.[1]

We have seen the true *Tsuga yunnanensis* from the Marquis of Headfort's estate at Headfort, Kells, Ireland, where a young plant appears to be making vigorous growth.

WIDDRINGTONIA, Endlicher.

CYPRESS PINES.

Pachylepis, Brongniart.

S. and Trop. African evergreen trees, or occasionally shrubs, belonging to the tribe *Cupressinæ* and closely allied to *Callitris*.

[1] Wilson, *A Naturalist in China*, i, p. 225 (1913).

Leaves of juvenile plants spirally arranged, linear, flat, long-pointed; on older trees (except on long shoots) scale-like and arranged in alternating opposite pairs; on long shoots usually intermediate, but sometimes juvenile and mature types of leaves

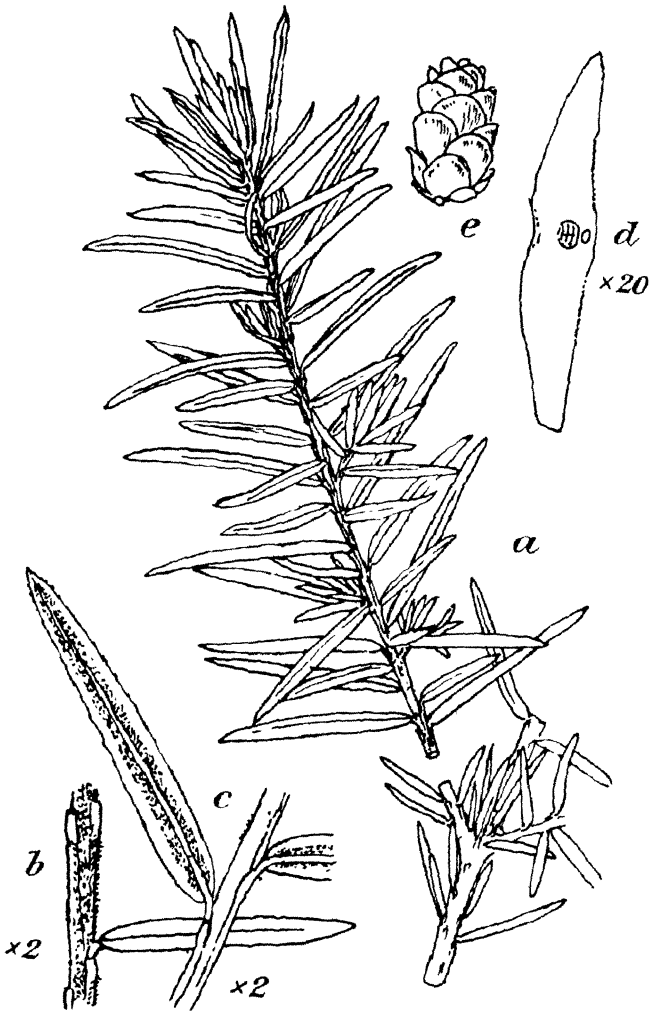

FIG. 119.—*TSUGA YUNNANENSIS.*

a, spray; *b*, portion of pubescent upper side of shoot, and leaf; *c*, glabrous under-side of shoot and leaf; *d*, section of leaf; *e*, cone.

and transitional forms are found. *Male and female* flowers borne on the same plant; the former terminate short shoots and are small, solitary, and stalkless; the female flowers axillary, shortly stalked or sessile; usually composed of 2 pairs of scales, each bearing 5 or more ovules at the base. *Cones* ovoid or globose,

erect, woody, smooth or rough, persisting for some time after shedding the seed. *Seeds* numerous, oval or ovoid, sometimes curved, with 2 wings. *Cotyledons* two.

Differs from *Callitris* in its smaller leaves, arranged in pairs, and (normally) 4 scales to the cone.

Wood of good quality, fragrant, easily worked, durable, and useful for similar purposes to that of *Pinus Strobus*.

The Widdringtonias can be grown out of doors in the mildest parts of Britain, but have no value for silvicultural purposes.

Masters, *Journ. Linn. Soc.* xxx, 205 (1893), and xxxviii, 267 (1905); *Flora of Trop. Africa*, vi, Sect. 2, pt. 2; Sim, *For. Flora of Cape Colony* (1907) and *Native Timbers of S. Africa* (1921).

Widdringtonia cupressoides, Endlicher.

SAPREE-WOOD.

Callitris cupressoides, Schrad. Berg Cypress.

A shapely shrub 6–12 ft. high, main branches 3–8 in. in diameter. *Branchlets* compact, erect. *Leaves* of young plants up to $\frac{1}{2}$ in. long; adult leaves small, closely pressed, triangular, blunt. *Cones* with 4 relatively smooth scales, $\frac{1}{2}$–$\frac{3}{4}$ in. long and wide, 2 of the scales broader than the other pair.

Distinguished from *W. juniperoides* by its dwarf habit and smooth scales.

Native of Table Mountain range and extending east and north to Natal and the Drakensberg.

The timber is of no commercial importance.

Widdringtonia dracomontana, Stapf.[1]

A plant allied to (and by Sim said to be inseparable from) *W. cupressoides*, from which it differs in its rough cone-scales.

Found in the Drakensberg range in Natal (Weenen District, and the headquarters of the Bushman's River between Catkin Mountain and Mont aux Sources), forming isolated woods or clumps at high altitudes.

Economic uses as in *W. juniperoides*.

Widdringtonia equisetiformis, Masters, based on a specimen at Kew (Baur, 1164) from the Katbergen, Stockenstrom, Div. S. Afr., turns out on further investigation to be only a cultivated form of *Callitris robusta*.[2] It was probably introduced at a mission station.

Widdringtonia juniperoides, Endlicher.

CLANWILLIAM CEDAR.

Callitris arborea, Schrad. Cedarboom.

A widely branched tree 20–60 ft. high. *Leaves* of juvenile

[1] *Kew Bull.* 1918, 206.

[2] *Journ. Linn. Soc.* xxxvii, 332 (1906).

plants spirally arranged, $\frac{1}{2}$–$\frac{3}{4}$ in. long, glaucous green. Those of long and leading shoots of older trees also spirally arranged, but shorter. Other leaves scale-like, in alternating pairs, covering the twigs, apex blunt. *Cones* solitary or several together, on short, lateral shoots, $\frac{1}{3}$–$\frac{3}{4}$ in. long and wide before expansion, globose; *scales* normally 4 (occasionally 6); woody, warted, strongly spurred near the apex. *Seeds* angular, narrowly winged, resinous.

Found on the Cedarberg mountains, where the forests represent an area of about 60 square miles. The altitude ranges from 3,000–4,000 ft., the best trees being found below 3,450 ft. The winters in this region are very cold and wet, the rest of the year hot and dry. The annual rainfall varies between 20–40 in., and the precipitation is confined to winter.

Wood moderately hard, yellowish, clean, fragrant, easily worked, practically free from insect attack, and much used for cabinet and furniture manufacture. It withstands damp well, and is durable when used for posts, but liable to injury from ground fires. From leaves, cones, and wood a hard resin is obtained, whilst the bruised leaves taken with brandy are said to have diuretic properties.

This tree seeds and regenerates well, but is very inflammable, and considerable losses have taken place through forest fires. With protection from fire it is a good tree for hot and dry places, and the possibilities of extended cultivation are occupying the attention of the S. African Forest Service.

Sim, *loc. cit.*

Widdringtonia Schwarzii, Marloth.

A well branched tree 50–80 ft. high. *Leaves* short, thick, blunt, closely pressed, arranged in 4 rows, and densely covering the shoots. *Cones* $\frac{1}{2}$–$\frac{3}{4}$ in. across when expanded, cone-scales more or less warted, and about $\frac{3}{8}$ in. wide.

Closely allied to *W. juniperoides*, but differing in its smaller, thicker, and blunter leaves and relatively smaller cones.

Found in the Willowmore district, Cape Province.

Widdringtonia Whytei, Rendle.[1]

MILANJI CEDAR.

Widdringtonia Mahoni, Masters.

A large tree up to 140 ft. high with a clear trunk of half the height, and 15 ft. in girth. *Bark* of old trees very thick, fibrous, the outer layer shed annually. *Branches* symmetrical in young trees, forming a wide-spreading head in old trees. *Branchlets* divided into small spray. *Leaves* of the juvenile state spirally arranged, glaucous green, up to 1 in. long, $\frac{1}{16}$–$\frac{1}{12}$ in. wide,

[1] *Trans. Linn. Soc.*, ser. 2, Bot. iv, 60, t. 9, figs. 6–11 (1894).

long-pointed, gradually becoming smaller as the tree advances in age until they are scale-like, arranged in opposite pairs and pressed close to the shoot. *Cones* ovoid, ⅓–¾ in. across, ½–1 in. long; *scales* 4, one pair slightly shorter than the other, woody, roughened with small warts, narrowed to and conspicuously spurred near the blunt apex. *Seeds* ovate or lance-shaped, dark brown, with two wide-spreading wings.

The Mlanji cedar was first reported from the Mlanji Mountains by Mr. Alexander Whyte in 1891. It has since been reported from Zomba, Melsetter, Chimanimani, and the N. Transvaal. The late Dr. Masters named the tree from the Chimanimani range, Rhodesia, *W. Mahoni*, by reason of its dull dark green (not glaucous green) leaves and its more oval, short-stalked cones. As these characters have since been found to be unreliable the tree is now included with *W. Whytei*. Mr. Whyte [1] described the Mlanji cedar as the most prominent tree in the forests in 1892, but reported that it was fast disappearing through the prevalence of forest fires. In 1895 Mr. John McClounie made an official survey of the forests and reported to the Colonial Office the following year.[2] He estimated that the best forest occupied 700–800 acres of the plateau round the source of the Tuchila river; there were 200 acres around the Likubula and a further 100 acres about the Luckenya, averaging altogether about 150,000 large trees. These trees were protected, and as early as 1895 plantations had been started elsewhere. A good deal of subsequent planting has been done in the Shire Highlands, and Hutchins reported[3] that "planted trees are doing well in Kenya Colony."

Wood yellowish or light yellowish brown, fragrant, straight-grained, easily worked, of excellent quality, equalling the best yellow pine, and suitable for general building purposes. It is one of the most useful timbers of the region and may become one of the most important soft-woods of the African continent. As the wood is very inflammable, trees are easily injured by forest fires.

W. Whytei thrives in Cornwall, and a tree grew well for a number of years in the garden of the late Mr. Osgood Mackenzie in Ross-shire.

[1] *Kew Bull.* 1892, pp. 122–123.
[2] *Loc. cit.* 1896, pp. 216–217.
[3] *Forest. Rep. Kenya Col.*

PART III
GINKGOACEÆ

GINKGOACEÆ.

Ginkgo, Linnæus.

A monotypic genus on which the family *Ginkgoaceæ* is founded, differing from *Taxaceæ* and *Pinaceæ* in several essential characters, notably in its wide, flattened leaves and motile male sperms. By the latter character it is allied to *Cycadaceæ* and to the *Ferns*. The single species is the sole survivor of one of the most interesting families of trees, widely distributed in the temperate regions of both hemispheres in earlier geological times, and once even included in the forest flora of the British Isles.

Ginkgo biloba, Linnaeus. (Fig. 120.)

MAIDENHAIR TREE.

Salisburia adiantifolia, Smith.

A deciduous tree up to 100 ft. high with a trunk 18–20 or more ft. in girth, often slenderly pyramidal and sparsely branched when young, becoming spreading with a dense head in after-life. *Bark* greyish, deeply furrowed on old trees. *Branches* irregularly whorled or produced at indefinite intervals, some erect and forming duplicate leaders. *Branchlets* horizontal or drooping, beset with short spur-like shoots, as in larch and cedar, which may continue to produce clusters of leaves annually for many years and then suddenly lengthen out into long shoots bearing scattered leaves. *Buds* conical, short-pointed, with bright brown scales. *Leaves* on stalks up to 3 in. long, fan-shaped, resembling the pinnule of a maidenhair fern, usually 2–3 in. across, but on vigorous young trees sometimes 6–8 in. across, light green when young, darker towards midsummer, golden in autumn; the upper margin divided into two large lobes, usually undulated or irregularly notched, with no midrib, but with numerous branching parallel veins; stomata on both surfaces. *Male and female flowers* produced on different trees. *Male flowers* appearing early in May from the short shoots as pendulous catkins (3–6 on one shoot), bearing numerous loosely arranged stamens. *Female flowers* arising from short shoots in pairs or in threes, each consisting of a long stalk bearing on either side

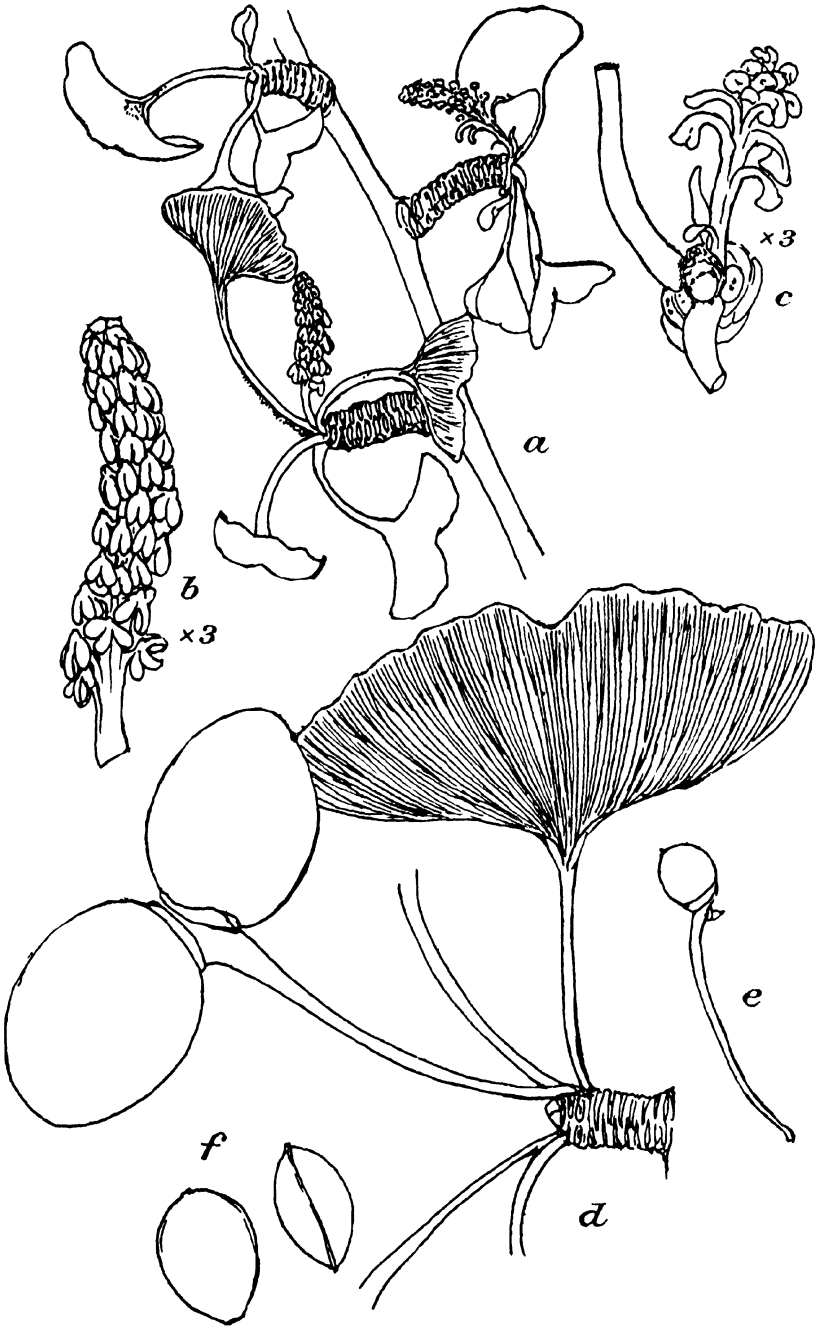

FIG. 120.—*GINKGO BILOBA.*

a, spray with young leaves and stamen catkins; *b*, *c*, male catkin; in *c* the lower stamens are transformed into small leaflets; *d*, shoot with leaf and two ripe fruits; *e*, young fruit and unfertilized ovule; *f*, stone of fruit in two aspects.

below the apex, a naked ovule, which is surrounded at the base by a collar-like rim, the nature of which has given rise to much discussion.[1] *Seed* with a fleshy outer covering resembling a small plum, orange-yellow in colour, enveloping a woody shell which contains an edible kernel. In falling to the ground in autumn the fleshy covering of the seed bursts and emits a most offensive odour. Fertilization differs from that of other trees except *Cycads* and *Ferns*, for the ovules are fecundated by motile sperm-cells conveyed to them by the pollen tubes. This discovery was made by Prof. Hirase at Tokyo in 1895–6.[2] Fecundation takes place in early autumn, and the development of the embryo is completed after the seeds have fallen to the ground.

The following forms are known in cultivation :—

Var. **fastigiata.**

Columnar in form, the branches being almost erect.

Var. **macrophylla laciniata.**

Leaves larger and more deeply cut than in the typical form.

Var. **pendula.**

Branches more or less weeping.

Var. **variegata.**

Leaves variegated with pale yellow.

It is doubtful if *Ginkgo* exists anywhere in a wild state, although it has been recently found growing spontaneously over some ten square miles near Changhua Hsien in the Chekiang province in China, where the trees are stated to be so common that they are cut for firewood.[3] In China, Manchuria, and Corea it is commonly planted, especially in the grounds of Buddhist temples, where magnificent specimens, some of them reputed to be over 1,000 years old (and probably preserved by Buddhist priests) are met with. Its introduction to Japan is thought to have been brought about by Buddhist priests, and magnificent examples are found in the precincts of temples and palaces. One seen by Wilson at Tokyo in 1914 was 82 ft. high and 28 ft. in girth. A male tree which he saw near the Min River above Kiating, W. China, in 1908, was 100 ft. high with a trunk 24 ft. in girth, and branches sweeping the ground.

The maidenhair tree was first made known to Western botanists by Kaempfer, a surgeon in the employ of the Dutch East India

[1] Shaw, *New Phyt.* vii, 85–92 (1908), and Coulter and Chamberlain, *Morphology of Gymnosperms*, 194 (1910).
[2] *Journ. Coll. Sci., Tokyo*, viii, pt. 2 (1895) and xii, pt. 2 (1898).
[3] *Pl. Wils.* ii, 1 (1914).

Company, who discovered it in 1690 and published in 1712 a description, with a good figure, of the foliage and fruit.[1] The tree was introduced into Europe in 1730, being first planted in the Botanic Garden at Utrecht. It was introduced into England in 1754. Most of the earlier trees raised, both on the Continent and in Britain, appear to have been males, and the first recorded female tree was one found by De Candolle near Geneva in 1814. Scions from that tree were grafted upon a male tree in the Botanic Garden at Montpellier, where the first perfect seed is reputed to have been produced in Europe in 1835. So far as is known "fruits" (seeds) were not produced in England before 1919, when a grafted branch raised from a scion obtained from Montpellier Botanic Garden in 1911 [2] produced five fruits on the large male tree at Kew. In 1922 a female tree at Bath produced a good crop of fruit.[3] Several cases have been recorded of female trees, far removed from male trees, "maturing fruits," [4] also of male trees suddenly bearing fruits, which has cast doubt on the dicœcious character of the tree, and even suggested the idea that female trees may be parthenogenetic. There is, however, a possibility that grafting has been practised on both male and female trees many years ago, and that records of the operation have been lost. Owing to the disagreeable odour of the fallen "fruits" the male tree is the best for gardens, but it is doubtful whether these can be recognised before flowers are produced. Some observers say that certain differences besides the flowers exist in male and female trees, the former being pyramidal and upright in habit, and losing its leaves earlier than the latter, which is moreover closer and more compact in habit. Both Sargent and Wilson, however, who have had a wide experience with the tree in China, Japan, and the United States, say that it is impossible to distinguish the sexes until the trees flower.

A peculiarity of growth is noticeable on old trees, particularly in Japan. From the larger lower branches peg-like structures develop which grow downwards, and on reaching the ground develop true roots from their apex and give off branches above. The growths are often very numerous and are sometimes as much as from 12–16 ft. long and 1 ft. in diameter.

Ginkgo wood is light, brittle, yellowish in colour, and of little value. It is said to be used in China and Japan for chess boards, chess men, and chopping blocks, also for firewood. The seeds are a regular article of commerce in Chinese and Japanese towns. They are eaten roasted at feasts, and are credited with promoting digestion and diminishing the effects of drinking wine.

The tree is perfectly hardy in England, where it thrives in a great variety of soils. Many well-grown trees, ranging from

[1] *Amœnitatum Exoticarum*, 811.
[2] *Kew Bulletin*, 47 (1920).
[3] *Loc. cit.* (1923).
[4] *Loc. cit.* 262 (1922).

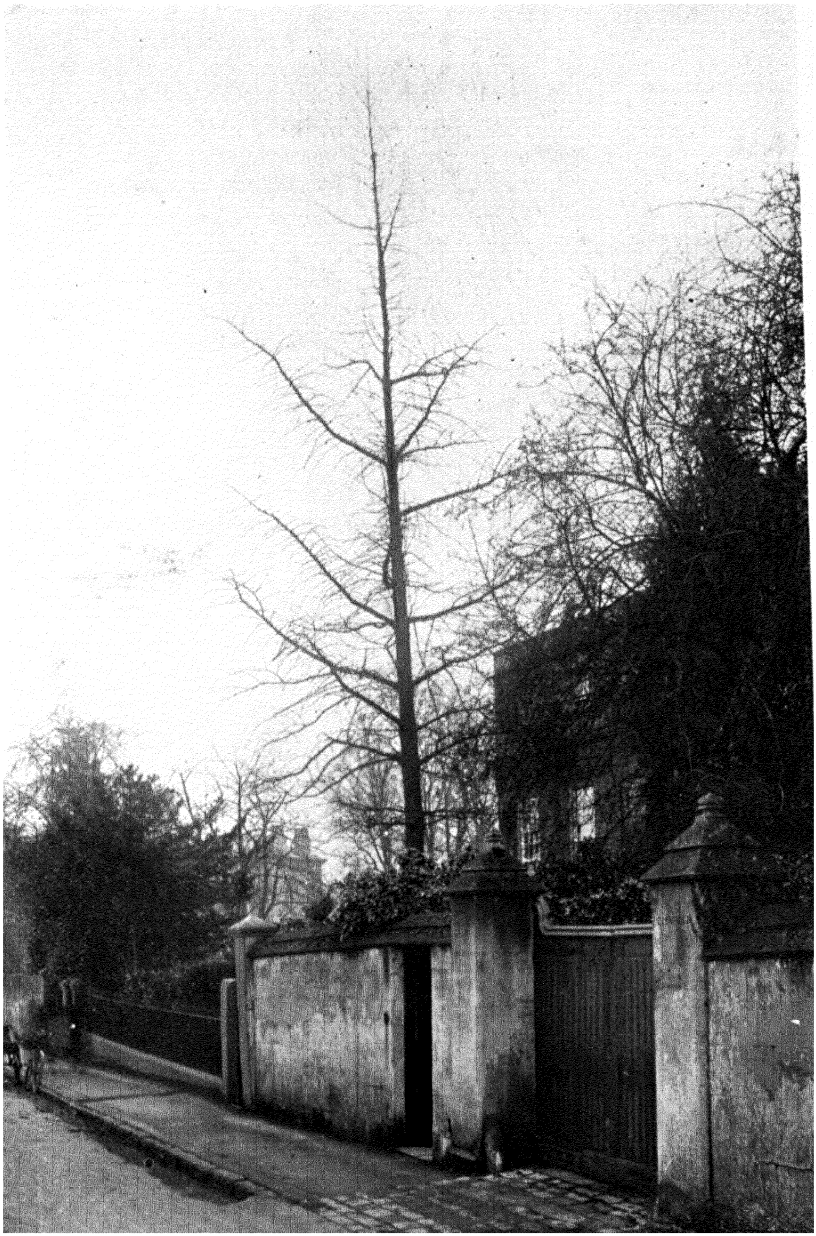

Photo by F. Perven

PLATE XXXI. MAIDENHAIR TREE (FEMALE) *GINKGO BILOBA*, AT BATH.

50–80 ft. in height, are known. The best results may be looked for by planting it in deep moist loam, where the atmospheric conditions are moist and free from impurities. It succeeds, however, under much less favourable conditions, even when planted in the centre of an industrial town. An old tree growing in a small yard between the Gas Works and Brewery at Brentford, and only separated by a wall from the exceedingly busy High Street, is an excellent example of this. Either as an isolated specimen, for planting in groups, or for avenues, the maidenhair tree is equally desirable. Propagation is by seeds, and the varieties are grafted on stocks of the type. It has no value for silvicultural purposes.

APPENDIX

ALPHABETICAL LIST OF SPECIES, HYBRIDS AND VARIETIES NOT MENTIONED IN THE FIRST EDITION.

TAXACEÆ

Cephalotaxus drupacea, var. nana, Rehder.

C. nana, Nakai.

A shrub with erect branches up to 6 ft. high spreading by suckers. *Fruit* as in the type ; *seed* about ¾ in. long.

Native of N. & Central Japan. Introduced to cultivation in 1916.

Journ. Arn. Arb. iv. 107 (1923).

Podocarpus formosensis, Dümmer (Nageia).

This species is closely allied to *P. Nagi* and is based on a specimen at Kew collected by Mr. Schmüser at South Cape, Formosa, on behalf of Mr. A. Henry. It differs from *P. Nagi* in its thicker textured, relatively smaller leaves which are narrowly elliptic or lanceolate elliptic, with obtusely truncate blackened apices which rarely possess the characteristic cusp of *P. Nagi*.

Gard. Chron., Oct. 19, 1912, p. 295.

Taxus Hunnewelliana, Rehder.

T. cuspidata × T. canadensis.

This reputed hybrid resembles *T. cuspidata* but is more graceful in habit with narrower leaves many of which point forward on the shoots, whilst the green margin of the under surface is more than half as wide as the stomatic band and lighter green than in *T. cuspidata*. The leaves usually assume a reddish tint in winter. It originated in America about 1900.

Taxus media, Rehder.

T. baccata × T. cuspidata.

This hybrid is intermediate between the parents. Its outstanding characters are its olive-green branches often reddish above, obtuse slightly keeled bud scales, and leaves similar to those of *T. cuspidata* but more distinctly two-ranked and often horizontally spreading. It was raised about 1900 in the Hunnewell gardens, Massachusetts, by T. D. Hatfield. Rehder recognises two varieties, *Hatfieldii* with erect branches, more vigorous than the type ; and *Hicksii* which is very similar to the Irish Yew in habit.

Torreya Jackii, Chun.[1]

A tree 30–40 ft. high and about 2 ft. in girth or more often a much branched shrub. *Branches* ascending with spreading or somewhat pendulous branchlets, which are greenish brown when young, shining red brown in the second and third years, becoming ultimately dull grey. *Leaves* falcate, gradually tapering to the spine-pointed apex, up to 3½ in. long, about ⅕ in. wide, smelling like sandalwood when bruised or burned. *Fruit* obovoid, an inch or more long, glaucous, stalkless or nearly so.

Discovered near Hsien-Chu Hsien, Chekiang, China, in 1924.

Differs from *T. californica* in its longer falcate leaves and obovoid fruits.

Torreya Fargesii, Franchet.

T. grandis, Rehder & Wils., in part.

A Chinese species allied to *T. grandis* with leaves more gradually pointed, darker green and rather flat above with two more or less distinct grooves along the midrib; seed globose-elliptic, deeply ruminate, almost to the middle. Native of Central and W. China.

Torreya nucifera, var. radicans, Nakai.

This differs from the type by the branches being decumbent and springing from a tufted base. They reach nearly 8 ft. in length and become bright red the second year. The short trunk is commonly less than 2½ ft. in diameter. It was found on the mountains of Audzu, Hondo.

PINACEÆ

Abies alba, Miller (A. pectinata, DC), var. acutifolia. Turrill.

A. Borisii regis, Mattfeld.

A tree with acute leaves as in *A. cephalonica* but with the hairy shoots of *A. alba*. This is described in the Kew Bulletin No. 1, 1925, p. 34, from specimens collected in Bulgaria in 1924. It is one of many forms which indicate the variability of *A. alba* in wild as well as cultivated trees. It is probable that in a natural state hybrids occur between the two species.

Abies Bornmuelleriana, Mattfeld.

A tall tree branching from the base. *Young twigs* glabrous, brown. *Buds* resinous, ovoid, pointed. *Leaves* densely arranged covering the upper side of the shoot, rigid, up to about 1¼ in. long, rounded or emarginate. *Cones* up to nearly 5 in. long, cylindrical, with exserted bracts, and scales up to 1¼ in. wide.

[1] *Journ Arn. Arb.* vi, 144 (1925). *Icones Plant. Sinicarum*, Fasc. i., 14 (1927).

A. Bornmuelleriana is a native of Asia Minor and is intermediate between *A. cephalonica* and *A. Nordmanniana*. From the former it differs in its emarginate leaves, and from the latter in its resinous buds and stiffer leaves which often have stomata on the upper surface.

Abies concolor, var. Wattezii, Beissner.

Leaves pale yellowish at first, changing to silvery white.

Abies Pardéi, Gaussen.[1]

A new species allied to *A. numidica* from which it is said to differ in its pubescent shoots, the leaves having median and not marginal resin canals and the cones with the bracts exceeding the scales.

In cultivation at Les Barres, France.

Abies Gamblei, Hickel.

The tree referred to by us on page 126 as *Abies Pindrow* var. *brevifolia* has since been raised to specific rank by Hickel.[2] the salient characteristics given being :—*Branchlets* reddish-brown, shining, glabrous, smooth. *Leaves* rigid, acute, up to 1½ in. long and about $\frac{1}{10}$ in. wide, shining above, paler below, erect or falcate, arranged parallel with the branchlets. *Cone* not seen.

The chief points of difference from *A. Pindrow* appear to be the reddish-brown not grey branchlets, and the much shorter, rigid, acute, paler coloured leaves. From the other allied Himalayan Fir, *A. Webbiana*, it differs in its glabrous shoots and shorter and narrower leaves.

It has been found in a wild state at Gaurikund in the Garwhal province, W. Himalaya, and we have seen it in cultivation at Bayfordbury, Borde Hill and elsewhere. It is certainly distinct in appearance from typical *A. Pindrow*, but it is doubtful whether it should be accorded specific rank.

Callitris neo-caledonica, Dümmer.

A tree about 25 ft. high with a broad crown. *Third year's branches* stout, round, rough, greyish-brown, clothed with the remains of the decurrent scale leaves ; *current year's twigs* short, articulated, three-angled, leafy, 1–3 in. long, up to $\frac{1}{16}$ in. broad, erect, densely crowded. *Leaves* ternately arranged, imbricate, scale-like, averaging 3·5 mm. long, with prominent dorsal grooves, opaque, minutely denticulate margins and an acute apex.

[1] *Bull. Soc. D'Hist. Nat. de Toul.*, lvii., 357 (1928).
[2] *Bull. Dendr. Soc. de France*, 1929, p. 37.

This species was collected by Schlechter in the Mountains of Ngove, New Caledonia, at an altitude of 3,000 ft.

It is distinguished from its ally, *C. sulcata*, by the short, congested articulate twigs, and the much shorter leaves with prominent dorsal grooves and minutely denticulate, opaque margins.

Cunninghamia Kawakamii, Hayata.[1]

A tree attaining in Formosa a height of 50 ft. and a girth of 4 ft. It is described as intermediate between *C. sinensis* and *C. Konishii* in the shape of the leaves, cones, scales and seeds. It is distinguished from *C. sinensis* in the shorter, less spreading and acuter leaves, in the smaller cones with entire, shorter, more rounded smaller scales, and in the smaller seeds. From *C. Konishii*, this second Formosan species is separated by the longer, acuter, more spreading leaves, and in the larger cones with narrower scales and larger seeds.

It was found by T. Kawakami at 2,000 ft. altitude at Rinkiko, Kyoshriyo.

Cupressus Dupreziana, Camus.[2]

A species based on fragmentary material collected by M. Lavaüden during his journey over the Tassile range in the Sahara, between Rhat and Djanet early in 1925.

It resembles *C. sempervirens*, but differs from that species in its distinctly compressed twigs the small leaves being usually furnished with three glandular pits in the part adnate to the branchlets, and especially by the much smaller and longer cones, the seeds when developed being of regular form, flattened, suborbicular and with wider, thinner wings.

According to Duveyrier extensive forests of this cypress formerly occurred in the region named, but have since been almost completely destroyed for the sake of their timber which has been largely employed for house building at Djanet and Rhat. The increasing dryness of the Sahara climate has also prevented natural-regeneration by seed. According to native accounts trees up to 40 ft. in circumference were formerly found.

Cupressus Forbesii, Jepson.[3]

A slender tree 15–20 ft. high. *Bark* very smooth and shining, reddish-brown to dark cherry red. *Branchlets* quadrangular. *Leaves* bright green, dorsal pits of leaves minute or commonly wanting. *Cones* globose, ¾–1 in. long. *Seeds* reddish-brown.

Native of the Mountains of San Diego County, California.

[1] *Icones Plant. Formosa*, 207 t. xvi. (1915).
[2] *Bull. Soc. Dendr., Fr.*, 1926, p 40.
[3] *Manual of Flowering Plants of California*, 58 (1923).

Cupressus Leylandii, Jackson and Dallimore.[1]

LEYLAND'S CYPRESS.

A vigorous tree of unknown ultimate dimensions. *Branch systems* compact, branchlets flattened. *Leaves* rather similar to those of *C. nootkatensis*. *Cones* ½–¾ in. diameter ; *scales* usually 8 ; *seeds* about 5 on each scale, about ⅕ in. wide, tubercled.

This tree is regarded as being a natural hybrid between *C. macrocarpa* and *C. nootkatensis*, and it was raised in 1911 from seed of the former species by Captain J. M. Naylor of Leighton Hall, near Welshpool. In 1888, however, what is practically an identical tree was raised at Leighton Hall by Mr. C. J. Leyland, uncle of Captain Naylor, the seeds in that case being taken from *C. nootkatensis*. The plants raised at that time were taken to Haggerston Castle, Northumberland where they are still to be seen. In general apppearance the tree most closely resembles *C nootkatensis*, but the larger cones and tubercled seeds are more like those of *C. macrocarpa*.

Cupressus lusitanica, var. flagellifera, A. B. Jackson.

Gard. Chron., Aug., 20, 1927, p. 149.

Branchlets long, pendulous, terminating in bi-pinnate divisions. *Leaves* awl-shaped, slightly spreading at the tips, larger and more spreading on the secondary branchlets. *Cones* large for the species, up to ¾ in. in diameter.

In cultivation at Woburn, Beds.

Analagous forms are *C. pisifera, var. filifera* and *C. Lawsoniana, var. filifera*.

Cupressus nevadensis, Abrams.[2]

A tree 20–60 ft. high in California, with spreading branches forming a broadly conical head. *Bark* fibrous, longitudinally fissured. *Branchlets* distinctly 4-angled. *Leaves* light green, somewhat glaucous, 1·5 mm. broad, acute, with a conspicuous dorsal resin duct. *Cones* broadly oblong to subglobose, 1 in. or more long and about ¾ in. broad. *Scales* 6–8, upper umbos pointed. *Seeds* numerous, glaucous, sparsely papillate, up to ⅕ in. long.

The resinous foliage suggests affinity to *C. Macnabiana* but the larger cones and glaucous seeds show a closer relationship with *C. Goveniana*.

It was found in the Sierra Nevada on Piute Mountains, Kun County, at an elevation of 5,000 to 6,000 ft.

[1] "*Kew Bulletin*," No. 3, 1926, pp. 113–115.
[2] *Torreya*, xix., p. 92 (1919).

Fokienia Kawaii, Hayata.[1]

A tree forming large woods on the Yunnan-Tonkin border. It is said to differ from *F. Hodginsii* chiefly in its smaller cones and in the shape of the seed and seed-wings.

Juniperus centrasiatica, Komarov.

A tree up to 40 ft. high with a dense grey green crown of foliage. *Branchlets* erect, about $\frac{1}{12}$ in. thick. *Leaves* scale-like, triangular from a broad base, bluntish, keeled and mostly without glands. *Cones* blackish, spherical or oblong, about 10 mm. long and broad. *Seeds* solitary, oval, bluntly keeled, rounded at apex.

Found on the Kuen-luen Mountains in Asia, at an elevation of 10,000–12,000 ft.

Juniperus communis, var. nipponica, Wilson.[2]

An alpine shrub distinguished by its deeply sulcate leaves and non-tubercled fruits containing only one seed. It is found on the high mountains of Hondo from the Shinano province northward.

Juniperus distans, Florin.

A species recognised by its laxly arranged branches, pendulous branchlets and dimorphic foliage arranged in whorls of three, some of the leaves being awl or lance shaped and others scale-like and appressed with all transitions, and by the ovoid cones, and the obovoid seeds rounded at the apex or with a small very obtuse point. It is a native of Western Szechuan.

Juniperus fœtidissima, Boissier.[3]

A tree or shrub 10–12 ft. high, very similar to *J. excelsa* and often confused in herbaria with it, but distinct in its stouter squarrose branches, longer more acute leaves which are less appressed at the tips, and by its larger fruits which are only 1–2 seeded. It is a native of Greece, Asia Minor, etc.

Juniperus glaucescens, Florin.

Closely related to *J. Komarovii*, this species is distinguished by the less closely appressed leaves, the slightly smaller ovoid cones, which are about $\frac{1}{4}$ in. long and broad, and the different sculpturing of the seeds.

Native of N.W. Szechuan, China, at Tsipula near Karlong at about 12,000 ft. altitude.

[1] *Tokyo Botanical Magazine*, xxxi, p. 116 (1917).
[2] *Wils. Conif. Japan*, 81 (1916). *Clinton Baker, Illustr. Conif.* iii, 20 (1913).
[3] *Fl. Orient.* v. 710.

Juniperus Komarovii, Florin.

A species allied to *J. tibetica* distinguished by the more slender, erect branchlets, the acute leaves and the smaller cones and seeds. Native of N.W. Szechuan.

Juniperus mekongensis, Komarov.[1]

A tree up to about 40 ft. high with a dense crown of slender spreading branches. *Leaves* ovate, bluntish, up to about $\frac{1}{10}$ in. long with deeply impressed glands. *Cones* ovate, blackish. *Seeds* solitary, almost spherical, about $\frac{1}{4}$ in. long by $\frac{1}{5}$ in. broad, pitted.

It is found in E. Tibet on the Zsachju, a tributary of the Mekong, at about 10,000 ft. altitude, and differs from the allied species in its slender branchlets and small pitted seeds.

Juniperus Potanini, Komarov.[2]

A tree up to about 50 ft. high with upright branches and very slender branchlets. *Scale-leaves* densely appressed, bluntish, dark green. *Cones* spherical, blackened, shining, about $\frac{1}{5}$ in. in diameter. *Seeds* ovate-conical, acute, smooth or wrinkled about 10 mm. long.

It is a native of the Province of Szechuan in Ta-tsien-lu, W. China and is easily distinguished from allied species by the conical pointed seeds.

Juniperus Przewalskii, Komarov.[3]

A tree up to 40 feet high. *Branches* and *branchlets* spreading or erect. *Leaves* scale-like, spreading or appressed, grey-green about $\frac{1}{10}$ in. long, rather acute, tubercled on the back. *Cones* $\frac{3}{5}$ in. wide, reddish-brown. *Seeds* obcordate or irregularly spherical keeled, obtusely wrinkled on the two sides, about $\frac{3}{5}$ in. long.

A native of Western China, in the eastern part of the Province of Kansu.

This juniper differs from allied species in the size of the cones, the size and sculpturing of the seeds and in the habit.

Juniperus Pseudo-Sabina, Fischer & Meyer.[4]

A shrub similar to *J. Sabina* in habit. *Leaves* like those of *J. Wallichiana* but less acute. *Fruit* smaller, recurved, often globose.

A native of the Altai and the Tarbagatai mountains in Turkestan.

[1] Komarov, *Not Syst. ex Herb. Hort. Bot. Reipubl. Ross*, v. 2., p. 28 (1924).
[2] *Loc. cit.*, p. 28.
[3] *Loc. cit.*, p. 28.
[4] *Index Sem. Hort. Petrop.* 65, (1841) and Plant *Schrenk.* ii. 13, (1842.)

Juniperus ramulosa, Florin.

A plant allied to *J. convallium* differing in the more slender branchlets, paler colour of the foliage and the nearly smooth seeds.

Native of N.W. Szechuan, China, at Ndröme (Chin. Mao-niu), 10,000 ft. altitude.

Juniperus recurva, Buchanan-Hamilton.

Coffin Juniper.

The so-called Coffin Juniper is represented in many gardens by thriving young plants raised from seed collected from trees found by Farrer and Cox at the entrance to the Chimili Valley, Upper Burma, where the timber is extensively used for coffins. Wilson considered it to be a form of *Juniperus Wallichiana* to which, however, it bears no resemblance in foliage. As it has the pendulous habit and ovoid one-seeded fruit peculiar to *Juniperus recurva*, we place it provisionally in that species for reconsideration when more mature plants are available.

Juniperus squamata, var. **Meyeri**, Rehder.

An erect many-branched shrub with short, straight branchlets. *Leaves* narrowly lance-shaped, up to about $\frac{1}{2}$ in. long, very glaucous on the back. A very handsome plant.

Var. **Wilsonii**, Rehder.

An erect shrub up to 6 ft. high with short crowded branchlets recurved at the tips. *Leaves* shorter and broader than in the type, crowded, broadly lance-shaped, about $\frac{1}{5}$ in. long. Both varieties are found in W. China.

Juniperus tibetica, Komarov.

A tree up to 90 ft. or more high with a very dense crown and short erect branches. *Leaves* almost triangular, oblong to almost linear. *Cones* reddish-brown, shining, up to $\frac{3}{5}$ in. long. *Seeds* spherical, up to $\frac{2}{5}$ in. long, obtuse, four angled, pitted and tubercled.

Found in Eastern Tibet and in the province of Kansu, W. China, from 10,000 to 12,000 ft. elevation.

It differs from the allied species in the obtuse 4 angled seeds.

Juniperus turkestanica, Komarov.

A tree up to about 40 ft. high or a shrub less than 6 ft. high with a dense crown. *Branches* erect or spreading. *Leaves* scale-like, about $\frac{1}{12}$ in. long with strongly impressed glands. *Cones* spherical or more frequently oblong $\frac{1}{2}$–$\frac{2}{3}$ in. long up to about $\frac{1}{2}$ in. in diameter,

blackish, shining, somewhat glaucous, with very succulent flesh. *Seeds* oblong or spathulate up to about ¼ in. long and about ⅛ in. broad, grooved, with a hard testa. Placed by other authors under *J. pseudo-Sabina, Fisch & Mey.* which differs however, in its much stouter branches, and cones twice the size with seeds of different character.

It is a native of Turkestan where it occurs in the provinces of Samarkand, Syrdaja and Kuldscha.

Juniperus zoidamensis, Komarov.

A tree 30-40 ft. high. *Branches* spreading or pendulous. *Branchlets* slender and crowded. *Leaves* scale-like, closely appressed, oblong or elliptical, bluntish, grey green, with linear glands. *Cones* reddish-yellow or reddish-brown. *Seeds* almost spherical, up to about ⅛ in. broad, strongly wrinkled.

This species is very similar to *J. Przewalskii*, but differs in its appressed leaves and smaller wrinkled seeds. It is found in Asia on mountains south of the Kuku-nor.

Larix europæa, DC. (L. decidua Mill.)

Attention has recently been directed to three geographical forms of this species which occur outside the main European larch area. They are from Polonia, Carpathia and Silesia respectively and have been referred to as var. *polonica*, var. *carpathica* and var. *silesica*. The late Professor Henry gave careful attention to these forms and in a letter to one of us in 1928, he said that "they can only be regarded as geographical forms" and that there "is no material difference between any of them and typical common larch." Raciborski went so far as to describe the Polonian form as a species under the name of *L. polonica*, but Henry points out that the characters he describes are not constant.

Var. **pendula**, Lawson.

WEEPING LARCH.

A tree with an erect leader, the branches spreading or ascending, the branchlets slender, elongated and pendulous.

Libocedrus formosana, Florin.

In this species the *sterile branchlets* are more slender than in *L. macrolepsis* and it has often shorter leaves, about $\frac{1}{12}$ in. long. The *fertile branchlets* are shorter than those of *L. macrolepis* with leaves similar to those found on the sterile branchlets. The *flower cones* are also smaller, the male inflorescence being about ⅕ in. long with 16–18 stamens, each with 2–3 pollen sacs. The *cones* are up to ¾ in. long and the *seeds* are about ⅕ in. long.

It is a native of Cent. and W. Formosa up to about 1,300 ft. altitude.

Microbiota.

A genus of uncertain position with one species in Eastern Siberia.

Flowers dioecious. Female inflorescence terminal on short branchlets, spherical or ovate with 2–4 coriaceous scales united above and forming a cup. *Cones* spreading horizontally, open at maturity with hardened, or almost woody scales. *Seeds* solitary, elliptical, not winged, erect.

Microbiota resembles the section *Sabina* of *Juniperus* in the twigs and *Thuya orientalis* in the cones.

Microbiota decussata, Komarov.

A densely branched shrub of dwarf habit with flattened branchlets. *Leaves* opposite, scale-like, acute. *Cones* about $\frac{3}{10}$ in. broad and $\frac{1}{10}$ in. long open at maturity.

Abundant in the river valley of the Sutschan in the province of Primorskaja east of Vladivostock.

Picea Moseri, Masters.[1]

This hybrid spruce was raised in France sometime prior to 1900, by M. Moser, who crossed *P. jezoensis* with *P. Mariana* (*nigra*), var. *Doumetii*. It has smooth branchlets, and quadrangular leaves which are slightly compressed, glaucous above and green beneath, $\frac{1}{2}$–$\frac{3}{4}$ in. long with an acute apex. Descriptions and figures are given in the following works.

Pinus Amamiana, Koidzu.

P. Armandi, Wilson (non Franchet).

A species allied to *P. Armandi* but differing from it in the black branches, with rigid leaves only about half the length of that species, or about 2 ins. long. *Cones* ovoid, much shorter than those of *P. Armandi*, on a peduncle about 1 cm. long. *Seeds* also shorter $\frac{2}{5}$ in. long by $\frac{2}{5}$ in. broad.

It is found in Japan on the islands of Tanagashima and Yakushima (Province of Oshumis).

Pinus Krempfii, Lecomte.[2]

A tall tree with smooth bark. *Leaves* in pairs up to about $1\frac{1}{2}$ in. long and $\frac{1}{10}$ in. broad, leaf sheath wanting, stomata numerous on the upper surface very few below, resin canals eight, two under the upper epidermis and six near the lower surface.

[1] *Journ. of the Roy. Hort. Soc., London*, xxvi., 1901, pp. 102–104.
[2] *Revue Hort. France*, 1902, p.164.

Cones ovoid, up to 2 in. long and 1½ in. in diameter with scales up to ¾ in. long, thickened at the apex and provided with a dorsal umbo. *Seed* with a wing about $\frac{3}{10}$ in. long.

This species was found in Annam on mountains of the Nhatrang region at about 4,000 ft. elevation. It is chiefly distinguished by the unusual width of the leaves and the absence of basal sheaths to the leaf clusters.

Pinus Schwerinii, Fitschen.

P. excelsa × Strobus.

A tree similar to *P. excelsa* in habit. *Branchlets* stout, green at first but becoming brownish green with age, glaucous, densely pubescent with short hairs. *Buds* cylindric—conic, ¼ in. long, with an acuminate apex, very resinous, with yellowish red to brown scales. *Leaves* slender, flaccid, pendulous, 3–5 in. long, with 3–4 prominent lines of stomata on the inner side. *Cones* straight or slightly curved, 3–6 in. long and about 1¾ in. in diameter on a stalk up to an inch long. *Scales* slightly convex and faintly striated longitudinally.

A tree 26 years old is growing among trees of *P. Strobus* on the estate of Dr. Graf von Schwerin at Wendisch-Wilmersdorf near Berlin. It was obtained from a local nursery, but the origin of the seed is unknown.

P. Schwerinii resembles *P. excelsa* in the glaucous shoots, the resinous acuminate, terminal buds, the pendulous leaves and the concave scales of the cones, whilst the pubescence of the shoots, the colour of the buds, the shorter leaves, and especially the shape of the cones re-call *P. Strobus*.

Pseudotsuga Douglasii, var. candida, Henry.

A sport with shining silvery-white foliage which was discovered in a shelter belt at Waterford, Ireland. The whiteness of the leaves is most conspicuous on current year's shoots and lasts throughout the first season to the end of autumn. During winter the leaves assume a greenish tinge which goes on increasing in depth until the second season.

Tsuga.

Miss Dorothy G. Downie has recently described four new species of *Tsuga*.—*T. calcarea*, *T. Forrestii*, *T. patens* and *T. Wardii*, based on material collected in Hupeh and Yunnan, which appear to us to be mere forms of the variable *T. chinensis*, and a fifth species *T. dura*, also from Yunnan, does not appear to be specifically distinct from *T. yunnanensis*.

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